

Challenges and opportunities in relation to water management in Spain

November 2025

Hosted by



With the support of



This report was prepared for **alinnea** by Gonzalo de la Cámara, an economist specializing in natural resources, academic director, and adjunct professor at IE University.

Review and update of the report: Florent Marcellesi, energy and climate expert.

alinnea is a climate Think & Action Tank based at IE University and supported by the European Climate Foundation (ECF).



Hosted by



With the support of



The findings, analyses, and conclusions presented in this report are based on the available information (obtained from primary sources or other research cited in the report, considered accurate and reliable) and on the methodologies applied during the research process. None of the collaborating individuals or institutions shall be held responsible for the interpretation of the information contained in this document, nor for any loss resulting from decisions of any kind made on the basis of the information contained in this report. Similarly, acknowledgment and/or thanks to any organization does not imply its endorsement of the final text.

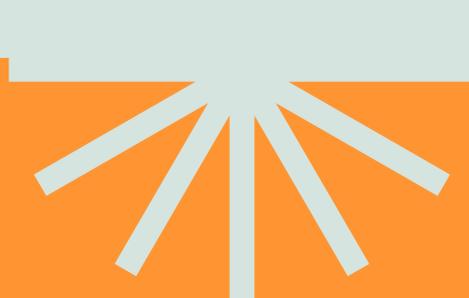
This report has been prepared with the support of the European Climate Foundation. The authors are responsible for the information and views expressed in this report. The European Climate Foundation is not responsible for any use that may be made of the information contained or expressed in this document.

Cite as: Fundación Instituto de Empresa (2025). Challenges and opportunities in relation to water management in Spain. Sector Overview Series. Report prepared for alinnea by Gonzalo de la Cámara.

Table of contents



1. Introduction	4
2. Water policy and institutional framework in Spain	5
3. Water resources and climate change: strategic research needs	8
4. Economic instruments and water governance	10
5. Digitalization and smart water management	11
6. Nature-based solutions and ecological restoration	12
7. Policy coordination and multilevel governance	13
8. Conclusions and recommendations	13
References	16





1

Introduction

Water resources are fundamental to the economy, society, and ecosystems in Spain. In many ways, as indicated in this paper, it can be said that water is both a limiting factor and a great opportunity for development (Matthews et al., 2024).

In the context of **Alinnea's** work, one of whose pillars connects food, land use, and water management, it is important to emphasize the fact that water sustains agricultural and food production (Cazcarro et al., 2015), provides stable and universal coverage to a population of just over 49 million people¹ (and a flow of 94 million international visitors in 2024²), and maintains unique ecosystems from coastal wetlands to high mountain rivers, among many other uses of water.

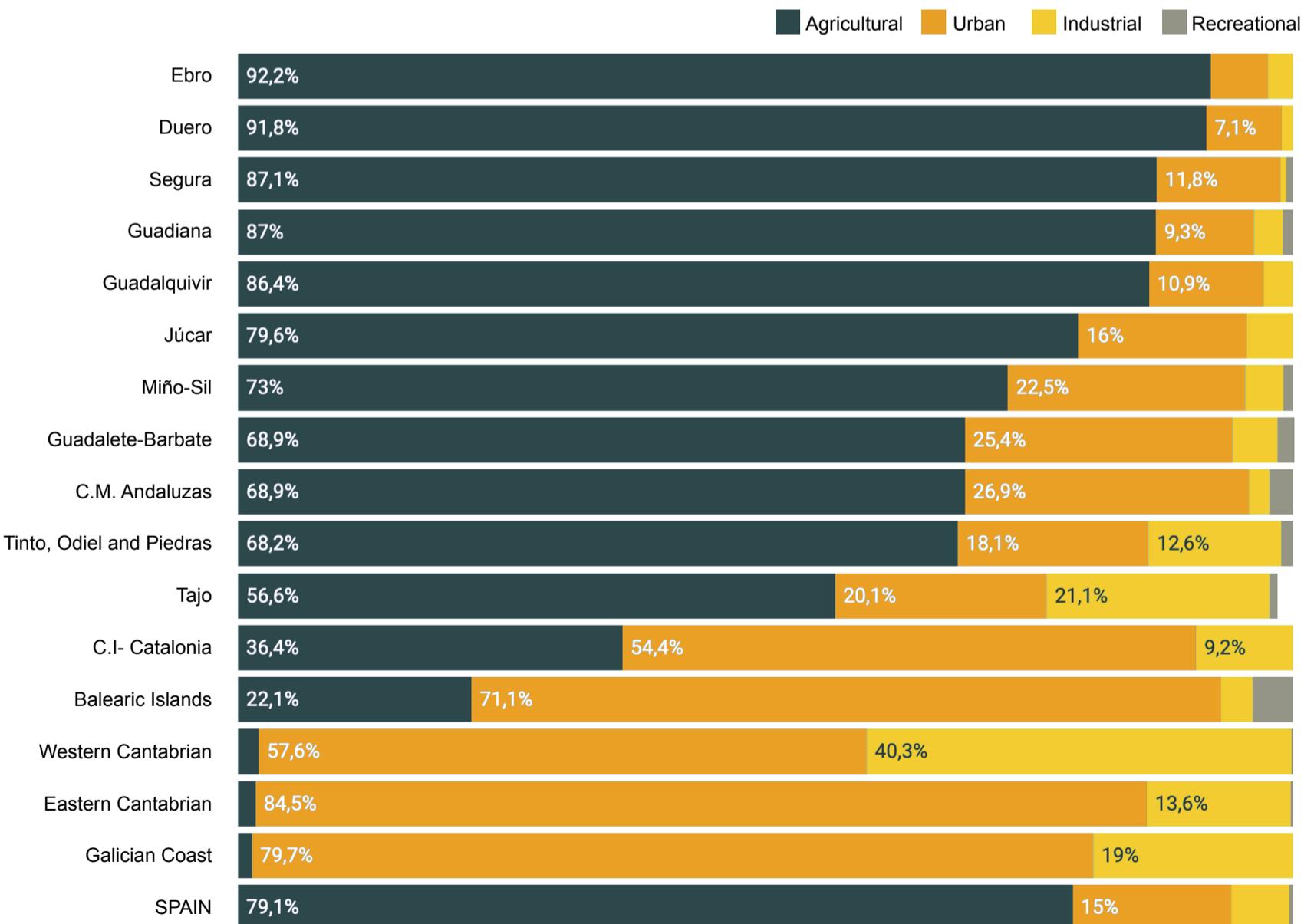
Spain, with a predominantly Mediterranean climate in terms of population and surface area, faces scarce and irregular rainfall that unequivocally and increasingly conditions long-term water availability. Pressures on water are intensified by the amplifying effect of climate change, urban growth, tourism, and an intensive agricultural sector. The data speak for themselves: almost 80% of the water consumed in Spain is used for agriculture and livestock, compared to 15% for urban supply (including tourism) and just under 6% for manufacturing (see Table 1). In inland river basins, such as the Ebro and the Duero, water for agricultural irrigation accounts for 90% of consumption, reflecting the heavy dependence of food systems on water availability (see Table 2).

This reality makes water security an inseparable element of the country's food security and, above all, of the Spanish

food system's ability to contribute to the gross value added of agriculture in the European Union. At the end of 2019, this contribution was 14.4%, the third highest in the EU: Spain is responsible for half of the EU's olive production and a third of its fruit production. In reality, water security is an essential factor for the resilience of the Spanish economy as a whole. However, the advance of climate change portends much more volatile rainfall in much of the peninsula, lower contributions at the headwaters of some basins, and more frequent and intense extreme events, exacerbating droughts and floods. In this context, Spain is forced to rethink water management with a strategic approach: integrating adaptation to climate change, protecting and restoring aquatic ecosystems, and ensuring the water-food-energy nexus.

The following sections analyze the institutional and economic framework of water management in Spain, the research needs to address climate change from this perspective, and innovative solutions (both technological and nature-based, as well as institutional) that can strengthen water governance in the country.

Table 1. Main uses of water in peninsular river basins



Source: RTVE infographic based on data from MITECO (2024).

1. 49,077,984 inhabitants as of January 1, 2025, according to the Continuous Population Statistics, National Statistics Institute (INE).
 2. 93,799,505 international visitors in 2024, according to the Statistics on Tourist Movements at Borders (FRONTUR), National Institute of Statistics (INE).

Table 2. Demand for water use in peninsular river basins

 Current volumes, in hm³, according to the 2021-2027 hydrological plans

Basin	Agricultural	Urban	Industrial	Recreational
Ebro	8.141	483	208	
Duero	3.346	260	39	
Guadalquivir	3.213	405	103	
Júcar	2.439	490	134	1
Tajo	1.993	707	744	27
Guadiana	1.759	189	55	19
Segura	1.476	200	9	11
C.M. Andaluzas	913	357	25	30
C.I. Catalonia	379	567	96	
Miño-Sil	324	100	16	4
Guadalete-Barbate	284	105	17	7
Tinto, Odiel and Piedras	182	48	34	3
Western Cantabrian	7	205	143	1
Eastern Cantabrian	4	196	32	1
Galician Coast	3	172	41	

Source · RTVE infographic based on data from MITECO (2024).



Water policy and institutional framework in Spain

Water governance in Spain is essentially characterized by hydrological planning based on the river basin as a management unit, in line with the European Union's Water Framework Directive (WFD) (2000/60/EC). The WFD established the ambitious goal of achieving **good ecological and chemical³ status for all water bodies** by 2015, a deadline that was later extended to 2027, and enshrined principles such as sustainability and no deterioration of water bodies. Spain transposed these principles into its legislation (Water Law, Royal Legislative Decree 1/2001, and derived regulations) and adopted a decentralized management model through the **Hydrographic Confederations**, the name given to river basin authorities in Spain.

These autonomous entities, which report directly to the Ministry for Ecological Transition and Demographic Challenge (MITECO) through its Directorate-General for Water, coordinate water management in inter-community river basin districts, i.e., those river basins that affect more than one Autonomous Community. Originally created in 1926 (first in the Ebro and Segura rivers), they are basin organizations that coordinate the General State Administration, the Autonomous Communities, Local Administrations, water

users, and environmental and civil society organizations in each river basin district⁴.

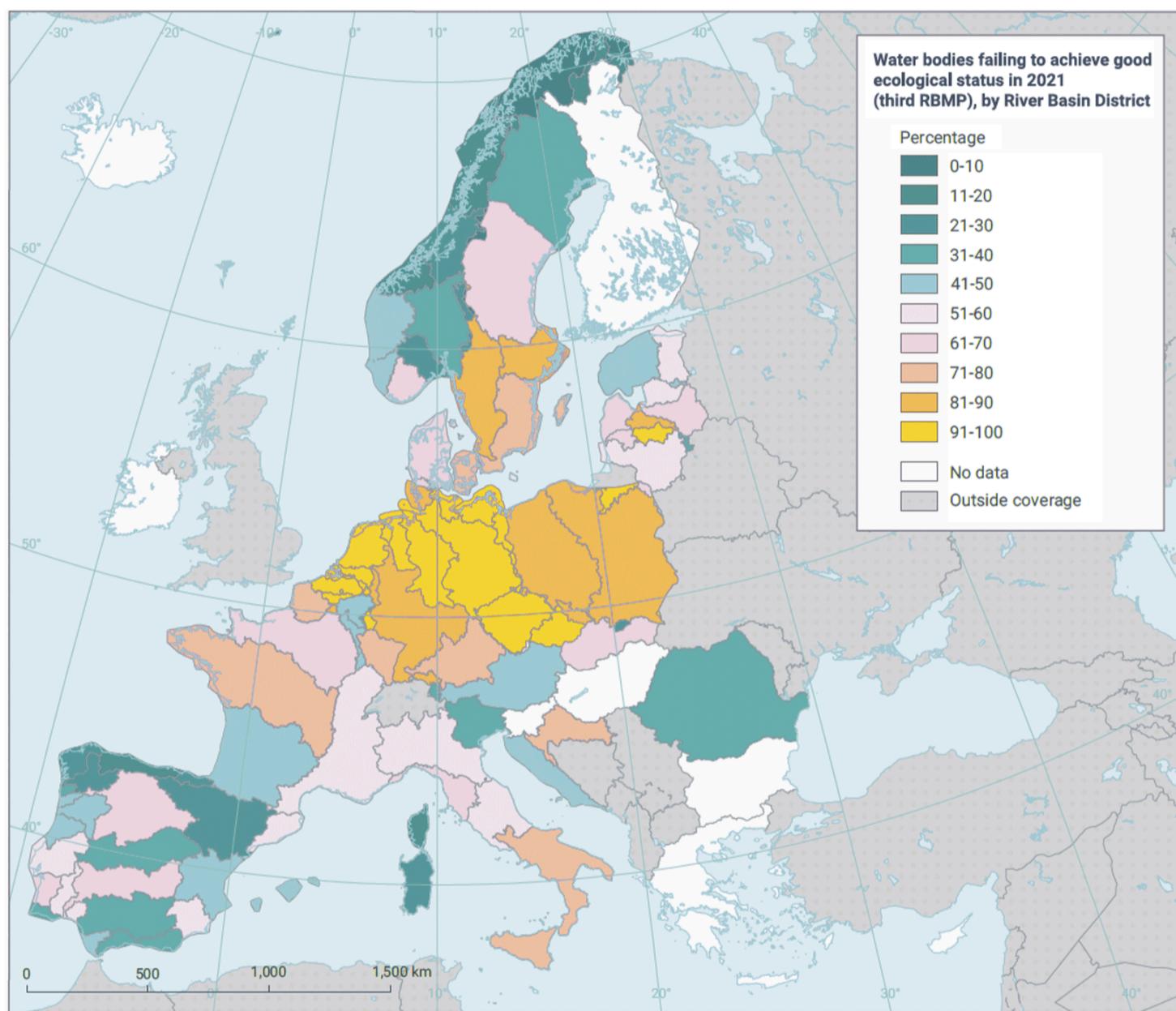
Their operation is based on the preparation and implementation of six-year **River Basin Management Plans (RBMPs)**, which are subject to periodic review and public participation. Basin planning has made it possible to integrate the management of surface and groundwater resources, aligning decisions with the ecological realities of each river rather than with administrative boundaries, a significant achievement that is not found in most countries around the world. However, it also presents challenges for the internal consistency of the system at the national level and for inter-basin coordination, especially in the face of competing and growing demands (agricultural, urban, environmental, etc.) and extreme phenomena that transcend basin boundaries and, strictly speaking, even national borders themselves. Some of these difficulties stem from a conception of water planning that sometimes seems equivalent to the calibration of hydrological models (to adjust resource availability to demand, sometimes without an in-depth analysis of the latter), rather than the planning of different economic activities and other water uses in the territory that generate pressures on aquatic ecosystems.

3. According to the EU Water Framework Directive (WFD, 2000/60/EC), good status of water bodies is defined differently for surface water and groundwater. In the case of surface waters (rivers, lakes, transitional and coastal waters), achieving good status means simultaneously complying with good ecological status and good chemical status. Good ecological status is determined on the basis of biological quality (presence and abundance of phytoplankton, macrophytes, benthic invertebrates, and fish), hydromorphological conditions (flow regime, river continuity), and physicochemical conditions (nutrient levels, dissolved oxygen, temperature, salinity, among others), allowing only a slight deviation from the reference conditions. Good chemical status requires that concentrations of priority substances, such as heavy metals and pesticides, do not exceed the limit values set out in the environmental quality standards (EQS) of the directive. As for groundwater, good status is assessed in quantitative and chemical terms. Good chemical status means that the concentration of pollutants such as nitrates, pesticides, or heavy metals does not exceed the set thresholds and that there is no salinization or alterations affecting dependent ecosystems. Good quantitative status requires that water abstraction does not exceed the natural recharge of the aquifer and that piezometric levels remain stable without affecting associated ecosystems, such as wetlands.

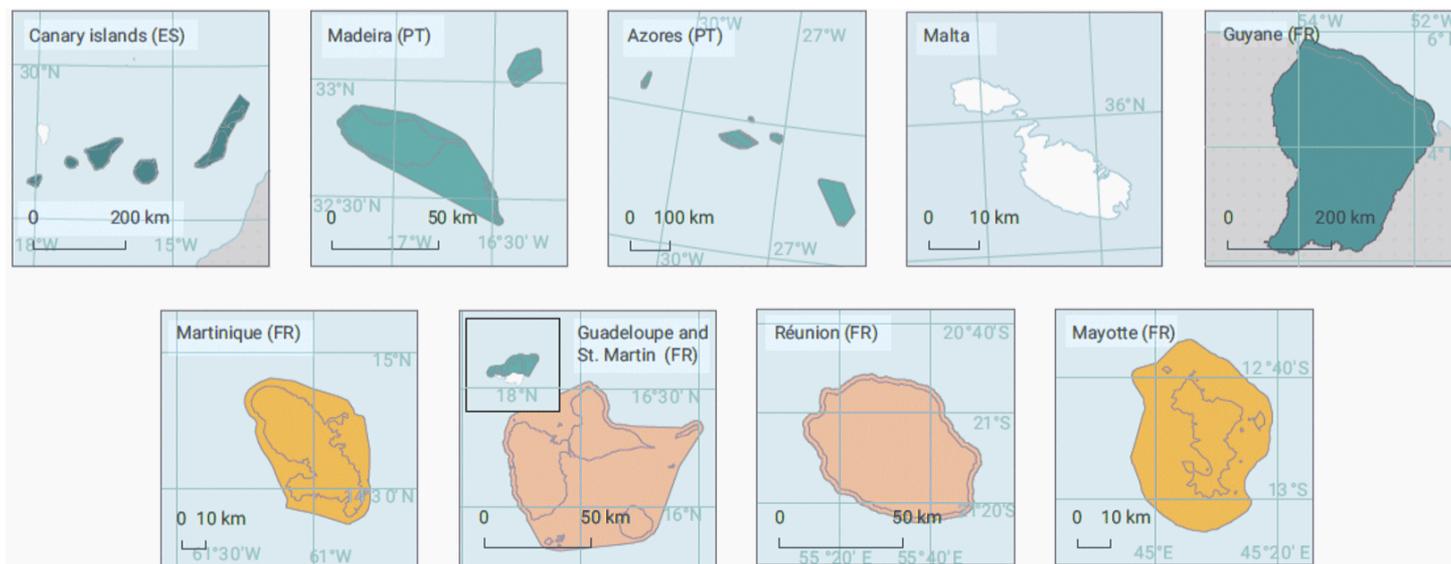
4. A river basin district is the water management unit based on a river basin, including both surface waters (rivers, lakes, transitional and coastal waters) and associated groundwater. It is defined in Article 2(15) of the Water Framework Directive as "a land and sea area made up of one or more neighboring river basins and associated groundwater and coastal waters, designated as the main unit for river basin management."

Spain is currently in the **third planning cycle (2021–2027) under the WFD**, with river basin management plans approved for the period 2022–2023. A critical assessment of these plans (EC, 2025) reveals progress and persistent shortcomings. On the one hand, the incorporation of environmental constraints has improved compared to previous decades, when water policy seemed to be the sublimation of agricultural development policy; on the other hand, structural deficiencies identified in previous cycles remain. In fact, more than 20 years after the approval of the WFD, around half of Spanish water bodies still do not achieve good ecological status, and it is very likely that a significant proportion of them will not achieve this by 2027 (see Map 1). The average health of surface water bodies in the EU is critical, with only 39.5% in good ecological status and only 26.8% achieving good chemical status (EEA, 2024). This reality contravenes the binding objective of the directive, anticipating the need for extensions until 2033 (the maximum allowed) and much more ambitious measures in the coming years. The European Commission warned that unsustainable water use remains a serious problem in Spain, exacerbated by drier and more uncertain weather; for example, overexploitation of water for irrigation contributes significantly to the failure to meet environmental objectives.

Map 1. Water bodies failing to achieve good ecological status in 2021
Third planning cycle, by river basin district.



Reference data: ©Eurographics, ©FAO (UN), ©TurkStat Source: European Commission - EuroStat/GISCO



Source: EEA (2024).

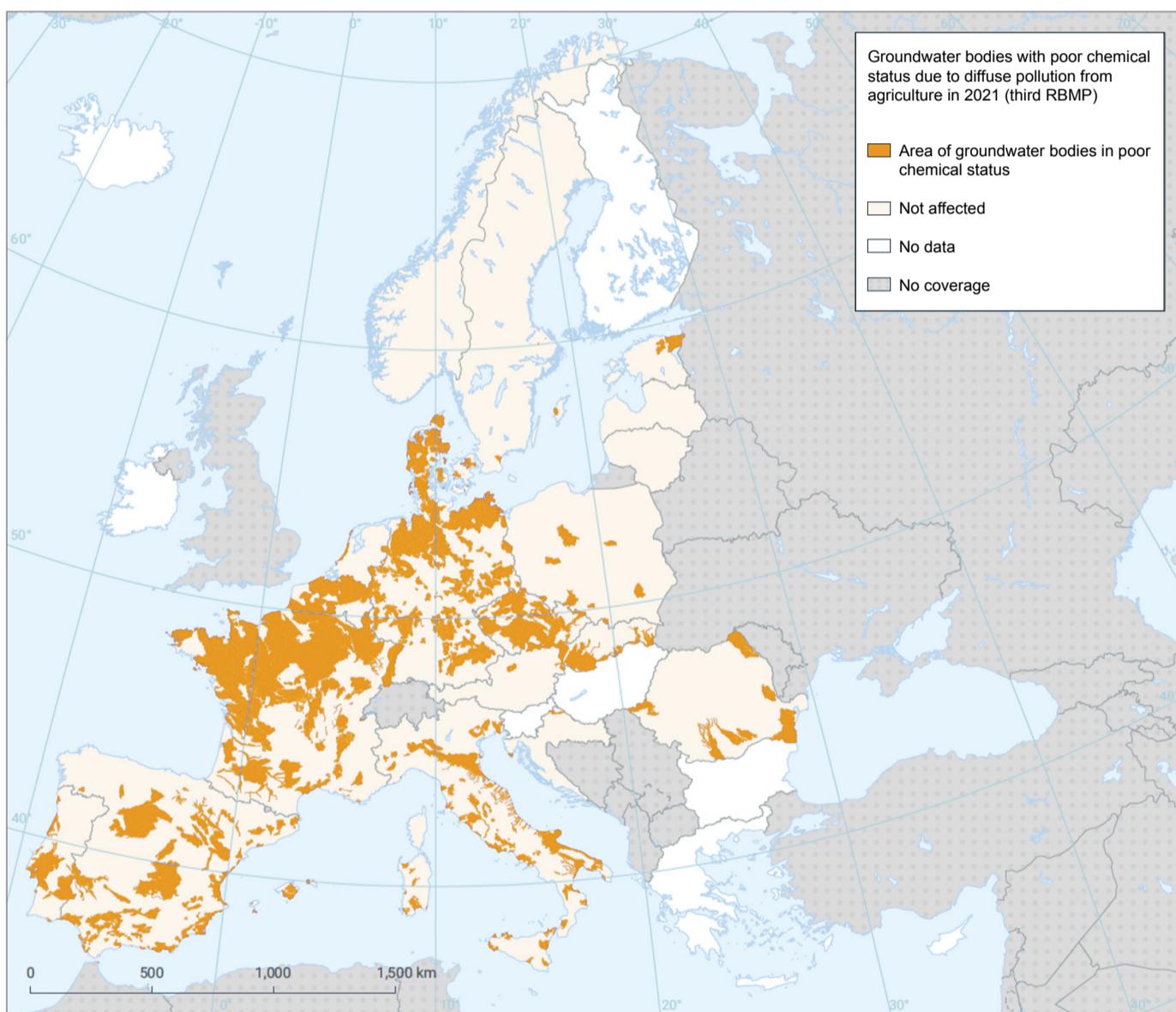
In fact, excessive withdrawals (i.e., above the natural recharge capacity) are responsible for the failure to achieve good quantitative or ecological status in 25% of groundwater bodies and 11% of surface water bodies in Spain. This data highlights the tension between demand (mainly agricultural) and the sustainable limits of long-term availability, a tension that current water plans have not yet fully resolved.

The 2021–2027 water plans introduce new tools and measures, including more stringent ecological flows in many rivers, greater control of discharges, and programs for saving and reusing reclaimed water in different basins. However, there is evidence of numerous shortcomings. The European Commission (EC, 2025) highlighted the extensive use of exceptions and extensions in Spanish PHCs, delaying the achievement of predetermined objectives. Likewise, the consideration of climate change in planning has been partial: although all plans include long-term scarcity projections, in practice many continue to authorize extraction volumes that do not reflect the expected reduction in water resources.

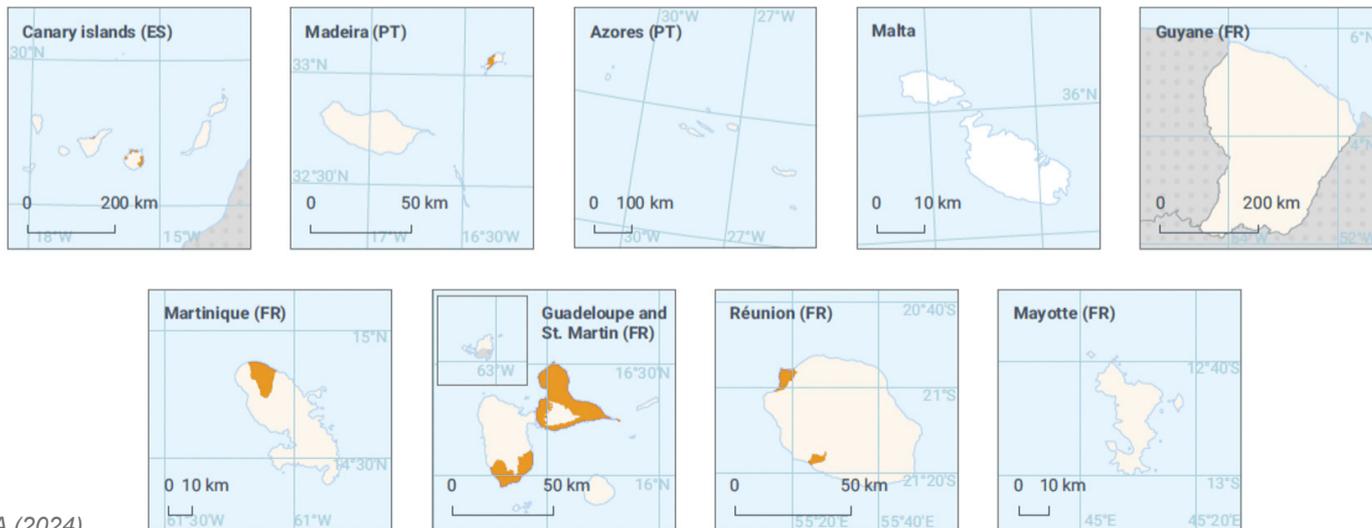
Paradigmatic and highly controversial cases in recent years, such as the overexploitation of the Doñana aquifer (Andalusia) or the pollution of the Mar Menor (Murcia region), highlight gaps in the effective application of regulations. Despite the creation of protected areas and figures such as hydrological reserves⁵, there has been a lack of strict enforcement to halt the deterioration. For example, Spain suffers from one of the most serious problems of **diffuse nitrate pollution** in Europe (see Map 2): it is the second country in the EU with the highest concentrations of nitrates in groundwater (Rodríguez-Berbel et al., 2022), behind only Germany. This is mainly due to the runoff of agricultural fertilizers, highlighting the weak coordination between water and agricultural policy to date, which leaves the former, at best, with a role of mitigating impacts.

Map 2. Groundwater bodies in poor chemical status due to diffuse pollution from agriculture in 2021

Third planning cycle, by river basin district.



Reference data: ©Eurographics, ©FAO (UN), ©TurkStat Source: European Commission - EuroStat/GISCO



Source · EEA (2024).

5. This designation is granted to certain bodies of water with the aim of preserving their natural state and protecting them from activities that could alter them. It is regulated by Articles 244 bis et seq. of the Public Water Domain Regulation (RDPH), approved by Royal Decree 849/1986 of April 11.

Looking ahead to **the fourth planning cycle (2028–2034)**, significant changes are on the horizon in the institutional and strategic landscape.

Firstly, as previously noted, 2027 marks (in principle) the end of the WFD deadline for achieving good status, meaning that 2028–2034 would operate under a regime of final exemptions and new targets that the EU could set. At the same time, in June 2025, the European Commission published its European Water Resilience Strategy⁶ at the European level to strengthen water security beyond the WFD (EC, 2025b). Spain will have to adapt its plans to the context of an intensified climate crisis and possible new EU guidelines (such as the announced European Blue Deal⁷).

Secondly, there will be an increasing need to integrate flood management (Directive 2007/60/EC) with water planning, achieving synergies between risk prevention measures and environmental objectives.

Thirdly, a more adaptive and science-based model will be required: hydrological and climate research must be translated more quickly into policy (for example, updating water

concessions based on scenarios of lower availability, an extremely important issue for Spain). Public participation and transparency in decision-making will also need to be strengthened, empowering users and local actors to increase co-responsibility in resource management.

Finally, at the international level, Spain will have to strengthen cooperation with neighboring countries, especially Portugal, with whom it shares the Duero, Tajo, Guadiana, and Miño river basins through the Albufeira Agreement⁸. Until now, Spanish-Portuguese collaboration on drought and scarcity management has been limited and must be deepened in order to jointly address extreme hydrological variations.

In short, Spain's institutional framework for water is at a turning point: after decades of incremental improvement, the combined challenges of the inevitable adaptation to climate change, pressures from the agricultural sector, and greater environmental demands are forcing a rethinking of instruments, a redesign of incentives, and a reformulation of approaches to ensure long-term sustainability in water management.



Water resources and climate change: strategic research needs

Climate change is already acting as a multiplier of water risks in Spain, a country with a predominantly temperate climate, with different varieties (see Table 1). The most recent scientific projections (IPCC, 2023) confirm worrying trends for the Mediterranean region: **a decrease in total precipitation in the southern and central regions of Spain** is very likely, **accompanied by greater aridity and more frequent and intense droughts**. As average temperatures rise (the country has warmed by $\sim 1.3^\circ\text{C}$ since the pre-industrial era), the rate of evapotranspiration (ETP) also intensifies, reducing aquifer recharge and river flow.

Table 1. Climate classification of Spain (Köppen-Geiger typology)⁹

Climate type	Areas in Spain	Characteristics
Mediterranean (Csa, Csb)	Mediterranean coast, Balearic Islands, Andalusia, Extremadura, Castile-La Mancha, inland peninsula (Madrid, Valladolid)	Hot, dry summers, mild winters, rainfall expected in autumn and spring
Oceanic (Cfb, Cfc)	North and northwest Spain (Galicia, Asturias, Cantabria, Basque Country, Navarre)	Mild temperatures all year round, abundant and regular rainfall
Mountain (Dfb, Dfc, ET)	Pyrenees, Central System, Cantabrian Mountains, Sierra Nevada	Cold winters, cool summers, frequent rainfall, snow in winter
Semi-arid (BSk, BSh)	Southeastern peninsula (Murcia, Almería, Alicante, Ebro Valley)	Low rainfall, high temperatures in summer and moderate temperatures in winter
Subtropical (Cfa, Af)	Canary Islands (especially Tenerife and Gran Canaria)	Mild temperatures all year round, variable rainfall depending on altitude and orientation

Source: Own elaboration.

6. The European Union's initiative to improve water resilience is officially called the European Water Resilience Strategy. This comprehensive, multi-year, multi-sector plan aims to address water-related challenges in Europe, with milestones set for 2030 and 2040.

7. The European Economic and Social Committee (EESC) began work on the Blue Deal in January 2023. In September 2023, the initiative gained political momentum with a joint call from the EESC and the European Parliament, which took the form of a jointly signed letter to EU heads of state or government calling on member states to support and adopt an ambitious European Blue Deal. In addition, in early September 2023, EESC President Oliver Röpké wrote to European Commission President Ursula von der Leyen asking her to include water among the top priorities on the European Commission's agenda, which happened with the new Commission after the elections. This led to the inclusion of the aforementioned Strategy among the Commission's priorities for 2024 and its publication in June 2025.

8. The "Agreement on Cooperation for the Protection and Sustainable Use of Water in Spanish-Portuguese River Basins" (BOE-A-2000-2882) was signed in Albufeira, Portugal, on November 30, 1998, and entered into force in February 2000.

9. The Köppen-Geiger climate classification is a climate classification system that categorizes the Earth's climates based on temperature and precipitation, with bioclimatic criteria that reflect the natural vegetation associated with each climate. It was initially developed by Wladimir Köppen in 1884 and later refined by Rudolf Geiger. Its main objective is to objectively delimit climatic regions using meteorological data. In Spain, the most widespread is Csa (Mediterranean with dry, hot summers). In higher inland areas, Csb (Mediterranean with dry and temperate summers) predominates. In the northern Atlantic strip, Cfb (oceanic) is found. In mountain areas, the climate varies between Dfc (subarctic) in the highest peaks and ET (tundra) in the highest peaks. In the southeast, BSh (hot semi-arid) predominates. Finally, in the Canary Islands, climates range from BWh (hot desert) in Lanzarote and Fuerteventura to Csa and Csb in the higher areas of islands such as Tenerife and La Palma.

A series of national studies have been projecting significant declines in water availability towards the middle and end of the century.

CEDEX (2010) already included projections indicating a general reduction in rainfall as the 21st century progresses, which would result in a decrease in water availability. Specifically, under the Intergovernmental Panel on Climate Change (IPCC) A2 emissions scenario¹⁰, average rainfall in Spain was expected to decrease by -5% for the period 2011-2040, -9% for 2041-2070, and -17% for 2071-2100. CEDEX (2017) also estimated, in most of its simulations, decreases in precipitation, with these decreases being greater in the southwestern quadrant of the peninsula and in the archipelagos. For Spain as a whole, the average changes for the RCP4.5 and RCP8.5 scenarios¹¹ are -2% and -4% for 2010-2040, -6% and -8% for 2040-2070, and -7% and -14% for 2070-2100, respectively. The increases in ETP for RCP 4.5 and 8.5 are 3% and 4% for 2010-2040, 7% and 10% for 2040-2070, and 9% and 17% for 2070-2100, respectively.

Yeste et al. (2021), meanwhile, warned that for a region traditionally unaffected by the challenges of structural water scarcity (the north of the peninsula), the rivers of the Pyrenees could see their flow reduced by up to 15% by 2040, with annual reductions of up to 40% observed in several parts of the Duero basin for the period 2071-2100, under the RCP8.5 scenario.

For its part, the National Climate Change Adaptation Plan (2021-2030) estimates a reduction in renewable water resources of around 17% by 2040-2070 in high-emission scenarios, with more pronounced losses in the southern and eastern basins of the peninsula. The State Meteorological Agency (AEMET, 2023) warns that, if emissions are not mitigated, Spain will face longer heat waves, concentrated torrential rains, and longer dry periods, altering the hydrological cycle. These trends are already materializing: the last decade has seen several of the driest years on record (2017, 2019, and 2022, for example) and extreme opposite events such as the isolated high-level depression (DANA) of October 2024, mainly in the Valencian Community. Seasonal variability is also increasing, making traditional management based on historical averages more difficult.

Given these projections, there is a **need for strategic research** to guide water management. One priority is to refine regionalized climate projections focused on critical hydrological variables: seasonal precipitation, runoff flows, aquifer recharge, and frequency of extreme events (droughts and floods). The IPCC scenarios must be translated into specific hydrological impacts by basin (downscaling¹²), considering different time horizons (2030, 2050, 2100) and ranges of uncertainty. In addition, research is needed on the response of aquatic ecosystems to the combined stress of climate and human uses, identifying ecological thresholds (e.g., lethal water temperatures for certain species and minimum flows to avoid further biodiversity losses in a context where biodiversity destruction rates are higher than in marine and terrestrial ecosystems). This applied science is key to defining **dynamic ecological flows** that incorporate climate change, rather than static

values that are obsolete under new conditions. Similarly, in the field of food systems, agricultural research must anticipate how declining water availability will affect yields and which adaptive practices are effective. Several studies point to severe impacts: for example, olive yields in Spain are projected to fall by around 20% under warmer and drier climate scenarios (Gratsea et al., 2022), while basic arable crops such as wheat could see their productivity reduced by more than 10% by around 2050 (Funes et al., 2021). The IPCC compiled evidence of declines in the yields of numerous Mediterranean crops (wheat, barley, vegetables, and fruits) associated with rising temperatures and water stress. This poses a risk to food and economic security. Therefore, there is an urgent need to research **more drought-resistant varieties, precision irrigation techniques, and planting strategies adapted to the new climate**.

In terms of **drought management**, Spain has extensive experience in special drought plans and indicator observation (such as reservoir reserves). However, the progressive nature of climate change requires these instruments to be updated. One focus of research is to improve **seasonal prediction and early detection of meteorological and hydrological droughts by integrating climate models and remote sensing**. The drought of 2022-2023, for example, was so severe that by early 2024, reservoir water had fallen to only 45.2% of total capacity (25,356 hm³ stored), with basins such as Guadalquivir, Guadiana, Segura, and internal basins in Catalonia at critical levels (between 16% and 20% of capacity). Having warning systems that combine climate, soil moisture, and flow data could improve anticipation and preventive management (staggered restrictions, perhaps some temporary transfers, commissioning of emergency wells, etc.). In addition, integrated planning must consider **scenarios of prolonged multi-year droughts**, not just short episodes: are the systems prepared for a possible decade-long "mega-drought" such as those that have occurred historically in Spain or more recently in countries such as Australia and Chile, with bioclimatic characteristics very similar to those of the Mediterranean basins? Answering this question requires paleoclimatic studies and long-term simulations that go beyond traditional assumptions.

At the same time, the **risk of flooding** is also amplified by global warming, due to more frequent extreme rainfall events in certain periods. Spain has suffered devastating floods. Flood risk management is addressed through Flood Risk Management Plans (FRMPs) that complement PHCs, but integrating both plans remains a challenge. Strategic research must provide tools for the design of **resilient infrastructure** and land use planning based on climate risk criteria. For example, hydraulic modeling of extreme floods under different climate scenarios will help redefine flood zones and update risk maps. This is critical to prevent new urban development in risk areas and to properly size defense works (dikes, r channeling). At the same time, it is essential to study **nature-based solutions** (restoration of floodplains, flood control wetlands) as preferred measures due to their ecological benefits. Adapting to climate change in terms of flooding also involves improving early warning systems for meteorological and hydrological events for civil protection.

In summary, integrated water planning under climate change

10.

11. The RCP (Representative Concentration Pathways) scenarios are greenhouse gas (GHG) concentration trajectories used in IPCC (Intergovernmental Panel on Climate Change) reports to model possible future climates. They represent different levels of radiative forcing (the change in net energy in the atmosphere due to GHGs) expressed in watts per square meter (W/m²) for the year 2100. RCO 4.5 represents an intermediate mitigation scenario; RCO 8.5 represents a scenario of high emissions or climate inaction.

12. Downscaling of regional climate models (RCMs) is a process that refines climate projections obtained from global climate models (GCMs, General Circulation Models) to provide more detailed information at the local or regional level. Since GCMs operate at a coarse spatial resolution (typically between 100 and 250 km), downscaling is essential for assessing the impacts of climate change at smaller scales, which are relevant for decision-making in sectors such as agriculture, water management, and urban planning.

requires cutting-edge research that addresses droughts and floods jointly, optimizing reservoir operation rules for both extremes. A **climate risk management** approach should permeate water policies: instead of reacting to disasters, prepare in advance based on the best available evidence. Moving from crisis management to risk and opportunity ma-

agement is imperative. This includes considering challenging and controversial, but possibly necessary, measures such as restructuring demand (e.g., permanently reducing irrigated areas in unsustainable zones) based on future water balance studies, but above all, taking a more comprehensive and complex view of water security at the basin level.



4

Economic instruments and water governance

The economics of water play a crucial role in sustainable management by influencing usage incentives and the financial availability for infrastructure and other management measures. A central principle of the WFD is the **recovery of costs** for water services, including environmental and resource costs, which is mainly implemented through the tariff system. In Spain, however, water prices have traditionally been low compared to the European average, especially in the agricultural sector, thanks, among other things, to decades of public investment and implicit subsidies.

This tariff gap indicates that the current price does not fully cover the costs of services, failing to comply with the recommendations of the European Commission and the OECD. In fact, the OECD warned in 2024 that water prices in Spain do not reflect the scarcity of the resource, particularly in agricultural uses, and urged the promotion of water use efficiency through more effective economic signals (Farnault and Leflaive, 2024).

There are several ways to improve the financial sustainability of water. One, perhaps the most obvious, is **to review** both urban and agricultural **tariffs** (levels, but above all structures) to move towards higher levels of cost recovery, to an end. This includes, in urban areas, incorporating infrastructure depreciation and environmental costs (e.g., advanced water treatment and wastewater effluent treatment); in agriculture, establishing irrigation fees that reflect the value of water and penalize excessive consumption while rewarding efficient consumption. International evidence suggests that tiered pricing (blocks based on consumption volume) can protect affordable basic use while charging progressively more for higher volumes. However, any tariff increase faces political and social resistance. Therefore, gradual and compensatory solutions are proposed: for example, reinvesting the revenue from new charges directly in the modernization of irrigation and water-saving technologies that benefit farmers themselves, so that they pay more but also consume less.

This type of **public-private financing model** can be effective: the public sector sets the objectives and frameworks (e.g., reduction of withdrawals), while private investment in efficiency (better equipment, sensors, artificial intelligence, etc.) is encouraged. There are already cases in which irrigation communities, with state support, have co-financed the modernization of their networks in exchange for more secure concessions, but with less total funding, achieving a symbiotic situation in terms of savings and productivity.

Another economic instrument that could be relevant (especially at the intra-basin level) is water banks and **water use and exploitation rights markets (transfer contracts)**, which have seen very limited development in Spain. The Water Law

(Article 67) allows for the transfer of rights between users, and exchange centers have been implemented in basins such as the Segura (Law 1/2018), especially in times of drought. However, legal rigidities and a lack of transparency persist, which have prevented a well-understood liquid market (not only as a market where there are many transactions or a high volume of water is exchanged, but one in which the full potential for improving efficiency through reallocation is exploited). The opening of well-regulated water markets in the general interest could improve allocation in specific situations of scarcity, allowing the resource to be transferred to uses of greater economic value (e.g., from low-value fodder crops to urban supply or high-value horticultural crops). For these instruments to work, however, governance must ensure that there are no negative impacts on third parties or the environment (e.g., by preventing speculation on rights to use and exploit overexploited water resources) (Delacámara et al., 2014).

In the **water-energy nexus**, policy integration offers opportunities for sustainability (De Roo et al., 2021). On the one hand, water services are energy-intensive: pumping groundwater, transporting flows through large aqueducts, or desalinating seawater can be energy-intensive processes. It is estimated that desalinating 1 m³ of seawater requires on average around 3–4 kWh of electricity, and agricultural pumping also accounts for a significant percentage of rural electricity consumption. This means that water strategies must go hand in hand with energy strategies, promoting the use of renewable energies in water facilities (e.g., solar parks in desalination plants or pumping during off-peak hours with wind surpluses).

Spain, with 770 desalination plants of varying sizes, is the European leader (and the fifth country with the highest installed capacity in the world). These plants have a combined production capacity of around 5 million m³/day (enough to supply ~34 million people), and are located mainly in regions with chronic water stress, such as the Canary Islands, the Mediterranean coast, and the Balearic Islands. However, **many desalination plants operate below capacity** (around 16% on average over the last two decades), mainly due to difficulties in finding effective demand (i.e., not those who need the desalinated water, but those who are willing to pay for it). Integrating renewable energies and improving efficiency can reduce these costs and expand their use (Sola et al., 2021).

On the other hand, the water-energy nexus can be seen in **hydroelectric power generation**: Spanish reservoirs (with a total capacity of ~55,000 hm³) are managed not only for water but also to produce electricity and regulate the energy system. Climate change and new consumption

patterns will require optimizing this dual function and avoiding conflicts (for example, turbinizing for electricity in dry summers can lower reserves for irrigation). Innovative policies could incentivize water storage as an energy backup (reversible pumping in reservoirs) while ensuring ecological

flows. In short, economic instruments and integrated management with energy conversion are strategic levers.



5

Digitalization and smart water management

New information and communication technologies (ICT) offer powerful tools for optimizing water management, improving the information available, and supporting real-time decision-making (Zafra-Gómez et al., 2024). Spain has begun to move toward smart water, although at an uneven pace depending on the sector and region. One of the pillars of this transformation is **Big Data management and the use of different forms of Artificial Intelligence (AI)** to process large volumes of hydrological, meteorological, and infrastructure data. For example, sensor networks in rivers, reservoirs, and urban distribution networks generate continuous data on levels, flows, water quality, and consumption. By applying AI algorithms, it is possible to detect patterns and anomalies and anticipate pipe leaks (to reduce non-revenue water, (NRW)¹³ Copernicus¹⁴) allows the water needs of crops to be estimated on a plot-by-plot basis, recommending optimal doses and avoiding excessive irrigation. In this way, digitization contributes directly to efficiency and sustainability, reducing losses and adjusting demand to the minimum necessary.

A notable advance is the implementation of digital twins for water: virtual replicas of water systems (a water treatment plant, a section of river, or even an entire basin) that allow different scenarios and responses to be simulated. Using a digital twin of, for example, a city's supply network, operations can be tested in the virtual world (valve closures, flow redistribution) to see how they would affect the system before implementing them. Weather forecasts are also integrated to simulate the behavior of a river in the event of flooding, helping managers decide when to open floodgates preventively. Spain is participating in European pilot projects for digital twins in urban water management (such as Barcelona, which has developed integrated models of its urban drainage network to predict local flooding). Similarly, the Hydrographic Confederations are modernizing their Automatic Hydrological Information Systems (SAIH), which for decades have been collecting real-time data on rainfall, levels, and quality. The novelty is that these AHI systems are now being transferred to **open data and geospatial visualization** (GIS) platforms, accessible not only to technicians but also to the public, thereby improving transparency. MITECO has recently promoted the digitization of the urban water cycle through funds from the Recovery Plan (PRTR), receiving more than 500 proposals from local entities in its second call for proposals. This indicates widespread interest in applying digital technologies to water supply and sanitation,

from the sensorization of sewer networks to detect rainwater intrusions to mobile applications for citizens to report service incidents.

However, the digital transition faces **significant challenges in terms of adoption and data governance**. First, institutional fragmentation can hinder common standards: each confederation or autonomous community could develop different systems, creating information silos that are not very interoperable. State leadership (perhaps through MITECO) is required to establish integrative platforms and data exchange protocols between administrations. Second, the digital divide affects many management entities, especially small municipalities (84% of Spanish municipalities have fewer than 5,000 inhabitants) or traditional irrigation communities, which lack the technical and human resources to take advantage of these technologies. Investment in training and technical assistance will be necessary to ensure that digitization is not concentrated only in large cities or companies but reaches the entire water system. Thirdly, there is the issue of data governance: who owns the information and how its quality, privacy (in the case of individual consumption), and ethical use are ensured. For example, detailed domestic consumption data could be considered sensitive; the extent to which such microdata is shared or anonymized will have to be defined. Cybersecurity is also critical, as digitized water infrastructure could be vulnerable to attacks that alter measurements or controls (imagine a malicious actor remotely opening floodgates). Therefore, along with the installation of technology, IT security measures and manual contingency plans for operating systems if automated ones fail must be strengthened.

Despite these challenges, the trend toward **smart water management** seems unstoppable due to its obvious benefits. Economically, digitization is expected to reduce operating costs (lower losses, predictive infrastructure maintenance avoiding costly breakdowns). Environmentally, it will facilitate the achievement of objectives by better monitoring ecological flows and detecting illegal discharges in real time. It also empowers users: today, a farmer with a smartphone can receive irrigation recommendations or supply cut alerts in advance, and a citizen can monitor their daily consumption and compare it with averages. For Spain, leveraging **AI, big data, and sensors** in the water sector is an integral part of becoming more resilient to climate change. In fact, the

13.

14. The Copernicus Program is the European Union's (EU) Earth observation system, designed to provide real-time environmental data with applications in climate change management, security, agriculture, water management, and natural disasters. It relies on a combination of satellites, in situ sensors, and climate prediction models to monitor the state of the planet.

European Commission has identified water digitization as a priority line of action within a future continental water strategy. In conclusion, Spain must accelerate the incorporation of smart technologies in water management, accompanied by institutional reforms that ensure their uniform and safe adoption.

It should be noted, however, that it is necessary to incorporate as many precautions as necessary in the digitization process (and especially in the use of AI, which demands increasingly complex insights from users and, therefore, greater intensity in data processing). There is growing evidence of the scale of energy and water consumption

associated, above all, with the cooling processes in data centers. The goal is to overcome the contradictions between ecological transition and digital transition and make both transitions fully complementary and synergistic. To this end, it is worth exploring the possibility of introducing greater efficiency in the data processing process, not only on the part of the data centers themselves, but also on the part of their end customers.



Nature-based solutions and ecological restoration¹⁵

Faced with water security challenges, **Nature-Based Solutions (NBS)** offer complementary or alternative approaches to traditional gray infrastructure. In Spain, a country with great biological diversity¹⁶, these solutions are gaining prominence in water and land use planning. An emblematic example is the **restoration of degraded wetlands**. Wetlands act as natural sponges that naturally retain water in wet seasons and release it in dry seasons, as well as recharging aquifers and purifying water by fixing nutrients. Restoration programs such as the Doñana 2005 Project succeeded in reconnecting floodplains in the Doñana National Park, improving its hydrology after decades of drying up. However, recent problems in Doñana indicate that it is necessary to go beyond restoring protected areas: it is vital to control extractions in the surrounding area and restore the natural return flows that feed these wetlands. Another case is the Mar Menor in Murcia, a coastal lagoon whose severe eutrophication (caused by agricultural runoff with nitrates) led to massive fish mortality. In response, the creation of upstream filtering green belts and the restoration of abandoned salt flats have been proposed to increase natural purification before the water reaches the lagoon. These SbN projects seek to restore ecological processes that provide water services (such as nutrient and sediment retention) on a continuous and large scale.

River restoration is another priority line of action. During the 20th century, hundreds of dams and weirs were built on Spanish rivers, fragmenting their courses. According to data from the Inventory of Dams and Reservoirs in Spain managed by MITECO, Spain has approximately 1,200 large dams (twice as many as the second European country with the most, France, according to the World Commission on Dams). These structures are those that are over 15 meters high or have a reservoir capacity of more than 1 hm³. In addition to large dams, there are numerous small dams and weirs distributed throughout the country. These smaller infrastructures are mainly used to divert water for irrigation or other local uses. Although no exact figure is available, it is estimated that there are thousands of these structures in

operation. In 2023, 487 obsolete river barriers were removed in rivers across Europe, with France and Spain leading the way in compliance with binding European regulations. These actions not only benefit biodiversity (allowing the free movement of fish and sediments), but also improve the natural capacity of rivers to regulate floods by restoring floodplains. The EU's goal of restoring at least 25,000 km of free-flowing rivers by 2030 has encouraged Spanish authorities to identify priority sections and finance renaturalization projects.

At the interface between water and agriculture, **regenerative agriculture practices** are proving to be nature-based solutions with multiple benefits. Regenerative agriculture promotes soil health through techniques such as cover cropping, agroforestry, rotational grazing, and reduced tillage. This increases soil organic matter and its capacity to infiltrate and retain water, reducing the need for irrigation and surface runoff. There is evidence that these practices significantly improve water use efficiency by increasing soil moisture retention and mitigating the effects of drought events (Magdaleno and Delacámara, 2015). In arid and semi-arid areas of Spain¹⁷, some pioneering farmers have managed to maintain stable yields with less water input thanks to regenerated soils that function as "sponges." In addition, by reducing or eliminating chemical fertilizers, nitrate pollution of aquifers and rivers is minimized, closing the nutrient cycle in a safer way. In this way, regenerative agriculture connects food security with water and climate security: healthy soil retains more water, more resilient crops are better able to withstand droughts, and surrounding ecosystems benefit from lower pollutant loads. The challenge is to scale up these practices from isolated experiences to more widespread adoption. Agri-environmental policies (e.g., in the new CAP) could remunerate farmers for ecosystem services such as water recharge or organic carbon sequestration in soils, providing an economic incentive for the expansion of regenerative agriculture.

In short, nature-based solutions are establishing themselves as win-win strategies that simultaneously address water

15. On nature-based solutions, see also the report in the same series as this document: *Cross-cutting Landscape (2025), Adaptation of Spanish cities to climate change through the implementation of Nature-Based Solutions*, Alinnea.

16. Spain and Italy are the EU Member States with the greatest biodiversity. Spain has the largest number of vascular plant species in Europe, with an estimated total of between 8,000 and 9,000 species, of which between 20% and 25% are endemic. In addition, it is home to between 60,000 and 70,000 species of fauna, more than a third of all those in the EU, including approximately 700 vertebrates and a wide variety of invertebrates. The great biodiversity of both countries is due to the variety of climates, landscapes, and their strategic location as meeting points for different ecological regions of Europe.

17. According to data from MITECO, more than two-thirds of Spanish territory is classified as arid, semi-arid, and dry sub-humid areas. These categories correspond to areas susceptible to desertification, characterized by a ratio between annual precipitation and potential evapotranspiration of between 0.05 and 0.65. Seventy-four percent of Spanish territory is at risk of desertification due to climatic and land use factors. This phenomenon particularly affects the Mediterranean coast, the Canary Islands, the southern sub-plateau, and the Ebro valley.

resilience, ecological conservation, and climate adaptation. They do not completely replace gray infrastructure (we will still need wastewater treatment plants, reservoirs, and

canals), but they can reduce the need for costly new works and provide adaptive flexibility.



7

Policy coordination and multilevel governance

The complexity of water management, which encompasses environmental, economic, social, and territorial dimensions, requires effective multilevel governance. In Spain, this involves coordinating policies from the European, national, and regional levels down to the local level, ensuring consistency and adaptation to each reality. A clear challenge is to translate the abundant scientific research available into operational public policies. There is often a gap between what science recommends (e.g., reducing withdrawals) and what regulations establish in a binding manner. To close this gap, adaptive governance models are needed (Hjorth and Madani, 2023): flexible legal and administrative frameworks that can incorporate new information and adjust decisions in near real time.

One promising approach is the creation of **scientific and technical advisory committees** integrated into the decision-making processes of river basin authorities and governments. These committees could review key indicators (groundwater levels, climate change, ecological status) on an annual basis and recommend adjustments to plans or concessions without waiting for the next six-year planning cycle. Likewise, water planning should be closely coordinated with other sectoral policies (agriculture, energy, tourism, land use planning, etc.) through formal mechanisms.

At the international level, Spain has much to contribute and learn in water governance. At the European level, the experience of the WFD has been an exercise in shared learning between countries; Spain can benefit from the best practices of other Member States in areas such as cost recovery (Denmark) or aquifer protection (France).

Multi-level coordination must also address potential

conflicts between administrations. In Spain, water competences are mainly at the state level in inter-community basins but at the regional level in internal basins, which can lead to disparities in approaches. It is important to create spaces for coordination between the state and the autonomous communities, such as sectoral water conferences, to harmonize criteria and disseminate successes from one region to another. Likewise, at the local level, involving municipalities and users is crucial for effective implementation. Many problems (water waste in some irrigated areas, nitrate pollution, urban flood management) will not be solved by European directives or national plans alone; they require concerted action by local authorities, irrigation communities, businesses, and civil society on the ground. For this reason, contemporary governance promotes **active public participation**: recent hydrological plans in Spain have involved participatory processes, usually in the form of formal public consultation processes, but it is possible to go further by granting civil society a certain degree of co-decision-making power on specific issues (for example, water governance roundtables in overexploited aquifers where farmers and environmentalists agree on extractions). Transparency is another pillar: making data, models, and decisions public builds trust and allows for citizen scrutiny.

In short, moving towards resilient water management requires a coordinated effort at multiple levels of government. The adaptive models suggested by science must be institutionalized so that policies can be adjusted with agility.



8

Conclusions and recommendations

Spain is at a crossroads in terms of water resource management. Throughout this analysis, significant **research gaps and policy challenges** have been identified which, if not addressed, will compromise both water and food security and several other legitimate objectives of the country, both in environmental terms (climate crisis, loss of biological diversity, desertification) and in macroeconomic performance.

Firstly, there is a persistent gap between the environmental targets set (in terms of good water status) and reality: approximately half of water bodies do not meet the target, and 90% of European river basins could still be in poor condition in 2027. This highlights the inadequacy of the measures implemented and requires efforts to be extended beyond the initial deadlines of the WFD.

Secondly, climate change is putting even more pressure on the system: lower inflows and extreme events are calling into question the water balance, requiring both infrastructure and patterns of use and consumption to be adapted.

Thirdly, current management shows sectoral imbalances: predominantly agricultural use with low relative efficiency, prices that do not internalize environmental costs, and emerging conflicts between sectors and territories (water transfers, irrigation vs. conservation, elimination of reservoirs and dams). In addition, institutional fragmentation can hinder agile responses: coordination between administrations and the integration of policies (water, agriculture, energy, urban planning) can be greatly improved.

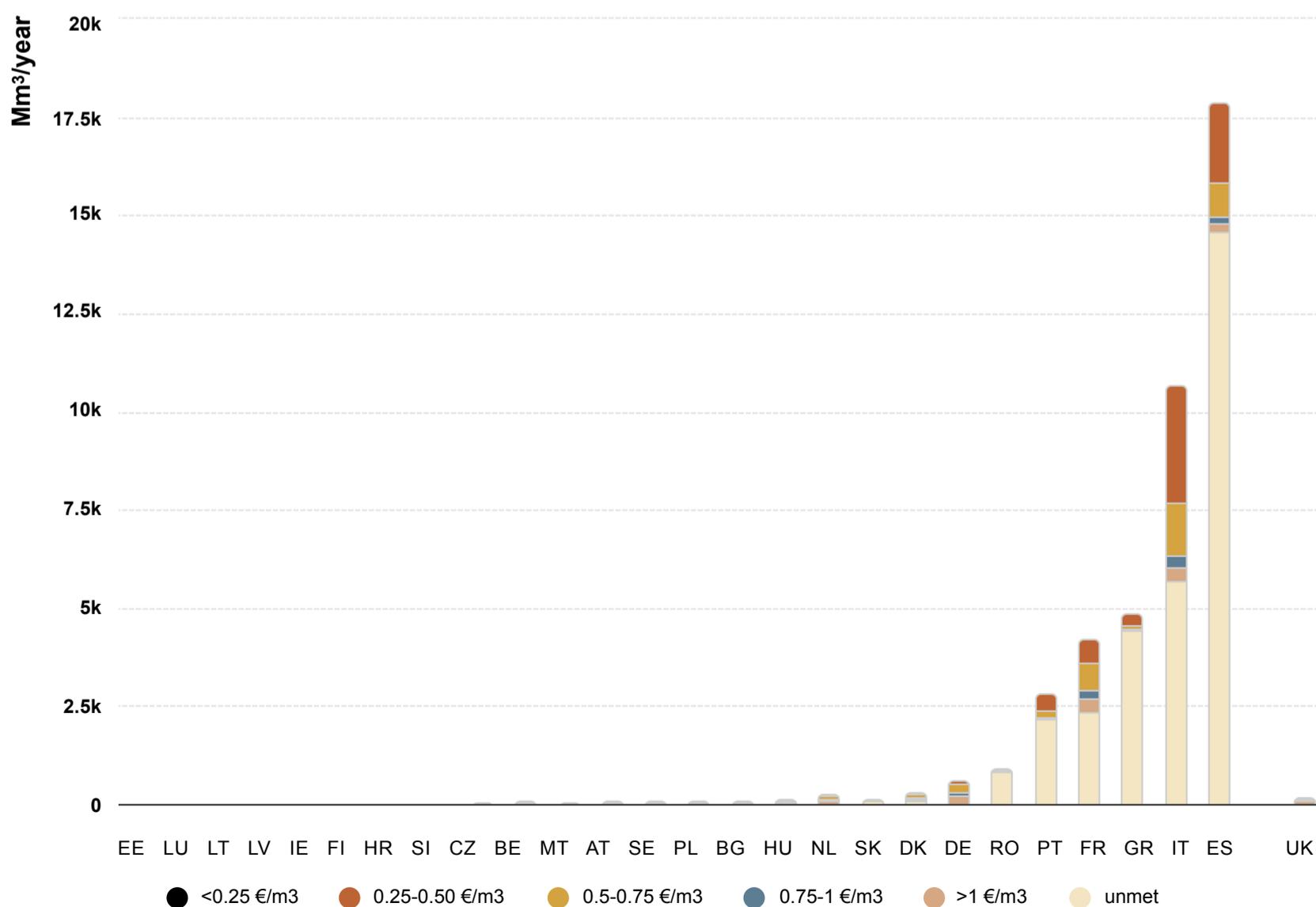
Given this situation, several **strategic recommendations** can be made.

At the policy and institutional level, it is urgent **to strengthen the implementation of the Water Framework Directive** by making full use of the tools it offers, making any new concession or increase in irrigation conditional on the effective achievement of good status in the basin, withdrawing exemptions except in very justified cases, and activating automatic sanctions or restrictions when environmental indicators deteriorate. Hydrological planning for the fourth cycle must be highly adaptive: incorporating binding climate scenarios, revising current allocations downwards where future balances require it, and definitively prioritizing environ-

mental demands (ecological flows) over economic uses, in accordance with the legal order of preference. A recommended strategic shift is **to transition from the traditional policy of increasing supply to one of demand management**: instead of seeking new supplies based on conventional resources (surface and groundwater), it is important to move forward in diversifying supply sources (reuse of reclaimed water and desalination of brackish and saline water through advanced treatments), where Spain already leads at the European level but is far from its true potential (see Table 3), and to focus on managing existing demand by increasing efficiency in use and sophisticated reallocation mechanisms. This involves providing technological support for reducing consumption (e.g., modernizing 100% of irrigation with smart irrigation) while being willing to **convert unsustainable activities** (e.g., replacing high-consumption crops with adapted ones or even evaluating the rescue of private rights of use and exploitation in critical aquifers).

In economic and governance terms, it is recommended **that the water pricing and financing scheme be reviewed in the context of a thorough redesign of incentives**. Moving towards full cost recovery in all sectors should be a short-term goal. To achieve this without disproportionate and counterproductive distributional impacts, it is suggested to establish low-priced basic consumption blocks for vital uses and increase rates exponentially for less priority consumption or intensive productive uses; apply the "polluter pays" principle with taxes on nitrates, etc., allocating these funds to environmental restoration; and promote social responsibility agreements with the tourism and industrial sectors to co-finance water infrastructure. It also seems desirable to **improve the transparency and accountability of the water services financing system**: today it is difficult to know how much subsidized irrigation water really costs or what investment is needed for treatment in certain basins.

Table 3. Volumes of reclaimed water reuse for agriculture
Millions of cubic meters per year.



Source: Pistocchi et al. (2018).

Amounts of reclaimed water that can be potentially deployed at different total costs for 27 Member States of the EU (Cyprus not included due to missing irrigation estimates). "Unmet" represents irrigation demand estimated for the Country, in excess of potential supply of reclaimed water.

From a technological and environmental perspective, recommendations include **accelerating investment in digitization and nature-based solutions**, while ensuring that accompanying measures are put in place so that both can truly contribute to the achievement of environmental and development goals. The state, supported by European funds, should complete the coverage of sensors and smart systems in all major networks by 2030 and create a national water data lake that concentrates information on quality, quantity, and uses accessible for advanced analysis.

At the same time, now is the right moment to establish a national **water renaturalization** plan as part of European efforts to restore ecosystems and to meet international commitments to conserve biological diversity: identify priority river sections and aquifers where pressure can be removed (reduction of extractions, removal of barriers, reforestation of watersheds based on rational criteria that do not lead to undesirable effects) and implement some flagship projects that serve as replicable models (for reference, not as a template).

In agriculture, it is important to scale up successful pilot programs in regenerative agriculture at the watershed level, linking cooperatives and large distributors to support farmers in the transition to sustainable practices in exchange for producing with less pressure on aquatic ecosystems. Such initiatives can be accompanied by **payment systems for ecosystem services**: for example, remunerating those who maintain vegetation cover that recharges aquifers or extensive livestock farmers who, through their management practices, prevent fires and conserve water-retaining pastures.

Finally, it is important to highlight the role that Spain can play in **global water governance**. As a pioneer in certain areas (desalination, reuse, and watershed management) and at

the same time highly vulnerable to scarcity, Spain is able to lead, for example, international alliances for water adaptation. Hand in hand with the recently published **European Water Resilience Strategy**, Spain can go sharing its lessons learned in droughts or diversification of supply sources and encouraging goals beyond 2027. Similarly, it should strengthen cooperation with Portugal (with whom it shares vital rivers) to jointly manage extreme scenarios: the recent joint letter from 11 countries calling for climate ambition for 2040 is a good precedent.

In conclusion, **Spain must redouble its strategic efforts in water economics and governance** to face a challenging future. Adaptation to climate change, water and food security, and ecosystem health are interconnected; therefore, solutions must be comprehensive. Reactive or incremental measures are not enough: transformations are needed in how we value, use, and manage water. Implementing the recommendations outlined here will lead to a more resilient, equitable, and sustainable water system and, with it, an equally more resilient, competitive, and fair economy. Spain, historically innovative in water management in arid climates, could once again demonstrate leadership in this critical area, ensuring that water continues to sustain its economy and well-being in the coming decades.



- AEMET (2023) Evaluation of statistical regionalization methods for the generation of climate projections within the framework of the PNACC-2 2021-2030, AEMET Technical Note 41.
- Cazcarro, I., Duarte, R., Martín-Retortillo, M., Pinilla, V., & Serrano, A. (2015). Water scarcity and agricultural growth in Spain: from curse to blessing? In *Natural Resources and Economic Growth* (pp. 339-361). Routledge
- CEDEX (2010) Effect of climate change on natural water resources. Management assignment to the Center for Public Works Studies and Experimentation (CEDEX) by the Directorate General for Water with the participation of the Spanish Office for Climate Change, December 2010.
- CEDEX (2017) Assessment of the impact of climate change on water resources and droughts in Spain. Technical Report for the Ministry of Agriculture, Fisheries, Food, and Environment (MAPAMA), Secretariat of State for the Environment, Spanish Office for Climate Change (OECC), Final Report, Single Volume, CEDEX Code: 42-415-0-001, Madrid, July 2017.
- Delacámara, G., Gómez, C. M., & Maestu, J. (2014). Water trading opportunities and challenges in Europe. *Routledge Handbook of Water Economics and Institutions*, 281-295.
- De Roo, A., Trichakis, I., Bisselink, B., Gelati, E., Pistocchi, A., & Gawlik, B. (2021). The water-energy-food-ecosystem nexus in the Mediterranean: current issues and future challenges. *Frontiers in Climate*, 3, 782553.
- Directive 2000/60/EC of the European Parliament and of the Council of October 23, 2000 establishing a framework for Community action in the field of water policy.
- Dunlop, T., Khojasteh, D., Cohen-Shacham, E. et al. (2024) The evolution and future of research on Nature-based Solutions to address societal challenges. *Commun Earth Environ* 5, 132. <https://doi.org/10.1038/s43247-024-01308-8>.
- European Environment Agency (2024). Europe's state of water 2024: the need for improved water resilience. EEA Report No 07/2024. Luxembourg: Publications Office of the European Union. ISBN: 978-92-9480-653-6. doi: 10.2800/02236
- European Commission (2025). Report from the Commission to the Council and the European Parliament on the implementation of the Water Framework Directive (2000/60/EC) and the Floods Directive (2007/60/EC), COM(2025) 2 final, Brussels, 4.2.2025.
- European Commission (2025b). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions. European Water Resilience Strategy. Brussels, June 4, 2025 COM(2025) 280 final
- Farnault, A. and X. Leflaive (2024), "Cost recovery for water services under the Water Framework Directive", OECD Environment Working Papers, No. 240, OECD Publishing, Paris.
- Funes, I., Savé, R., de Herralde, F., Biel, C., Pla, E., Pascual, D., ... & Aranda, X. (2021). Modeling impacts of climate change on the water needs and growing cycle of crops in three Mediterranean basins. *Agricultural Water Management*, 249, 106797.
- Gratsea, M., Varotsos, K. V., López-Nevado, J., López-Feria, S., & Giannakopoulos, C. (2022). Assessing the long-term impact of climate change on olive crops and olive fly in Andalusia, Spain, through climate indices and return period analysis. *Climate Services*, 28, 100325.
- Hjorth, P., & Madani, K. (2023). Adaptive water management: on the need for using the post-WWII science in water governance. *Water resources management*, 37(6), 2247-2270.
- IPCC (2023) Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 35-115, doi: 10.59327/IPCC/AR6-9789291691647.
- Law 1/2018, of March 6, adopting urgent measures to mitigate the effects of drought in certain river basins and amending the revised text of the Water Law, approved by Royal Legislative Decree 1/2001, of July 20.
- Magdaleno, F., and Delacámara, G. (2015). Natural Water Retention Measures: from design to implementation through European projects. *Civil Engineering*, 179, pp. 131-138.
- Matthews, J.H., Maestu, J., Kolkaila, A., Ei Phyo, P.E., Gomez, C.M., Muñoz Castillo, R., Rodriguez, D.J., Duel, H., Panella, T., & Vlaanderen, N. (2024). *Managing Water for Economic Resilience: De-risking Is Not Enough*. Corvallis: Alliance for Global Water Adaptation (AGWA).
- Pistocchi, A., Aloe, A., Dorati, C., Alcalde Sanz, L., Bouraoui, F., Gawlik, B., Grizzetti, B., Pastori, M., Vigiak, O. (2018). The potential of water reuse for agricultural irrigation in the EU: A Hydro-Economic Analysis. EUR - Scientific and Technical Research Reports
- Royal Legislative Decree 1/2001, of July 20, approving the revised text of the Water Law (TRLA). Published in BOE no. 176, of 07/24/2001.



Rodríguez-Berbel, N., Soria, R., Ortega, R., Lucas-Borja, M. E., & Miralles, I. (2022). Agricultural land degradation in Spain. In *Impact of Agriculture on Soil Degradation II: A European Perspective* (pp. 263-297). Cham: Springer International Publishing.

Sola, I., Sáez, C. A., & Sánchez-Lizaso, J. L. (2021). Evaluating environmental and socio-economic requirements for improving desalination development. *Journal of Cleaner Production*, 324, 129296.

Yeste, P., Rosa-Cánovas, J. J., Romero-Jiménez, E., Ojeda, M. G. V., Gámiz-Fortis, S. R., Castro-Díez, Y., & Esteban-Parra, M. J. (2021). Projected hydrologic changes over the north of the Iberian Peninsula using a Euro-CORDEX multi-model ensemble. *Science of The Total Environment*, 777, 146126.

Zafra-Gómez, E., Garrido-Montañés, M., López-Pérez, G., & Navarro-Ruiz, M. A. (2024). Transparency and Digitalization in Water Services: Reality or Still a Dream?. *Water*, 16(3), 367.



Hosted by



With the support of

