The Water Governance System of Spain

two thousand years of safe and efficient planning and management of water resources

contents

1 THE WATER GOVERNANCE SYSTEM OF SPAIN: PLANNING, MANAGEMENT, EFFICIENCY, AND SAFETY

The guarantee of a water supply with sufficient quality and quantity is vital for the development of society and to fight poverty and illnesses anywhere in the world. In other words, **water is life, health, and energy**, or put another way, the lack of water is factor that limits the quality of life and progress in countries.

Today, the guarantee of this vital resource is threatened by phenomena such as population growth, increased demand for food production and energy, more limited availability due to the adverse effects of climate change, lower quality of the available water resources, conflicts associated with access to water in shared river basins, or extreme meteorological phenomena such as drought and floods.

The existence of a water management and planning system that guarantees the supply with sufficient quality and quantity is essential to ensure the effective development of a society and its economy and to offer high levels of security, minimizing the risk of failures in any of the components of the system.

Water management systems in the 21st century must not only be effective in order to provide this guaranteed supply and therefore effectively provide what has been referred to as "water security". They must also be sustainable so that in order to allow Governments and their societies to provide effective and balanced coverage of the economic, social, and environmental objectives associated with all growth models. Due to its transversal nature, water plays a **fundamental role in all sustainable development models**, because the guarantee of this resource is a necessary condition for economic progress, for social development, and for the conservation of our habitats and ecosystems.

In countries and regions that suffer a chronic shortage of the resource, as is the case of Mediterranean countries, the implementation of a sustainable and effective water management system is more complex, and also more necessary. This is the case of Spain, a country that combines chronic shortage with irregularity of precipitation. However, **Spain's water governance system is an example of success**, an example of the capacity to adapt to the environment using a governance system based on **planning, public participation, and technological development and innovation**. This system has made it possible, for more than 2,000 years, to guarantee the security of the water supply. A model in continuous adaptation to respond to the challenges presented by the 21st century and that continues to allow Spain's economy, society, and environment to provide an effective response and solid guarantee to the challenge of water scarcity and flood management.

Spain's water management system brings together the **common efforts of Public Administrations and private enterprises**, and it has been and continues to be a source of inspiration for other countries, in the Mediterranean region as well as in other areas that face similar water management challenges. The Spanish government is also **firmly committed to the international community in regard to water**, and with its goal of reducing the proportion of people who lack access to drinking water and sewage by 2015; a commitment to the basic human right of access to water and sewage that has been recognized by the UN and a commitment to the peaceful solution of cross-border conflicts, many of which are the result of disputes regarding the distribution of shared water resources.

The Spanish government is actively working to honour these commitments through its policies to promote development and bilateral and multilateral technical cooperation in Latin America as well as in the Mediterranean, and in other regions of the world in which the Spanish water management system could be a useful point of reference. Likewise, the Government has given its firmest support to the Spanish production sector to take advantage of the know-how of Spanish companies involved in the water sector, through the promotion of the **Spain Water Mark**.

2 WATER GOVERNANCE IN SPAIN: A SUCCESS STORY IN ADAPTATION TO SCARCITY

Spain's history and its evolution over the course of centuries cannot be separated from the work carried out by early civilizations up to modern times to more effectively manage water, ensuring the supply as a necessary condition for development.

The Romans and Arabs were the first to design large-scale infrastructure to bring water to population centres and fields, realizing, even then, that the available water resources were insufficient to cover the needs of the few thousand inhabitants who populated the country at that time.

Today, we can still see the remains of those monumental infrastructures as we walk through our cities. To give just a few examples; first, Rome, with its dams, fountains, sewers, and aqueducts, the most famous and frequently-visited of which is the aqueduct of Segovia; and as for Arabic Spain, with its refinement, culture, and especially the innovations introduced into irrigation farming, such as the *Acequia Real del Júcar* (Júcar Irrigation Channel), the Arrayanes pool or the Aljafería pool (Zaragoza).

Spain has also inherited the laws and agreements of these civilizations. The Contrebia Belaisca Plaques (Botorrita, Aragón) dating to the 1st century BC, is the first documented lawsuit over the channelling of water in the Iberian peninsula, not to mention the Valencia Water Court, a thousand-year old institution that has successfully withstood the test of time and history.

Al-Andalus gave us techniques that have served as a model for the collection and transport of water such as qanats that were applied in Madrid and in Crevillente (Alicante). And leaping forward in time, in the 18th century, the Enlightenment intellectuals were pioneers in the construction of large canals that could be used not only for irrigation, but also as new navigable routes for people and goods, such as the Castilla Canal, or the Imperial Canal of Aragón.

These advances were used almost until the end of the 19th century, when the implementation of a ground-breaking water policy for the time acted as one of the crucial factors that made it possible, over the span of just one century, for the population to increase six-fold, agriculture to open its doors to markets, and for new industries to take root, translating into an increase in consumption and the transformation of Spain into a modern society.

Thanks to **Spain's well-designed water policy**, over the course of the 20th century, the amount of irrigated crop land increased from 900,000 to 3,400,000 hectares, and from 200 MW of hydroelectric power to 17,000 MW, from 296 km of canals, to tens of thousands of kilometres of canals, and from 57 large dams to more than 1,200, with urban water consumption increasing from 10 litres per inhabitant per day, to 300 l/inhabitant per day. A revolution that was the result of an innovative model based on management by hydrographic river basins rather than by territories, which took into account the necessary protection of our environment and an incipient model of sustainability from the very start.

As a result, Spain is, and continues to be, **a paradigm in man's fight to use water resources responsibly**. The marked irregularity of these resources in space and time has made it necessary to develop significant and on-going actions to put water at the service of the population and sustainable development.

3 THE RESPONSE BY SPAIN'S WATER SYSTEM TO THE CHALLENGES OF THE 21ST CENTURY

Spain's water governance system approaches the new challenges posed in the 21st century –increased water demand, decreased availability of water resources, increased quality standards– from water-resource planning according to river basin districts. It is within this planning framework that the new demands and available resources are studied and the actions that must be carried out our planned and prioritized: from increasing the regulation of rivers, taking into account the effects of climate change, to intensifying the actions to incorporate new, unconventional resources into the water cycle (such as desalination, regeneration, or reutilization). This planning is also where the measures to improve water quality are programmed, to guarantee the health of aquatic ecosystems and their associated services, ensuring the balance between the pressures generated by the uses of the water and the correct functioning of water resources.

This planning also provides the framework for the **integration of actions aimed at the management of extreme meteorological phenomena** – the droughts and floods, which are so typical in Mediterranean climates – and one of the principal threats to both the security of the water supply as well as the safety of property and people, through Special Plans for the management of droughts and floods that are covered in the Plans.

Spain's hydrology, in figures	
Surface area	509.000 km²
Average annual precipitation	649 mm
Average annual precipitation Vigo (Northwest Spain)	1.909 mm
Average annual precipitation Almería (Southeast Spain)	196 mm
Average annual runoff	220 mm
Average annual runoff of the Cantabrian coast (Northern Spain)	700 mm/year
Average annual runoff of the Segura district (Southeast Spain)	<50 mm

And just as importantly, the planning also serves to **coordinate different public development policies**, from agriculture to land organization, and including energy planning, industry, and tourism.

In a country such as Spain, in which agricultural use is very significant, and in which the satisfaction of the demands must be combined with efficient use of a scarce resource, it is essential to guarantee the supply for agricultural uses. This responsible usage, along with the **modernization of crop irrigation**, has become one of the identifying traits of the Spanish Water Management System, as a successful example in the fight to guarantee food safety and to strengthen the competitiveness of the fruit-vegetable industry as a vigorous sector that provides high added value to Spain's exports.

A system that combines the measures to manage demand with the measures to manage the supply, emphasizing the efficient use of the resource as a guarantee for the implementation of a sustainable model that is effective to guarantee the supply for all uses in all parts of the country, and that is environmentally friendly in accordance with the most stringent requirements of European legislation in the area of water and the environment. A system that also complies with the international agreements signed with the countries with which we share water, such as France and Portugal.

Spain's water governance system is based on the integrated management of water resources – with hydrographic river basins as the areas of action – on the management unit of the river basin, and on the existence of Hydrographic Confederations.

It is also supported on the fact that the structural measures (dams, reservoirs, desalination plants, water transfers, etc.) and non-structural measures (management systems, information systems, and communication systems, etc.) are proposed within the joint framework of integration of actions in the river basin, defined in the Hydrological Plans of each river basin district, as well as in the National Hydrological Plan. A series of plans which also include other measures such as the coordinated use of surface water, desalination water, and utilized water, as well as the management of water (demand) and the actions to be implemented (supply).

In turn, the System is governed by an extensive and highly developed regulatory framework that gives the system the necessary legal coverage and guarantees of public participation. And it is also important to highlight that the Spanish Water Governance system is built on a strong and long-standing tradition of public participation (User Communities), which makes the responsibility for the management and protection and conservation of bodies of water a task that is shared between users and administrations. It is a management system that is derived from the idea of bodies of water as property of the public domain, whose use is subject to prior administrative control governed by Law, as a guarantee of legal security in the administrative traffic. A set of principles of governance drawn from European and national legislation forms part of this legal framework.

None of this would be possible if the Spanish system were not **supported on a series of technologies in which Spain is a world leader**, and on the fact that Spain has a set of hydraulic infrastructures that support not only the guarantee of the water supply but also the management of risks such as droughts and floods – exacerbated by climate change – as well as the achievement of environmental objectives, including the provision of ecological flows, etc.

Consequently, the spanish water governance system includes tools that make it possible to provide adequate and modern management of natural, engineering, anthropic, and technological risks that are inherent in large-scale hydraulic infrastructure, with a special focus on the reduction of the impact of climate change as one of the main sources of natural risks. A model of governance that remotes sustainability of investments and transparency in decision-making.

4 CATALOGUE OF CAPACITIES AND SERVICES

Together with this document, a catalogue has been developed that describes the capacities and services that define the Spanish water governance system, which make it an effective and solid solution to face the challenge of water scarcity and the problems associated with it. The catalogue groups these capacities into four groups: water-resource planning, sustainable management, service efficiency, and security for citizens. Four groups that describe a **system of good governance, with a high level of technology and innovation**, built on complex in modern infrastructure systems.

The full catalogue is available at

http://www.magrama.gob.es/es/agua/temas/sistema-espaniol-gestion-agua/

4.1. WATER-RESOURCE PLANNING

The development of the Spanish Water Management System began in the early 20th century with water-resource planning as the most effective tool for the efficient and **fair distribution of the available water resources**, and for the identification of measures to make it possible to carry out that distribution sustainably, from the economic, social, and environmental points of view. This planning, which initially consisted of a simple list of works (1902), would later (1930s) incorporate multidisciplinary studies for the use of water resources for supply, as well as for the development of irrigation farming, industry, and energy production.

The Ebro Hydrographic Confederation has the honour of being the first to be created, also by Royal Decree dated 5 March 1926, making it the first River Basin Entity created in the world.

At the time it was established, the idea that the development of an active water policy was necessary had already taken root in Spain, with the approval of the first National Hydraulic Works Plan in 1902 and the organization of the National Irrigation Congresses. The Organizational Commission of the Confederation, directed by Manuel Lorenzo Pardo, played an important role in increasing awareness, which resulted, and less than two years, with the inclusion of 1,875 corporations, associations, and entities in its Assembly.

They soon pushed forward with the plans for works in the execution of projects. Initially, the principal objective was to create irrigated farmland as a guarantee of the food supply of a country that had been decimated by famine as a result of recurring droughts. Industrial development led to the development of hydroelectric power generation, which is still an important part of Spain's electricity mix. During the 1960s and 70s, the Confederations were given the goal of managing water to improve quality of life. During this time, numerous supply and drainage installations were built in towns and cities.

Recent decades have been marked by the increasing complexity of water management, within the framework of a decentralized Spain, and with the help of sophisticated hydrologic information and pollution prevention systems. The current challenge is to comply with the European Union's Water Framework Directive, which requires the achievement of good ecological conditions of water by the year 2015, while at the same time satisfying water demands much more efficiently.

The river-basin management model was later adopted by different countries, and is currently in force in the European Union.

The Ebro Hydrographic Confederation was established in 1926. The idea was the development of the river basin based on water; for this reason, the Confederation was made up of hydraulic, civil, mechanical, electrical, agricultural, and forestry engineers. And always with the participation of the users. Infrastructure was developed for supply and drainage, irrigation, hydroelectric generation, forestry uses, etc.

The river-basin management model was later adopted by different countries, and is currently in force in the European Union.

This water-resource planning, which incorporates the participation of users and the administrations involved as one of the guiding principles of governance, used management by river basin districts as the reference unit. This Spanish innovation took the form, organizationally, of the Ebro Hydrographic Confederation, which dates back to 1926 and was the first entity of this type created in Spain.

The model of water-resource planning based on river basin districts therefore replaced the political territorial division model, which did not and does not coincide with the management unit of the waterway, its affluents, tributaries, and the territories that are dependent upon or associated with the resource in the river basin as a whole. Water-resource planning based on river basin districts was formally instituted in the Water Act of 1985 (ley de Aguas de 1985), with the European Union adopting it for Europe as a whole with the establishment of the Water Framework Directive.

Water-resource planning is, also, the framework that is best suited to respond to the assignment of resources, because the gestation and execution of actions to make water available to users takes a long time, not only because it is necessary to involve the different administrations, users, and social agents in the management of water, but also because it is necessary to prioritize investments to effectively and efficiently use the available resources.

For 30 years, and with the purpose of strengthening the legal security of the Spanish Water Management System, Spain's water-resource planning has had regulatory force and character, supported on two main pillars: public participation, expression of the inclusive nature of the decision-making process, on one hand, and technical rigour, as a guarantee that the plan is correct and suited to the physical, economic, social, and environmental reality of each region.

Water-resource solutions that go beyond the scope of a river basin are covered within the larger framework of national water-resource planning, through Laws, as this is the proper space for addressing all those measures that affect more than one region, which include water transfers between river basins.

From the point of view of supply, the Spanish water management system addresses the two factors that may explain the shortage of water: first, that the lack of infrastructure makes it impossible to make the water available to users which is technically, economically, and environmentally possible, and secondly that even if all possible water were available, there are more existing or expected users than the resource to be used.

Water-resource planning therefore identifies the actions that allow better management of the supply, in any of its facets (increased regulation of surface water, use of underground water, and increased joint usage with surface water, reutilization, desalination) so that when technically and environmentally feasible, the availability of water is assured for the potential users – particularly for those with lower economic capacity – and, in addition, for the environment associated with the water ecosystems.

Water-resource planning therefore combines the management of the supply with the management of the demand in an integrated manner that promotes the economically efficient, environmentally acceptable usage of the resource that satisfies the demands that promote the necessary socio-economic activity in the different territorial spaces.

Today, river-basin plans place special emphasis on achieving good condition of the water, in order to ensure long-term sustainability of the use of water resources and, consequently, solidarity with future generations. In this sense, the Strategic Environmental Evaluation of the plans guarantees that all of the actions that are planned and carried out from a perspective that respects the environment, water quality, and sustainability.

The general objectives of **water-resource planning** are to achieve good water conditions and adequately protect the public domain water resources, satisfy water demands, balance and harmonize regional and sector development, increasing the availability of the resource, protecting its quality, reducing the cost of its use, and rationalizing its uses in harmony with the environment and other natural resources, guided by the criteria of sustainability and water use, through integrated management and long-term protection of water resources. Likewise, water-resource planning must help to alleviate the effects of floods and droughts.

An important milestone in the process was the preparation of the White Paper on Water in Spain (2000. MIMAM), because it constitutes a vital foundation for water management, especially in the planning process

The incorporation of European Parliament and Council Directive 2000/60/EC, dated 23 October 2000, establishing a European Community framework in the area of water policy, hereinafter referred to as the Water Framework Directive (WFD), adds a new focus to the traditional focus of satisfying demand, that is aimed at achieving good ecological conditions in all bodies of water. The WFD makes it possible to define a series of uniform environmental goals among Member States for masses of water and to progress together in the achievement of those goals. To facilitate compliance with the deadlines for the implementation of the WFD for Member States, the Common Implementation Strategy, which is coordinated by the Directors-General for Water, was developed.

The information included in the catalogue describing the following capacities and services associated to water planning include:

- **1.0.** Water-resource planning
- **1.1.** Management of Hydrological Information
- **1.2.** Complex computer models in water-resource planning
- **1.3.** System for the evaluation of the conditions of bodies of water
- **1.4.** Systems for the economic evaluation of projects and recovery of costs
- **1.5.** Water-energy relationship
- **1.6.** Establishment of ecological flow regimes
- **1.7.** Transfer of resources between river basins. The Tajo-Segura case
- **1.8.** Planning in the management of river basins, land organization, and agricultural-hydrological and forest restoration
- **1.9.** Spatial information systems as support to water resource planning and public participation
- **1.10.** Consulting regarding the management of water resources and adaptation to climate change
- **1.11.** Water accounts
- **1.12.** Water management in cross-border river basins
- **1.13.** Training and transfer of know-how

4.2. SUSTAINABLE MANAGEMENT

The Spanish Water Management System, to guarantee adequate sustainable management of water, is based on what has come to be referred to as "GIRH", *gestión integrada de recursos hídricos* or integrated management of water resources, a concept which has been accepted worldwide as the way to promote **coordinated handling and development of water, the earth, and the related resources**, in order to maximize the resulting social and economic welfare fairly, without compromising the sustainability of vital ecosystems.

The management of water in Spain is based on a single hydrological cycle and that all continental waters, regardless of their origin, have the same legal consideration. Water is a public resource and falls within what we call the Public Domain Water Resources. Since it is a public resource, the ownership of which is always exercised by the Public Administration, access to water is **regulated by law** which determines which uses are freely accessible and which uses must be obtained through the granting of some type of authorization or license. Consequently, what are uses are classified into the following categories under **the legislation in effect**:

- **Common uses:** this may be general uses (directly in natural waterways to drink, bathe, water livestock, etc.). Governed by the principles of freedom, gratuity, and inequality, for which no type of administrative authorization is required, or *special uses* (navigation, etc.). Which involve special circumstances of hazardous nest or intensity of usage, which may affect the proper conservation of the public water domain, and for this reason, the aforementioned principles do not apply and these uses therefore require administrative authorization.
- **Private uses:** those uses that could potentially **limit or exclude usage by others**, whether involving consumption or not, of the public water domain (water supply to towns, irrigation, hydroelectric plants, etc.).

According to Spanish law, in order to be able to use water, a special permit from the competent Administration is therefore required. The special permit is defined in the Water act and is called an **administrative concession**. The administrative concession is therefore the **title that legitimated the use of surface water or ground water**.

The legal titles that allowed the use of water and the characteristics of the water usage, are therefore administrative concessions that are recorded in the Water Registry, and which are the fundamental tool for the management of the resource, providing transparency and public availability of the knowledge of those uses, and which are essential to properly exercised the control and inspection functions of the public water domain.

The Water Registry was established in 1901. Its current operation, with the legal security requirements that correspond to Registry activities, was defined in the Water Act of 1985, with the computerization of the registry regulated in 2013. The Water Registry is the fundamental tool for the preparation of statistics regarding the legally committed resources, by providing an official record of the existence, status, and conditions of the water uses; it promotes legal security by creating a medium to provide evidence of and protection to the uses recorded in it; and at the same time, provides a detailed knowledge of the volume of water committed and its use, and makes it possible to accurately determine whether the current water usage is efficient, rational, and sustainable. It also makes it possible to determine whether and where available resources exist to allow the creation or expansion of production processes and to guarantee the sustainability of consolidated uses, which are understood to be those uses that generate socio-economic stability and social welfare through effective water usage.

In regard to water quality, the system is based on the basic management tool of the National Census of Effluents, the instrument which makes it possible to ensure that effluents are properly carried to the waters that are subject to the obtaining of the corresponding authorization. The data on effluents and their corresponding conditioning factors is included in the National Census of Effluents, a computerized database that is essential for monitoring and control.

One of the fundamental aspects in water management is monitoring, supervision, and control of levels of quantity and quality of the water, and of the activities that could potentially cause pollution or degradation of water resources in the public domain. In terms of quantity, the ROEA (*red oficial de estaciones de aforo* or official network of metering stations) has been in operation since 1912. This network, which is based on manual measurement devices, provides information on the circulating flows, and has been expanded since the 1980s with computerized networks such as the SAIH (*sistema automático de información hidrológica*, or automatic hydrological information system), a real-time alert system for the prevention and management of floods

Water quality is controlled through water monitoring programs:

i) programs to monitor the condition and protected zones defined in accordance with the obligations contained in the Water Framework Directive and transferred to national law through the Water Act, whose purpose is to monitor the chemical and ecological condi-

tion of surface water and the chemical and quantitative status of groundwater; likewise, the quality of water in protected areas is also monitored, including: water intended to supply cities and towns, water affected by agricultural nitrates, areas that are sensitive to nutrients of urban origin, and bathing areas;

ii) SAICA (sistema automático de información de calidad de las aguas or automatic water quality information system) a real-time computerized water-quality alert and measurement system.

The programs to monitor water condition are defined in accordance with the obligations established in the regulations in effect and are intended to monitor the chemical and ecological conditions of surface water and the chemical and quantitative conditions of groundwater. Likewise, the quality of water in protected areas is also monitored, including: water intended to supply cities and towns, water affected by agricultural nitrates, areas that are sensitive to nutrients of urban origin, and bathing areas. This information requires the collection of field samples and later laboratory analysis, with varying frequency depending on whether the samples are of water (monthly), sediment (annual), or biota (every two or three years).

Comunidades de Regantes or Irrigation Communities are thousand-year-old institutions with a long historical tradition, created from the start to facilitate fair distribution of water and well-organized crop irrigation. The first period in the history of irrigated farming in Spain goes back to Pre-History and the Age of Antiquity, although its origins are hard to pinpoint, and varies for the different hydrographic river basins.

Likewise, the organization of Irrigation Communities is not well defined in our Historical Law, because they were governed by rules dictated by the Romans and Arabs. The rules for the distribution of water for irrigation were based on customary law, on habits that would eventually be translated into written ordinances.

Today, the legal framework on which the Irrigation Communities is based is the Water Act that is currently in force, which establishes their basic structure and powers. The first Water Act dates back to 1866, and the most recent went into effect in August 1985, has been reformed recently. In Spain, since ancient times, the Irrigation Communities have been given different names (Water Courts, Irrigation Unions, Water Councils, Central User Councils, etc.)

Today, the term Irrigation Communities refers to the groups of all of the landowners in an irrigable zone, who are obliged by law to assemble for the common, autonomous, non-profit administration of the public waters. These Communities have their own legal entity; they are Corporations of Public Law and are classified as part of the Public Administration.

The figure of the Irrigation Community is strengthened by the Administration itself, because it not only recognizes the existing Communities, but also requires future users who use the common water to form an Irrigation Community. As a result, most of Spain's irrigated farmland is integrated into these groups, which pay a vital role in the proper use and management of the water, in order to guarantee coverage of water demands. According to the National Irrigation Plan - Horizon 2008, published by the Ministry of Agriculture, Fishing, and Food, in 2001 there were 7,196 Irrigation Communities in Spain.

Source: www.fenacore.org

Lastly, Spain has been carrying out a series of actions as part of the "National River Restoration Strategy" to **prevent deterioration in bodies of water and gradually improve their ecological conditions**. The Strategy includes the Programme for the Conservation of Public Domain Water Resources (small actions for the improvement of waterways and to reduce damage caused by floods), the River Restoration and Rehabilitation Programme (larger-scale projects), the River Volunteer Programme (to involve citizens in the management of rivers) and the R&D&I programme in this area. The Programmes also include actions that are aimed at improving the training of the civil servants and technical staff involved.

The **Valencia Water Court** is the oldest legal institution existing in Europe. Although there were some legal institutions that resolved conflicts over water in the lands of Valencia in the times of the Romans, the organization that we have inherited dates to the times of Al-Andalus, and quite possibly to the period of the Caliphate of Cordoba, perfected following the conquest of the Kingdom of Valencia by King James I.

The Irrigation Communities are governed by ancient Ordinances, handed down orally since the times of the Arabs, and written down at the start of the 18thcentury. An administrative Board, elected democratically from among all of the members of the Community, along with the chairman-union head of the Community, ensure strict compliance with the regulations. All of these people must be direct workers and farmers of their lands, with a known reputation as "honourable men, Law scholars from all parts of the world have found a model for legal functioning in our Institution, as demonstrated in the number of water-related topics covered in different international forums and associations: "Water for Peace" (Washington, 1967); creation of the "International Association for Water Law", March 1968; "International Conference on Water Rights in the World" (Valencia, 1975-Caracas, 1976); approval of what we could call the "Magna Carta of Water in the world" (Mar del Plata, Argentina, 1977); and, more recently, the conference "Water management in the 21st century", held at the Lonja de Valencia, in December 1997, as part of the variety of activities of the Valencia III Milenio foundation.

Source: www.tribunaldelasaguas.org

The information included in the catalogue describes the following capacities and services associated to sustainable management:

- **2.0.** Management and water administration
- **2.1.** Computerized registries of water rights
- **2.2.** Systems for control of pressure on bodies of water
- **2.3.** Networks for monitoring the state of bodies of surface water
- **2.4.** SAICA alert network
- **2.5.** Networks for monitoring the state of bodies of ground-water
- **2.6.** Drought management plans
- **2.7.** Marking of boundaries of public domain water resources
- **2.8.** Environmental restoration measures in rivers and reservoirs contaminated by anthropic activities
- **2.9.** Integrated environmental restoration measures and green infrastructure
- **2.10.** ERHIN Programme

4.3. SERVICE EFFECTIVENESS

Water, as an essential element for life, must be made available to all people and to society as a whole. In this sense, in a country like Spain, the effectiveness of the service is a basic premise that guides actions to achieve the basic objectives covered in the water management and planning; and doing it efficiently, in other words, **making the best use of the available resource without reducing the security of the supply**.

Some of the capacities and services that form part of this block include the following:

1. Collection and regulation of water (surface and groundwater): When nature, due to its irregularity over time, fails to provide the water that is necessary for sustainable development, regulation works must be carried out (reservoirs and pools) to store water when it is available, and collection works in aquifers, which have a much greater degree of hydrological inertia.

Spain's **long history of dam construction is well known**. This construction process began in Roman times (the Inventory of Great Dams began with the Cornalbo and Proserpina dams in the 2nd century AD) and has been marked by technological milestones, such as the Almansa arch dam, whose origins remain unknown, and many others (Elche, Elda, Ontígola, Relleu, Alcantarilla, Gasco,...), without leaving out Spain's activity in its overseas colonies. It is important to note that the construction of dams and irrigation land extended from Mexico to Texas and California, as demonstrated by the small dams constructed around San Antonio, and El Molino and La Misión, near San Diego and Los Angeles, respectively.

Guaranteeing the availability of water in sufficient quantities and with adequate quality, will be one of the principal problems for the planet that will have to be solved in this century. More efficient use of the resource is achieved through savings techniques, management of demand, of reuse, of combined use of surface and groundwater, etc., and the use of unconventional techniques (desalination) are increasingly among the preferred courses of action for the management of this resource, which is as scarce as it is prized. However, the construction of new dams will undoubtedly continue to be necessary, along with the optimization of the operations of existing reservoirs.

In this sense, **the harmonization of these infrastructures with the environment**, as well as adequate levels of safety will be aspects that are increasingly demanded by society.

As a result of the long-standing dam-construction activity in Spain, the number of reservoirs has increased considerably, in addition to the age of a large number of them.

There are currently more than 1,200 dams with an approximate capacity of 56,000 hm³. Of these, 450 were constructed prior to 1960, and more than 100 before 1915.

2. Drinking water treatment: To ensure proper water quality and guarantee the health of consumers, raw water must be adequately monitored and treated.

3. Desalination: In a country with scant precipitation, it is necessary to incorporate unconventional water resources to cover the demand. In islands and near coastlines, desalination of seawater or brackish water provide access to large quantities of the resource, and thanks to improvements in technology, it is becoming more economically competitive.

The unique characteristics of the Canary Islands for obtaining water have been created over the course of centuries, as their inhabitants faced the deficient supply that up until quite recently conditioned the development of the islands. The popular culture for water use, inherited generation after generation since the time of the first native inhabitants, is what makes the Canary Islands an example for the rest of the world in regard to water management.

The use and distribution of groundwater has been elevated to an art form and has been exported to many other places on the planet. The technical precision of the reservoirs and dams, many located in unlikely areas, maximizes the use of surface runoff. And the economy of the islands with the most notable shortages is supported on desalination, which has been used in the Canary Islands for more than three decades. In recent years, thanks to research and experimentation, the islands have moved to the forefront in the field of reutilization worldwide, with their economic future depending to a large extent on this.

Desalination

The first seawater desalination plant in the Canary Islands and in Spain was constructed on the island of Lanzarote in 1964. It produced 2,500 m^3/day of drinking water using the M.S.F (Multi-Stage Flash distillation) process.

The efforts by the different public administrations and private initiatives have increased current production to 588,057 m^3/day in all of the islands. The economic growth experienced in the islands to the east would never have occurred without seawater desalination. Thanks to this technology, water is no longer a limiting factor hindering development.

According the Government of the Canary Islands, desalination production in 2012 was 188.0 Hm^3. The most important current figures for desalination are as follows:

Desalination

	Nº Desalination	Plants	Private	Production
Tenerife	44	5	36	118.143
Gran Canaria	137	11	126	336.195
Fuerteventura	64	4	60	65.049
Lanzarote	80	0	80	62.570
La Gomera	1	0	1	4.100
El Hierro	4	4	0	2.000
La Palma	0	0	0	0

Source: www.gobcan.es

4. Water transport: Canals, pipelines, and river basin transfers: When nature, due to its irregularity in space, fails to provide the water that is necessary for sustainable development, works must be constructed to carry and transport water, taking the resource from the points where it flows or is stored to the points of water demand.

The Tajo-Segura transfer, providing water to south-east Spain for 35 years

In 2014, the Tajo-Segura transfer turned 35, with more than 11.5 billion litres transferred (11,467 cubic hectometres), or an average of 770 cubic hectometres per year. Spain's largest water project, this transfer connects the headwaters of the Tajo River to the Segura river basin and provides resources for agriculture and supply, which has allowed the agricultural-food and social development of the south-east of Spain (Alicante, Murcia, and Almeria), which is the driest region on the European continent. The canal that connects the two river basin districts is 242 kilometres long and then expands into two main canals, what is known as the post-transfer, to distribute the water within the Segura river basin.

According to recent studies, the transfer has generated an annual contribution to the GDP of 2.36 billion euros and has created more than 100,000 direct jobs. The agricultural sector in this area of Spain is mainly an exporter, which represents an added value for the water sent from the aqueduct, and it has played an important role during the economic recession by continually generating jobs.

The legislative reforms introduced in the new hydrological plans for the Tajo and the Segura, and in the national legislation, guarantee the future operation of this infrastructure, as well as the priority of fulfilment of the demands of the river basin that is providing the water. This infrastructure is considered to be national in scope and is therefore managed by the Government of Spain through the Ministry of Agriculture, Food, and the Environment.

5. Sewerage and waste water treatment: In the integrated water cycle, surplus water that has already been used must be returned to waterways and aquifers through the corresponding drainage and sewerage infrastructure, which also prevents problems with human health. Also, in many cases, this waste water exceeds the self-treatment capacity of the corresponding medium that receives it, which means that is must be treated previously in waste water treatment plants.

6. Regeneration and reutilization of treated water: In a country that is accustomed to water shortages and drought, waste water, rather than a problem, becomes an opportunity to add resources to satisfy the demand for water, with prior regeneration treatment to make it suitable for reuse.

Water treatment and reuse to make the Segura a living river once again

Thanks to the efforts focused on water treatment and reutilization, the Segura River (south-east Spain), in just over 10 years, has gone from being catalogued as the most polluted river in Spain, to having undetectable pollution levels in all of its sections, with an obvious improvement in the environmental condition of the entire river basin.

The Water Treatment and Drainage Plan of the Region of Murcia, undertaken by the Regional Government, was started in 2001 after a study phase in which the European and US water-treatment systems were studied. The total investment in water-treatment infrastructure totalled 635 million euros (co-financed by the European Union) and 47 large waste water treatment plants were built, with a maximum treatment capacity of 540,000 cubic metres per day, 70 percent of the tertiary level. Also, a fee based on the "polluter pays" principle was instituted.

Thanks to these plants, close to 110 cubic hectometres are reused in agriculture directly or indirectly through the Segura River or its tributaries every year, which represents 90 percent of the total treated water. The drastic improvement in water quality has also promoted the recovery of river wildlife, as demonstrated by the return of species such as otter and eels, in even the sections most affected by human construction, downstream from the city of Murcia, as well as the appearance of lagoons associated with the waste water treatment plants that were integrated into the Ramsar international network.

The recovery of the Segura River is an internationally-recognized example of success, published in prestigious industry magazines such as Water XXI or Journal of Water Reuse of the International Water Association (IWA). It has also been chosen by the World Bank as an example to be followed, and its strategies are being applied in the development of a plan for the restoration of the Matanza-Riachuelo River in Argentina.

7. Systems for integrated cycle management and citizen services: In the urban environment, effectiveness translates into the search for a virtuous integrated water cycle, which requires careful management, as well as the application of technology and R&D&I.

Canal de Isabel II Gestión is the company that manages the drinking water supply and sewerage of the Region of Madrid (6.4 million inhabitants).

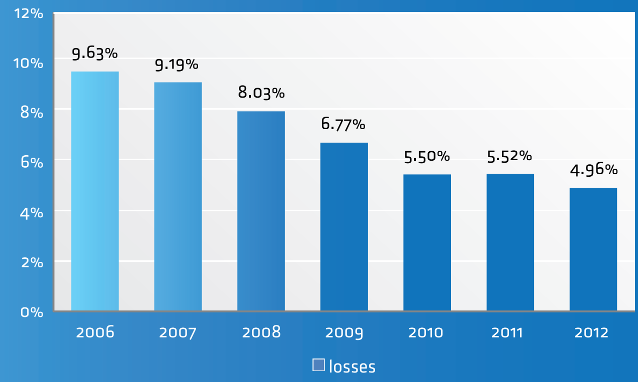
In regard to drinking water, it has 14 reservoirs with a capacity of 945 m^3, 86 drought wells, 13 drinking water treatment plants, 304 tanks, 17,000 km of pipelines, to supply 530 hm^3/year.

In regard to drainage, it manages 12,000 km of collectors and 154 waste water treatment plans, which also treat 100% of the sludge. The total quantity of water treated per year is 490 hm^3.

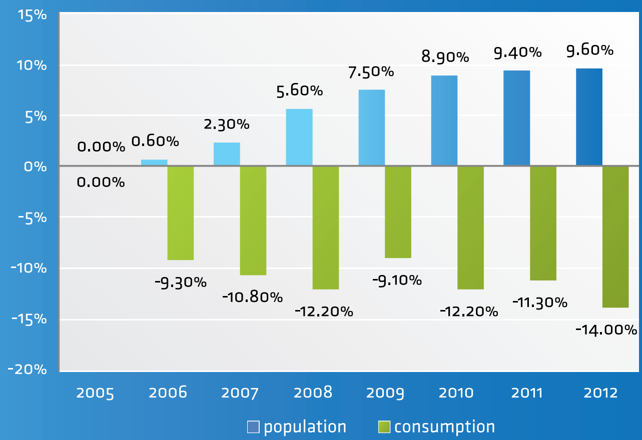
Twenty-five plants treat water for reuse, producing 10 hm^3 per year.

The efforts made over the last few years to improve efficiency have translated into a reduction in annual consumption and extremely low network losses.

NETWORK LOSSES



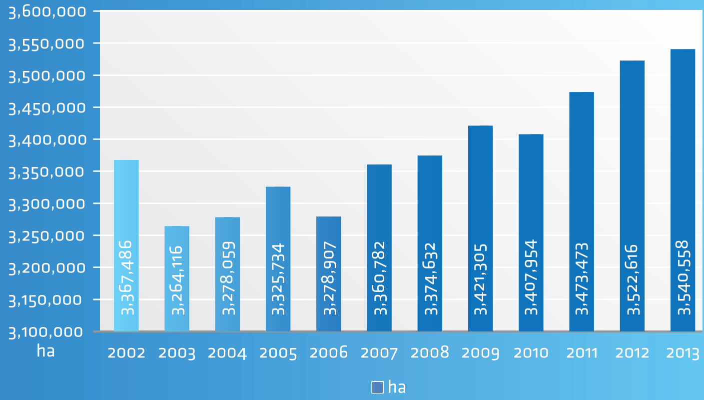
POPULATION INCREASE AND EVOLUTION OF CONSUMPTION



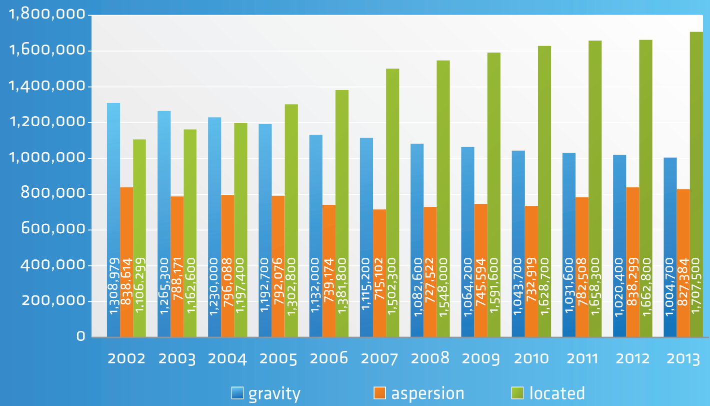
8. Integrated management and modernization of irrigated farmland: In the area of irrigated farmland, one of the sectors that consumes the largest quantity of water worldwide, and also in Spain, technologically-controlled management and modernization actions are associated with improved quality of life of farmers and increased generation of wealth. But they also generate savings and increase the efficient use of water, and above all improve water quality by reducing diffuse contamination caused by the addition of nutrients and pesticides to water.

Over the last 15 years, actions have been taken to modernise close to 1.5 million hectares of irrigated farmland.

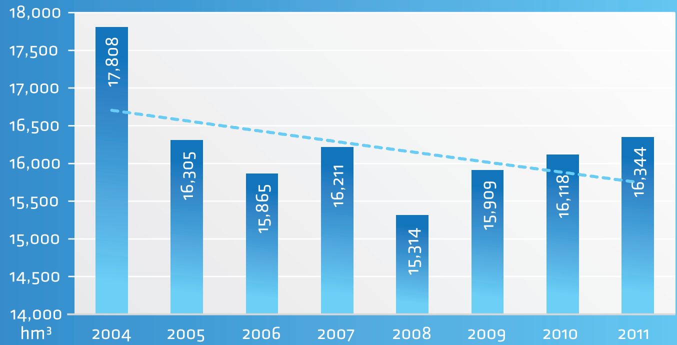
EVOLUTION OF TOTAL IRRIGATED SURFACE AREA. 2002-2013



EVOLUTION OF IRRIGATED SURFACE AREA IN SPAIN BY IRRIGATION TYPE



WATER USE IN THE AGRICULTURAL SECTOR



9. Power generation from water: In addition to the nexus between water and food, one of the most pressing global issues today is the nexus between water and energy. In Spain, one of the vectors of growth has been the water intended for energy uses, which was already present when the river basin organisations were created, with a special focus on hydroelectric plants, including reversible pumping facilities that can balance supply and demand, which makes them especially useful for incorporating renewable energies such as wind and solar.

The Duero River runs through the Region of Castilla y León from east to west, covering more than 700 kilometres, with the final section running through geographic relief that makes it extraordinarily favourable for hydraulic power generation. This route of the waterway, which marks the natural and administrative border between Spain and Portugal, since the first decade of the 20th century has been seen as the ideal location for the installation of the water falls and the installation of electrical power plants. Along the length of these approximately 170 km, the Duero drops more than 560 metres and has a large flow of water due to the contribution of the tributaries at the end (including the Esla River, which accounts for approximately 40% of the total flow of the Duero in the region of Castilla y León).

Along the Duero river basin, a combination of reservoirs, located on different rivers, form the entire system for obtaining electrical power: the Compuerto reservoir (Carrion River), the Santa Teresa, Villagonzalo, and La Almendra reservoirs (Tormes River), the Cernadilla, Valparaiso, Agavanzal reservoirs (Tera River), Ricobayo and Esla reservoirs, Villalcampo, Castro, Aldeadávila and Saucelle reservoirs (Duero River). Of these, the Ricobayo (Esla River, with a capacity of 1,143.3 Hm^3) and the Almendra reservoir (Tormes River, with a capacity of 2,648 Hm^3) are two of the most important.

The Duero System as a whole is designed to exercise the function of regulating the flow of water in the river basin, to generate large reserves that minimise runoff losses, in order to generate a significant amount of energy.

The reservoir contained by the Almendra Dam (provinces of Salamanca and Zamora) on the Tormes River is the largest in the Duero river basin and the third largest in Spain, with a capacity of more than 2,600 Hm^3. The dam is the tallest in Spain and is an impressive work of engineering: an arch dam with double elliptical curvature, more than 200 metres high from its base and more than half a kilometre long at the curved top of the dam. The dam's two curves are flanked by levees. The reservoir is associated with the Villarino Power Plant (Salamanca), built between 1964 and 1970, and located more than 15 km away. The force of the water is exploited through a complex work of engineering consisting of a tunnel 7.5 metres in diameter that carries the reservoir's water to the centre, taking advantage of an elevation difference of more than 400 metres. The plant is equipped with six turbine-pump sets, with more than 800 MW of power and an average production of around 1,000 GWh, achieving a milestone record in 1979 with more than 2,600 GWh.

The Aldeadávila plant and dam (Salamanca) was built between 1952 and 1962 and was expanded in 1986. This is Spain's largest hydroelectric plant, with an output of more than 1,100 MW and annual average production of more than 2,500 GWh.

The information sheets prepared in the catalogue mentioned above describe the following capacities and services associated with the effectiveness of the service:

- **3.1.** Collection and regulation of water (surface and groundwater)
  - 3.1.1. Collection of groundwater: principal and most significant aspects in the design and support of project management
  - 3.1.2. Collection of surface water: principal and most significant aspects in the construction of dams and reservoirs.
  - 3.1.3. Construction and operation of pools for irrigation
- **3.2.** Drinking water treatment
- **3.3.** Desalination
  - 3.3.1. Principal and most significant aspects in the design and support of project management
  - 3.3.2. Principal and most significant aspects in construction
  - 3.3.3. Principal and most significant aspects in the operation, maintenance and repair
- **3.4.** Water transport: canals, pipelines, and river basin transfers
  - 3.4.1. Principal and most significant aspects in the design and support of project management
  - 3.4.2. Principal and most significant aspects in construction
  - 3.4.3. Principal and most significant aspects in the operation, maintenance and repair
- **3.5.** Sewerage and waste water treatment:
  - 3.5.1. Principal and most significant aspects in the design and support of project management
  - 3.5.2. Principal and most significant aspects in construction
  - 3.5.3. Principal and most significant aspects in the operation, maintenance and repair
- **3.6.** Regeneration and reutilization of treated water:
  - 3.6.1. Principal and most significant aspects in the design and support of project management
  - 3.6.2. Principal and most significant aspects in construction
  - 3.6.3. Principal and most significant aspects in the operation, maintenance and repair
- **3.7.** Systems for integrated cycle management and citizen services:
  - 3.7.1. Collection and drinking water treatment
  - 3.7.2. Distribution
  - 3.7.3. Sewerage and urban drainage
  - 3.7.4. Water treatment
  - 3.7.5. Sludge management in waste water treatment
- **3.8.** Management of the integrated cycle of agricultural water
- **3.9.** Integrated management and modernization of irrigated farmland
  - 3.9.1. Principal and most significant aspects in the design and support of project management
  - 3.9.2. Principal and most significant aspects in construction
  - 3.9.3. Principal and most significant aspects in the operation, maintenance and repair
- **3.10.** Power generation from water. Types of hydraulic power plants and elements that comprise them
  - 3.10.1. Mini-plants (capacity less than 10 MW)

4.4. SECURITY FOR CITIZENS

Spain's water management system provides water security, or in other words, the security that the infrastructure in place is sufficient to guarantee adequate water in terms of quantity and quality for each use in all parts of the country. These infrastructures are also able to **respond to extreme weather phenomena, such as floods and drought**, which is another dimension of the security that Spain's Water Management System must provide.

The security of citizens in relation to Water Governance is an aspect that has multiple facets: hydrological security to protect against floods caused by heavy water flow in rivers (determination of possible flood zones), security in the satisfaction of demand (water supply and irrigation) in times of drought, physical security against infrastructure incidents (dams, reservoirs, pipelines).

These situations can be mitigated and even prevented by carrying out risk analyses and studies that make it possible to prioritise and plan the investment required for the upkeep and maintenance of infrastructure and to manage infrastructure in the case of extreme weather phenomena.

A flood defence plan that saves lives in the Segura river basin

The General Flood Defence Plan of the Segura river basin recently demonstrated its effectiveness during the floods of September 2012, known as the Saint Wenceslas floods, when the large dams, lamination levees, and the Automatic Hydrological Information System (SAIH) successfully stopped a virtual tsunami of fresh water in the Guadalentín River and the Rambla de Nogalte, two waterways that sadly are known for their severe flows during periodic episodes of Gota Fría.

In an area such as the Segura river basin (southeast Spain), where floods have caused serious human and material damage over the course of history, the flood defence systems are quite old. However, the existing combination of large dams, lamination and shunting dams and automatic flow control stations was mostly created at the end of the 20th century, with a series of approximately 23 large projects, and it has been improved ever since.

The cyclical floods of the Murcia farmland and the Lower Floodplain of Alicante have not occurred for years, so until 2012, there was no way to know what the response would be to storm phenomena as intense as the tragic Santa Teresa flood of 1973. The positive performance in response to the Saint Wenceslas flood proved that dams "save lives and homes", but even so, it still showed that there is still much to be done. The Segura Hydrographic Confederation has initiated a plan with new measures, which include not only dams and levees, but also the marking of boundaries of occupied creeks and a new expansion of the SAIH to coastal creeks, another point of conflict in the river basin.


S.A.I.H.
Tajo

In regard to flood management, in addition to having the aforementioned SAIH (real-time alert system for flood management) in place in all of the hydrographic regions of Spain, there is a National Cartography System of Floodable Zones (*Sistema Nacional de Cartografía de Zonas Inundables*, SNCZI) that is available on the Ministry's website (where it can be consulted by any interested entity or individual), which specifies the boundaries of the public water domain (easement and supervision zones) in all parts of Spain's hydrographic network. Likewise, in applying the Flood Directive, all of the areas with a significant potential risk of flood (*Áreas de Riesgo Potencial Significativo de Inundación*, ARPSI) are identified and defined, and hazard maps and flood risks for return periods of 10, 100, and 500 years have been prepared for them (and are available at the SNCZI website). With this base, flood risk management plans will be prepared for all of Spain's hydrographic regions by no later than December 2015.

Since the year 2000, the **Tagus River Hydrographic Confederation** has had a system responsible for collecting, transmitting, and processing the data from its network of 202 stations: The Automatic Hydrological Information System (Sistema Automático de Información Hidrológica, SAIH). The system provides information on levels in reservoirs, rivers, and channels, water flow, rainfall, snow, opening of valves and sluices, etc.

More than 3,000 measurement sensors and more than 150,000 km of cables have been installed, along with the design of a satellite communications system and specific computer applications.

The information is transmitted in real time and is updated every 15 minutes. The information is incorporated into the hydrological-hydraulic models that help the organisation make decisions.

The real-time information provided by the SAIH has been proven to be vitally important for the management of dam drainage organs during episodes of flooding, and is the fundamental element for ordinary management of dams and irrigation land, and the collection of historic data.

These extreme situations must be incorporated into water governance because the predicted effects of Climate Change are expected to make them more frequent: longer periods of drought and increased flooding.

Spain's water management system responds to these future (and already present) challenges with a dynamic of different actions that thus far have proven to be effective. This means that the extrapolation of event probabilities is no longer reliable and sufficient safety margins must be applied to prevent disastrous effects for towns and citizens. For this reason, Spain's water management system has the resources to carry out the studies that are required to take into consideration the effects of Climate Change and to prioritize and plan the investment that is needed to continue to successfully guarantee security in response to these events.

The information sheets prepared in the aforementioned catalogue describe the following capacities and services associated with security for citizens:

- **4.0.** Management of hydrological risks
- **4.1.** Floods. Flood risk management plans
    - 4.1.1. Cartography of flood risk zones
    - 4.1.2. Automatic hydrological information networks. The SAIH network (Automatic Hydrological Information System)
- **4.2.** Management of dam and reservoir safety
    - 4.2.1. Integrated dam and reservoir risk management systems
    - 4.2.2. Dam operation standards: preparation and application
    - 4.2.3. Dam emergency plans and population notification systems
    - 4.2.4. Dam and reservoir monitoring and auscultation
    - 4.2.5. Management of dam sub-pressure
    - 4.2.6. Repair of hydromechanical equipment in dams
    - 4.2.7. Repair of hydraulic infrastructure in service

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68
kg of landfill

8
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litres of water

156
kWh of energy

111
kg of wood

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