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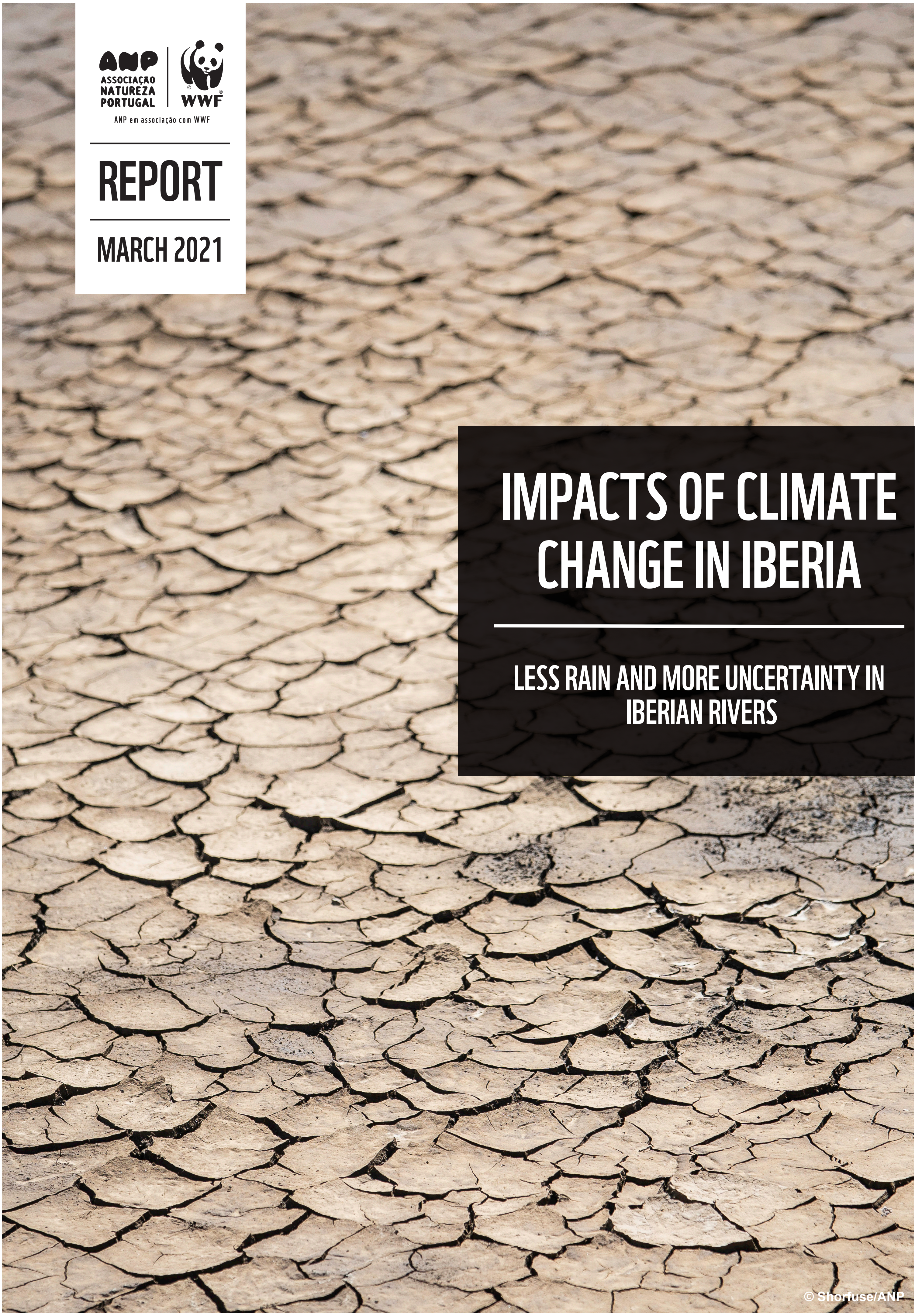

# IMPACTS OF CLIMATE CHANGE IN IBERIA

## LESS RAIN AND MORE UNCERTAINTY IN IBERIAN RIVERS

# CONTENTS




**AUTHORS:**
Afonso Do Ó (ANP|WWF)
Rafael Seiz (WWF España)



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Guadiana River
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# A FUTURE WITH LESS WATER

Most studies on climate change point to the Mediterranean Region, and in particular the Iberian Peninsula, as a critically vulnerable territory (e.g. EEA 2017, Forzieri *et al.* 2015, Ciscar *et al.* 2014). Uncertain seasonal patterns, increasing temperatures and reduced rainfall will combine to cause a growing risk of water scarcity, along with more frequent droughts, heatwaves, flash floods, wildfires, coastal erosion and progress of desertification due to reduced soil humidity (CEDEX, 2017).

These risks will particularly impact the Peninsula's freshwater resources and ecosystems, already affected by regional scarcity, excessive demand and abstraction, river fragmentation and pollution. As a result, our water sources and allocation systems are already under stress, and the near future will bring greater challenges if we do not change our management and relation with rivers, wetlands and aquifers.

## WHAT WILL HAPPEN TO THE CLIMATE?

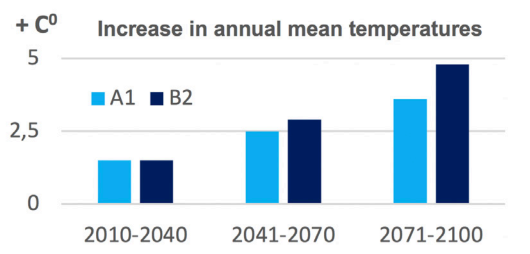
Country profiles published by the OECD (2013) already pointed to the most significant climate trends that remain valid in the present. The main changes and trends observed for both Portugal and Spain include:

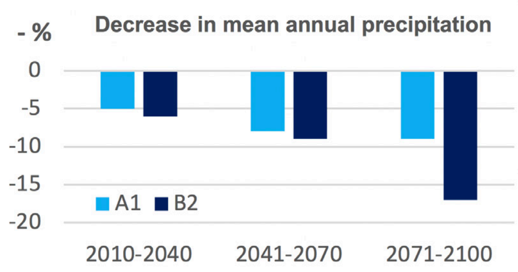
- General increase in temperature over the 20th century of a much greater magnitude than the global average, and more accentuated in winter.
- Rainfall showed a downward trend over the 20th century, especially in the south. However, given the high variability of rainfall, no precise trend is yet clear for the 21th century.
- Frequency of longer droughts has increased over the last 4 decades.

"IT IS LESS LIKELY THERE WILL BE ENOUGH WATER FOR RIVERS, AQUIFERS AND RESERVOIRS IN THE IBERIAN PENINSULA IN THE NEAR FUTURE"

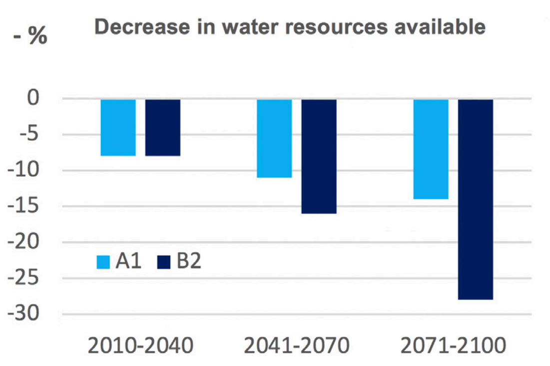
Based on two different Greenhouse Gas (GHG) emission scenarios (A2 and B2), the main projected impacts include:

- Overall increase in annual mean temperature and greater differences are expected during the spring and summer, possibly reaching up to 7ºC in the summer season for North-western regions.
- Decrease in mean annual precipitation, but some projections suggest increases in rainfall in the eastern Iberian Peninsula during the period 2011-40.



- Decrease in water resources mainly due to the reduction in rainfall.
- Increase in the frequency of intense and short droughts over the first decades of the 21st century, and in the frequency of longer droughts over the last decades of the 21st century.
- Increased frequency and intensity of heatwaves.




In general, all of these trends have been confirmed in more recent and regionally downscaled studies, such as those based on the IPCC scenarios RCP 4.5 and RCP 8.5 (IPCC, 2013).

Even considering the uncertainty and differences between the various projections, the future is bleak. Overall, models confirm a reduction in rainfall, combined with a consistent increase of mean temperatures resulting in greater evapotranspiration. On the ground this will result in less water in soils, less water flowing in rivers and less water recharging aquifers as the 21th century advances. Even without changes from human demand, plants and animals will find it harder to meet all their water needs. For us, it will be equally challenging to allocate the available water resources to maintain our current lifestyle.


## WHAT WILL HAPPEN TO NATURE?

Climate change will impact freshwater ecosystems by changing the quantity, quality and timing of water supplies. Driven by a range of factors, these impacts will be complex and hard to predict but will include (World Bank, 2010):

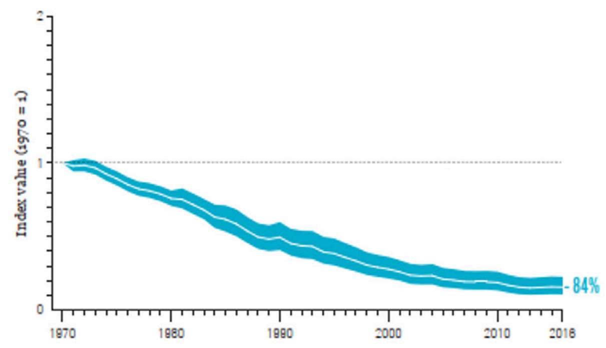
- Variations in the volume, seasonality and intensity of rainfall;
- Shifts from snow to rainfall;
- Alteration of surface runoff and groundwater recharge patterns;
- Increased evapotranspiration;
- Higher air and water temperatures;
- Rising sea levels;
- More frequent and intense tropical storm surges.





Furthermore, reduced precipitation and higher temperatures are already increasing water demand for irrigation, urban supply and most other human uses, directly impacting flow-rates in freshwater ecosystems.

All together, these changes are contributing to the dramatic decline of freshwater biodiversity (-84% between 1970 and 2016), as shown by WWF's Living Planet Report 2020. Freshwater species are at particular risk of climate-related extinctions due to their high levels of endemism and niche adaptation, coupled with a reduced ability to shift location in contrast with marine or terrestrial species (Poff *et al.*, 2012).




The crisis of freshwater biodiversity is evident. Around a third of freshwater fish species are threatened with extinction, and 80 species have already been declared extinct. Populations of migratory fishes, including sturgeon and salmon, have fallen by 76% since 1970. In the Iberian Peninsula most river basins are artificially regulated and river habitats degraded, resulting in a severe negative impact over endemic species of migratory fish, similar to the trends at the global level. In fact, Iberia has a long history of anthropogenic disturbance that has led to the poor conservation status of its ichthyofauna (freshwater fish), with 52% of species now classified as Critically Endangered, Endangered or Vulnerable, according to IUCN criteria (Maceda-Veiga, 2013).

Specifically, climate change poses significant risks to freshwater species in three different ways:

- Direct impacts on the species themselves (for example, higher temperatures may leave populations unviable) - as previously described and reported for the Peninsula;
- Changes to ecosystem structure and processes, such as shifts in flow timing, temperature changes, river or wetland shape - e.g. many of the major Iberian river sources and upstream stretches are drying up for longer periods and suffering increased quality-related problems (RCM, 2019);
- Secondary anthropogenic impacts influenced by climate change, e.g. increased water use, dam building, aquifer abstractions and others - as shown in the results from the assessment of the EEA on the second River Basin Management Plans (EEA, 2018) for both Portugal and Spain (MITECO, 2018)

# WHAT WILL HAPPEN TO US?

The impacts of climate change on freshwater ecosystems will not only affect biodiversity, but also economies and societies (WWF-ABInBev, 2019).

Freshwater ecosystems provide a range of provisioning services such as inland fisheries, and regulating services such as waste assimilation, sediment transport (necessary for downstream coastal beaches and tourism), flow regulation, and the maintenance of estuarine, delta and nearshore marine ecosystems. Freshwater ecosystems also underpin irrigated agriculture, are still core to the energy supply of both countries, and supply Iberian cities and industries with water.

## AGRICULTURE

Increasing temperatures and reduced rainfall across the Peninsula are likely to increase the demand for freshwater and affect the agricultural economy of both Iberian countries.

More frequent and severe droughts, particularly in the vast water-scarce areas of the inner and southern Peninsula, will trigger higher demand for irrigation, posing more pressure and increasing risk on both surface and groundwater bodies. In fact, in irrigated agriculture, higher temperatures lead to more evapotranspiration, which decreases runoff and increases water demand. Changes in quantity or timing of precipitation affect the viability of agricultural operations, leaving the most vulnerable farming communities at even greater risk.

Other expected impacts include plagues and diseases, soil erosion and increased risk of desertification, all of which affect the performance and sustainability of underpinning freshwater ecosystems.



## HYDROPOWER

Climate change will impact energy systems, and hydropower in particular. On the demand side, heating and cooling patterns will change due to rising temperatures. On the supply side, impacts include changes to the variability of wind, solar and hydropower resources, the availability of crops for bioenergy feedstocks, the efficiency of thermo-electric power plants and transmission lines, and technology downtime from more frequent and intense extreme weather events

Climate change is also expected to have a negative impact on the hydropower system of the Iberian Peninsula. As the work of Pereira-Cardenal *et al.* (2014) already pointed, changes in river runoff are expected to reduce hydropower generation, while higher temperatures are expected to increase summer electricity demand, when water resources are already limited. Changes in precipitation will not only reduce runoff and decrease hydropower production (with accompanying increases in thermal generation), but will also increase irrigation water use, while higher temperatures will shift power demand from winter to summer months. The combined impact of these effects will generally make it more challenging to balance agricultural, power, and environmental objectives in the operation of Iberian reservoirs.

Finally, increased demand for water may trigger new hydropower developments, with detrimental effects on river flows, fish migrations and sediment dynamics, once again affecting the health of freshwater ecosystems that are key to a sustainable adaptation to climate change.

# ARISING PRESSURES AND MISPERCEPTIONS

All the pressures caused by reduced water supply and increasing demand do not only trigger and increase water scarcity risks, but also often lead to misleading perceptions and fallacies (https://fnca.eu/desmontandofalacias/).

One that is very common in both Iberian countries is that more dams will secure more water and increase renewable energy production. In both cases, things aren't exactly like that: in Iberia, the high rate of water demand depletes almost all artificially regulated resources yearly, and does not allow much storage for drier periods. On the other hand, it would be contradictory if it could, as it would reduce the reservoirs' capacity to regulate floods (Del Moral & Saurí, 2013 - a full dam affected by heavy rains would need to release stored water, further exacerbating flooding).

Furthermore, hydropower may be renewable but not necessarily sufficient. Water resources are limited, and infrastructure is already excessive - in Spain, the maximum production reached in 2007 corresponded to only 47% of the installed capacity. Hydropower is also not sustainable. It has massive impacts on riverine ecology and fragmentation as described in the previous section (AEMS, 2013). Finally, hydropower is not necessarily climate-friendly. Some dams have been shown to generate more emissions (due to biomass decay) than the emissions saved from not burning fossil fuels (Scherer & Pfister, 2016).

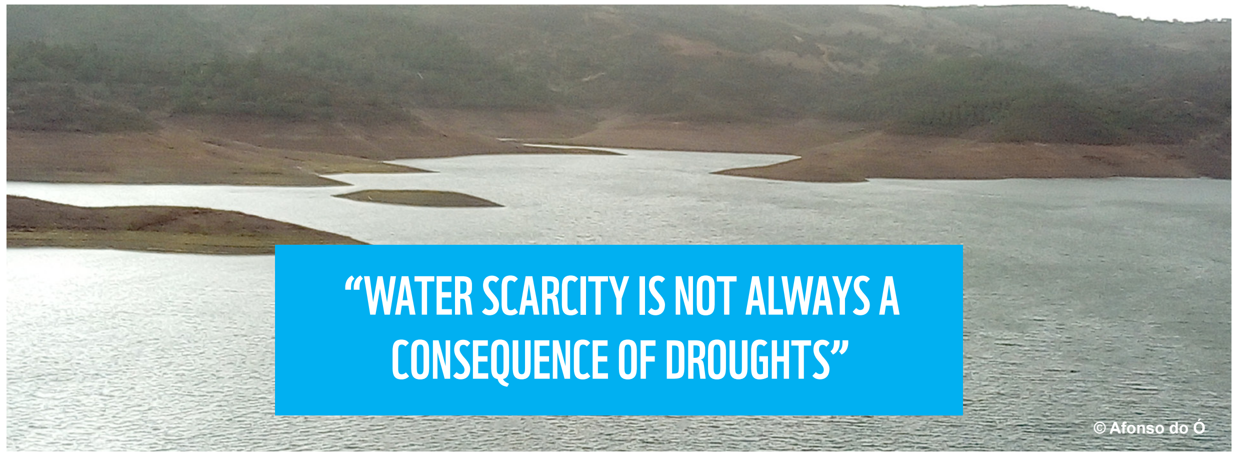
Other critical misunderstandings include:

- The idea that irrigated fields are relevant carbon sinks that help to store $CO_2$, when such storage capacity depends mostly on the crop lifetime (usually very short in irrigated farming), and on the soil's organic matter content (often reduced by intensive farming and agrochemicals - Sapkota *et al.*, 2020);
- The idea that irrigation will "green" landscapes and stop desertification, while in fact such process is mainly caused by excessive use of soil, water and living resources, and many of the arid landscapes of southern Iberia are natural and keepers of important biodiversity and ecological values (Martínez-Fernández & Esteve-Selma, 2005);
- The idea that modernized and more efficient irrigation will save water to face climate change, when in fact such efficiency, undeniable and supported by improved technologies, is most often used to expand irrigated lands and crops (and to supply crops that are not adequate to local conditions), thus increasing overall consumption and the scarcity risk it is often intended to reduce (Corominas & Cuevas Navas, 2017);
- Overall, the idea that freshwater reaching the ocean is "wasted water", when that water has an ecological role to play.

# RECOMMENDATIONS

## WE CAN FACE THE CHALLENGE, BUT WE HAVE TO ACT

It is key to separate challenges brought by recurrent natural periods with reduced rainfall in comparison to average values (i.e. drought spells), and problems resulting from the unbalance between water demands and water availability in the water allocation systems that we manage (i.e. water scarcity) (EC, 2007). In the Iberian Peninsula it is frequent that long and severe drought spells intensify the water scarcity issues that human systems suffer, but lower rainfall is not always the cause of all our problems.




In fact, the intensive artificial regulation of Iberian river basins has allowed us to unnaturally extend the availability of water, and displace the water allocation for several years. Our reservoirs, channels and transfers have brought us false water security against the "untameable" nature. However, this has also supported the continuous growth of water demands to a point in which our reservoirs no longer ensure enough water when it rains less. Also, the use of groundwater has increased significantly to compensate for the lack of surface resources. Far from being a solution, water scarcity has not decreased and we begin to run out of easy and "cheap" artificial solutions.

In an uncertain scenario of climate change, with projections of less water available and increased water demands for human development and biodiversity, we cannot look back to search for solutions. We must learn to use our systems in a different way, incorporating water risk in decision making. To this regard, it is key that we progress on water monitoring that helps us to have better information, allowing us to differentiate situations that we cannot reasonably control and foresee from those that are the consequence of poor management of water resources, and that must be considered within the framework of ordinary hydrological planning.

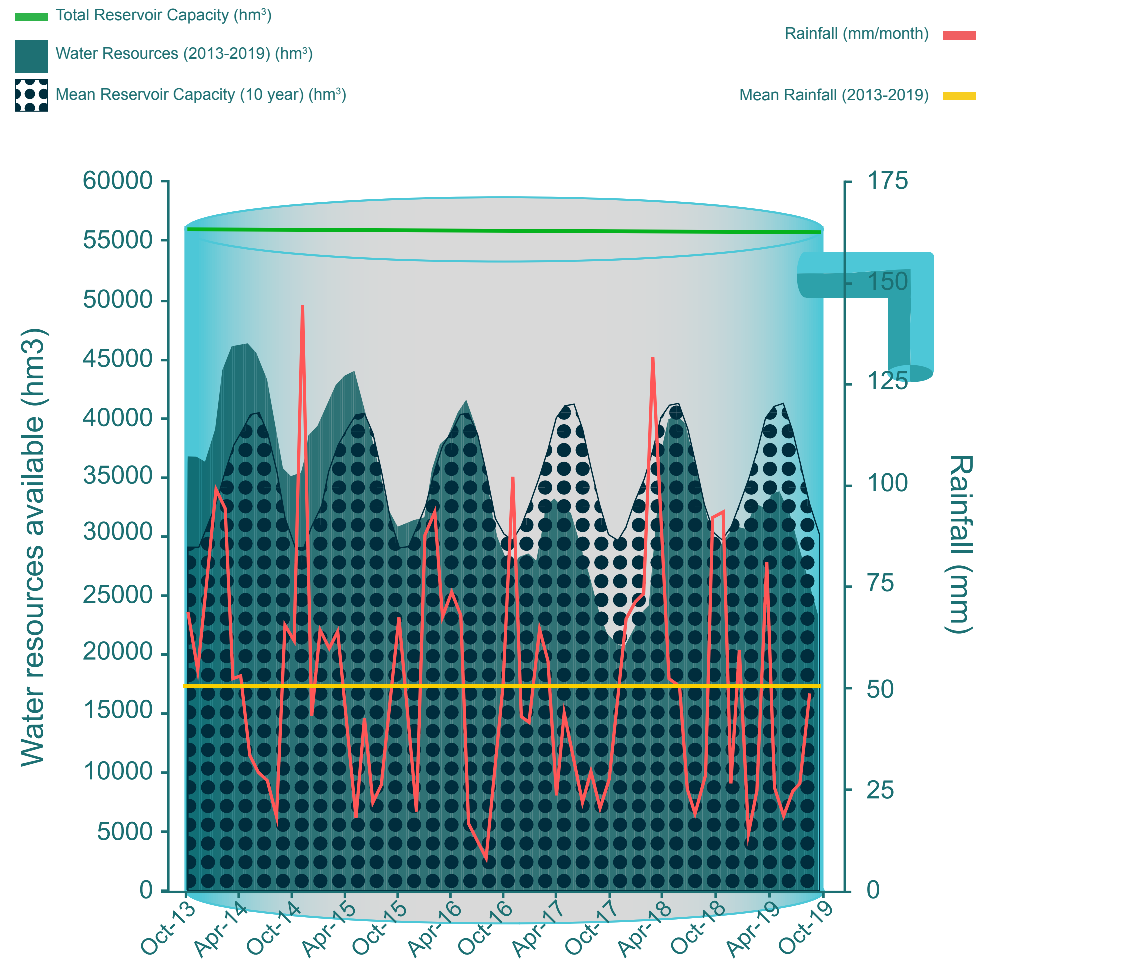



Figure 1. Comparison between the water resources (in reservoirs) and the rainfall in Spain (2013-2019). As seen, not all the water reserves match the rainfall peaks and water demand by users drop the resources available in the reservoirs faster than the recharge form the precipitation. Also note the downward trend in water resources despite the maintenance of the rainfall, as a result from intense water demands from users.

**The correct implementation of the Water Framework Directive is a key element for the Iberian river basins, incorporating the precautionary principle in the management of resources and providing instruments to guarantee sufficient water reserves. To this regard, River Basin Management Plans must integrate a proactive management of water risks, reduce and adjust demand to available resources, and improve the ecological status of rivers, wetlands and aquifers, ensuring water needs for nature. These are the key actions that need to be put in place:**

**1. PROGRESS ON COST RECOVERY OF WATER SERVICES** - it is essential to set a water pricing policy that serves as an incentive for rationally using resources and ensuring an adequate contribution from water users to improve their status of water sources, in accordance with the "polluter pays" principle. For example, Spanish authorities must set a tariff on the use of groundwater to stop the overexploitation of key aquifers such as the upper Guadiana or Doñana, and Portuguese authorities should do the same for the southern coastal aquifers of the Algarve. Both should set progressive water tariffs according to the water volumes used by irrigation farmers in most of the river basin districts.

**2. INTEGRATE MANAGEMENT OF EXTREME EVENTS (FLOODS AND DROUGHTS) IN RIVER BASIN MANAGEMENT PLANS** - the implementation of the WFD must be coordinated with the implementation of the Flood Directive (FRMPs) and the development of Drought Plans to avoid overlapping measures and resources. To this matter, both countries need to develop and implement robust monitoring systems that prevent the risks of extreme events well in advance, diagnose its consequences and assess its impacts on the water bodies. Such systems must clearly differentiate issues related with the management of reservoirs and allocation systems (e.g. water scarcity) from the consequences of rainfall decrease (e.g. droughts), when it is necessary to prioritise minimum environmental flows to limit negative impacts on rivers, wetlands and aquifers.

**3. REDUCE AND LIMIT DEMAND ON AVAILABLE RESOURCES** - in order to limit the negative impacts of extreme events and water stress situations, human demand for water must be adapted and more flexible than in our current allocation systems. Storing water in reservoirs must be compatible with keeping a complete environmental flow regime for rivers (not just minimum flows, but also maximum flows, rate of change and sediment load) to maintain the good status of habitats and biodiversity. This will not only increase resilience of rivers and wetlands but also ensure strategic water reserves during drought periods. To this end, water authorities must strictly control water allocation, monitoring water use with flow meters, satellite imagery and other telemetric tools, in order to effectively identify water resources available for economic activities and needed for environmental functions.



**4. DEVELOP THE USE OF MULTIPLE WATER SOURCES** - allocation systems have traditionally relied on regulating river flows through dams and extracting water from aquifers. However, in the present context of climate change and emerging new water uses, we need to use technology wisely to ensure our water demands. Desalination and water reuse may come into play, and coupled with our present regulation capacity, should help us reduce the pressure on natural water bodies and diversify our sources for water. Each river basin or water system should determine the most adequate source-mix in order to guarantee the conservation of aquatic ecosystems while responding to human demand, including from novel uses.

**5. IMPROVE THE TRANSBOUNDARY MANAGEMENT OF SHARED FRESHWATER RESOURCES** - the challenges posed by climate change on Iberian shared river basins call for an effective transboundary management, based on a permanent and empowered technical secretariat and on a revised flow regime of the Albufeira Convention, which ensures e-flows and assumes effective uses and abstractions in water management. Though there is room for improvement of the details and agreements under the Convention, the structures and bodies of collaboration between Portuguese and Spanish authorities should be reinforced to ensure an effectively coordinated water management.

**6. SUPPORT A WATER SAVING CULTURE IN IBERIA** - people in Portugal and Spain have shared water management challenges for centuries. Today, they share new challenges as a result of climate change. Our societies must change their relationship with water, promoting a more sustainable use of water resources, especially by the productive sectors that consume the most (mainly agricultural uses). Given our dominantly Mediterranean climate and the impacts of reduced water security as a consequence of climate change, we have to cut down our dependence on intensive water uses, ensuring that the resources brought by more efficient technologies revert to ecosystems in order to increase strategic reserves for nature and people. The examples of intensification in the use of water resources that we have both in Portugal (e.g. the expansion of intensive irrigation linked to the Alqueva system) and Spain (e.g. the continuous overexploitation of the aquifer in the Campo de Cartagena in Murcia) show the likely collapse of key biodiversity areas and the decrease of water security for both nature and people.

**The water challenges our two countries share today are different from those in the past. A water safe future will require new approaches. We have to move towards a new water culture that assumes uncertainties, manages risks, and recognizes the role of healthy aquatic ecosystems as a key tool for adapting to climate change.**

## WE SHOULD LOOK TO NATURE TO FIND OUR WAY

**The COVID-19 crisis is a sign from nature to us. It's a SOS to the human enterprise, bringing into sharp focus the need to live within the planet's 'safe operating space'. The environmental, health and economic consequences of failing to do so are disastrous.**

Now more than ever before, technological advances allow us to listen to such messages and better understand the natural world. We can estimate the value of 'natural capital' – the planet's stock of renewable and non-renewable natural resources, like plants, water, soils and minerals – alongside values of produced and human capital – for example, roads and skills – which together form a measure of a country's true wealth (WWF, 2020). Our economies are embedded within nature, and it is only by recognising and acting on this reality that we can protect and enhance biodiversity and improve our economic prosperity.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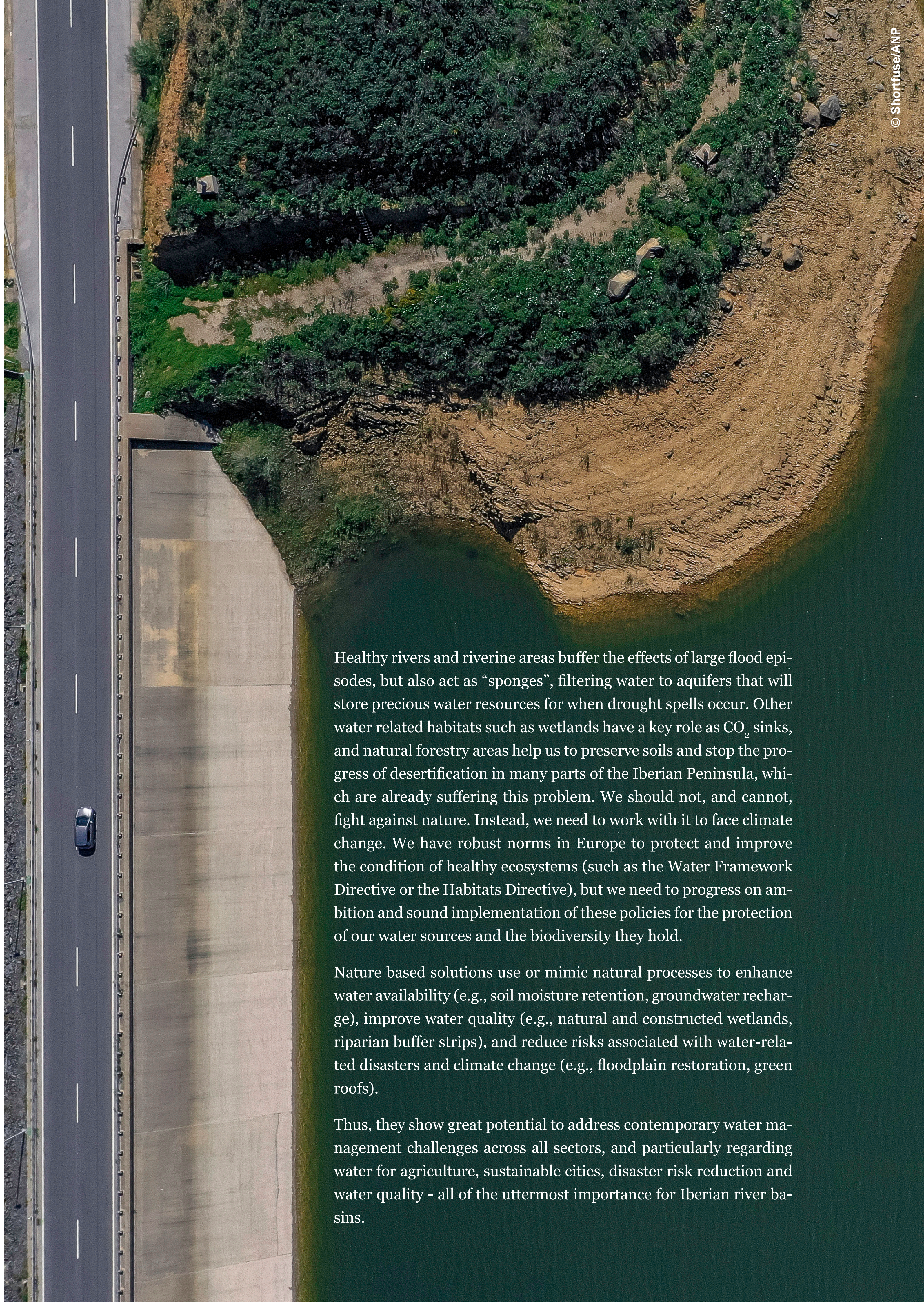
**"AQUATIC ECOSYSTEMS ARE KEY FOR SUSTAINING ECONOMIC DEVELOPMENT IN THE IBERIAN PENINSULA, BUT ARE ALSO FUNDAMENTAL FOR US TO DEAL WITH CLIMATE CHANGES"**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Healthy rivers and riverine areas buffer the effects of large flood episodes, but also act as "sponges", filtering water to aquifers that will store precious water resources for when drought spells occur. Other water related habitats such as wetlands have a key role as $CO_2$ sinks, and natural forestry areas help us to preserve soils and stop the progress of desertification in many parts of the Iberian Peninsula, which are already suffering this problem. We should not, and cannot, fight against nature. Instead, we need to work with it to face climate change. We have robust norms in Europe to protect and improve the condition of healthy ecosystems (such as the Water Framework Directive or the Habitats Directive), but we need to progress on ambition and sound implementation of these policies for the protection of our water sources and the biodiversity they hold.

Nature based solutions use or mimic natural processes to enhance water availability (e.g., soil moisture retention, groundwater recharge), improve water quality (e.g., natural and constructed wetlands, riparian buffer strips), and reduce risks associated with water-related disasters and climate change (e.g., floodplain restoration, green roofs).

Thus, they show great potential to address contemporary water management challenges across all sectors, and particularly regarding water for agriculture, sustainable cities, disaster risk reduction and water quality - all of the uttermost importance for Iberian river basins.

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ANP, em associação com a WWF
Laboratórios Audax, Rua Adriano Correia de Oliveira, 4 A – Lab H3, 1600 – 312 Lisboa
www.natureza-portugal.org

WWF España
Gran Vía de San Francisco, 8-D. 28005 Madrid