

Intervention of the Doñana Biological Station EBD-CSIC at the Extraordinary Plenary Session of the Doñana Participation Council, 10 April 2023

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This extraordinary plenary session has been convened to analyse the proposed law "Improving the planning of irrigated areas of the Condado de Huelva in the municipalities of Almonte, Bonares, Lucena del Puerto, Moguer and Rociana del Condado (Huelva)" presented in the Andalusian Parliament, due to its repercussions on the conservation status of the Doñana aquifer on which numerous species and habitats listed as priorities by Andalusian, Spanish and EU legislation depend.

Spain has been sentenced by the judgment of 24 June 2021 of the Court of Justice of the European Union (C-599/19 Doñana) for failing to fulfil its legal obligations under the Water Framework Directive (2000/60/EC) and the Habitats Directive (92/43/EEC), by not taking into account the illegal water abstractions for cultivation nor the water abstraction for urban supply in the estimation of total groundwater abstractions in the Doñana region, as well as by failing to provide any measure to prevent the alteration caused by groundwater abstractions to the habitat types listed as priority habitats.

The wetlands are probably the most important natural asset of Doñana, with two main types, the marshes and the lagoons. The marshland is formed on a clayey substrate capable of retaining rainwater as well as water entering through streams and brooks, which, in turn, are also dependent on groundwater.

The lagoons of Doñana

Most of the lagoons in Doñana depend on groundwater, appearing at the discharge points of the aquifer. Rainfall allows the aquifer to recharge, giving rise in normal years to an important network of lagoons (Figure 1). This lagoon system is unique in Europe because of the great abundance and heterogeneity of the lagoons it contains. In 2004, a year of maximum flooding, the Doñana lagoon system has been mapped in detail by using a multispectral image. In the Doñana National Park alone, about 3000 temporary lagoons were plotted, most of them of small dimensions (<50m²), which are characteristic of these Mediterranean temporary lagoons. The vegetation on the edges and in the basins of the temporary lagoons constitutes a habitat type classified as a priority by the EU (Mediterranean temporary lagoons HIC 3170).

There are a few lagoons that dry up very rarely (permanent lagoons), while the majority are temporary lagoons, which dry up every year during the summer. The flood levels and hydroperiod of the lagoons located on sandy soils depend directly on the fluctuations of the water table, with the dynamics of some of the lagoons located in the "vera" area (ecotone between marshes and scrubs), where sandy and clay layers alternate, being more complex. Mediterranean systems such as Doñana are characterised by significant fluctuations in water availability depending on

the recurrence of wet and dry periods. On the other hand, unsustainable exploitation of the Doñana aquifer, characterised by extraction in excess of the recharge level, has continued to grow in recent years, severely affecting the dynamics of the entire system, including the integrity of priority habitats and the species that depend on them.

The water table has descended across the whole Doñana area. Most of the areas in which the CHG (Hydrographic Confederation of the Guadalquivir river) sectorises the aquifer show negative trends, only two of them are spared from this general decline. The drop in the water table has a direct impact on the lagoons by affecting their hydroperiod (the time they remain flooded) and the surface of the flooded area each year, frequently drying up lagoons completely for several years in a row. When the succession of years without flooding episodes exceeds the average recurrence time of the typical Mediterranean droughts, the vegetation of the lagoons disappears and thus the habitats listed in the Habitat Directive are lost. The process ends with the complete disappearance of the affected lagoons as they are completely colonised by terrestrial vegetation.

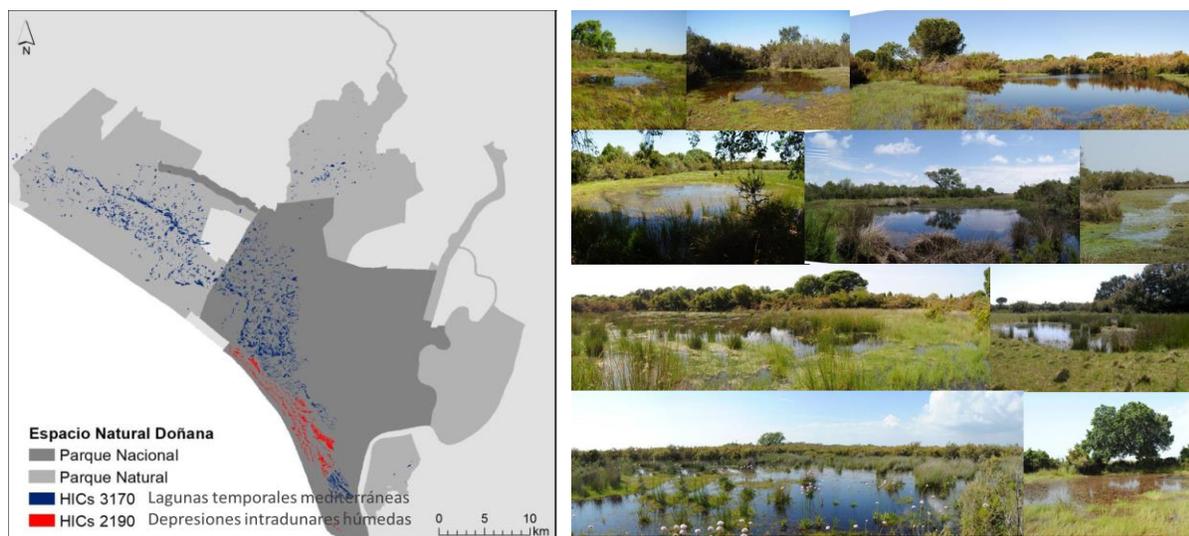


Figure 1. Left: Distribution of two of the habitats listed as EU priority habitats that are completely dependent on the water table (Mediterranean temporary lagoons and humid intradune depressions). Right: examples of Mediterranean temporary pools in Doñana.

Current conservation state of the Doñana lagoons

The deterioration of the Doñana lagoon system is widespread. The small ponds has disappeared first. Using remote sensing, the 316 largest lagoons (>900 m²) in the National Park were monitored between 1985 and 2018, estimating the maximum area flooded for each year and the date on which they dry out completely.

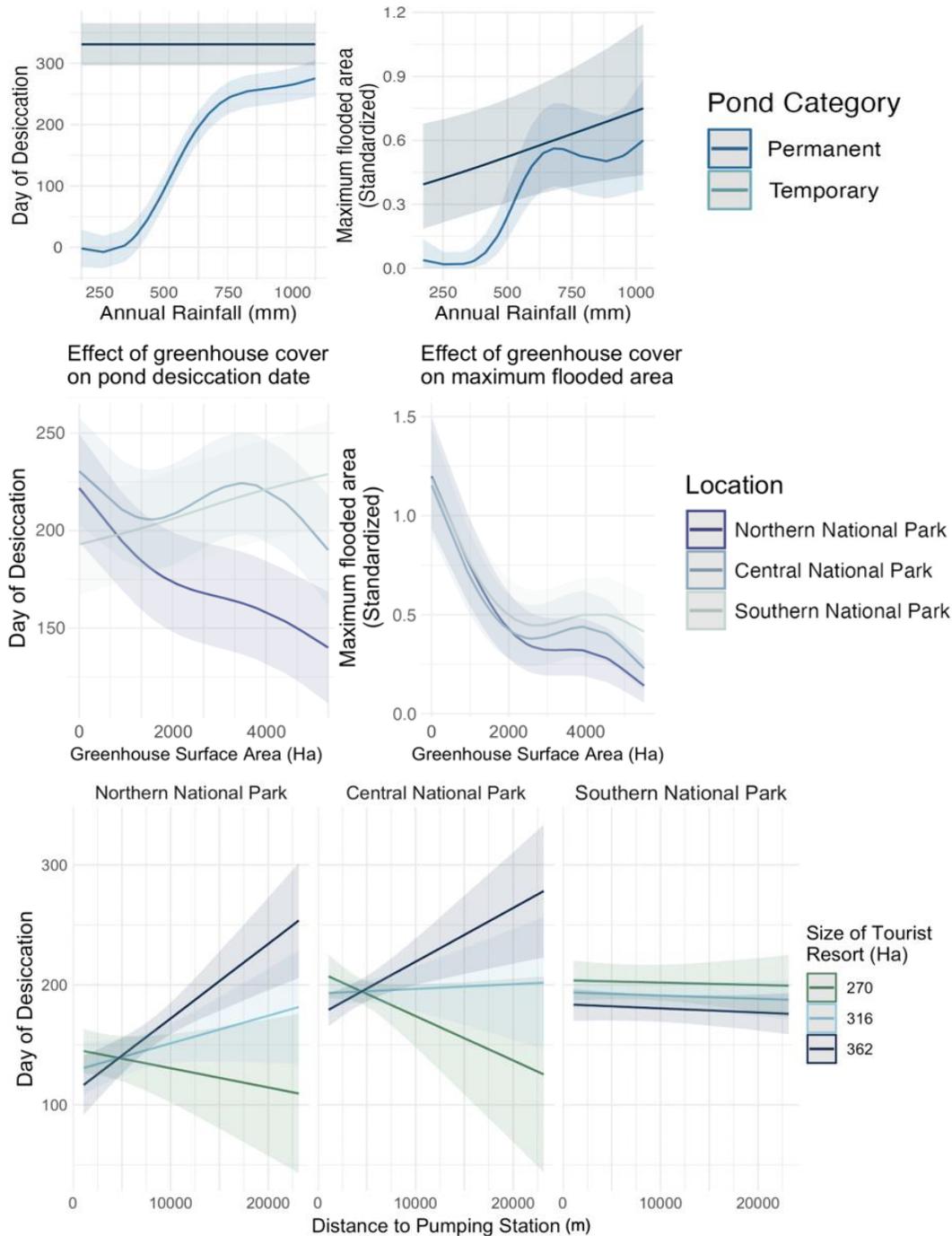


Figure 2. Effect on the date of desiccation and maximum flooded area of the significant variables: annual rainfall, area covered by greenhouses, distance to the Matalascañas boreholes (de Felipe et al 2023).

The lagoons show a significant overall tendency to dry out earlier and in reducing the total area flooded. Fifty-nine percent of the surveyed lagoons have not been flooded since at least 2013. The observed changes are significantly related to temperature and precipitation each year, as well as to the extent of cultivated areas, the urbanized surface of Matalascañas, the distance to the urbanisation pumping stations and the operability of the golf course (Figure 2).

With these analyses, we can see the effect of human variables related to water consumption once the effect of climatic variables has been controlled for: 80% of the lagoons had a negative anomaly on the date of drying up, and 84% in the surface flooded, i.e. lagoons have worsened more than expected due to rainfall and temperature alone. The negative impact is generalised, with particular intensity in the areas adjacent to Matalascañas, the entire western area of the National Park, the “Mogea” and the “Abalarío” areas, and positive anomalies are only observed in the restored “Sotos” area (Figure 3). It's to be expected that this situation has got even worse to date.

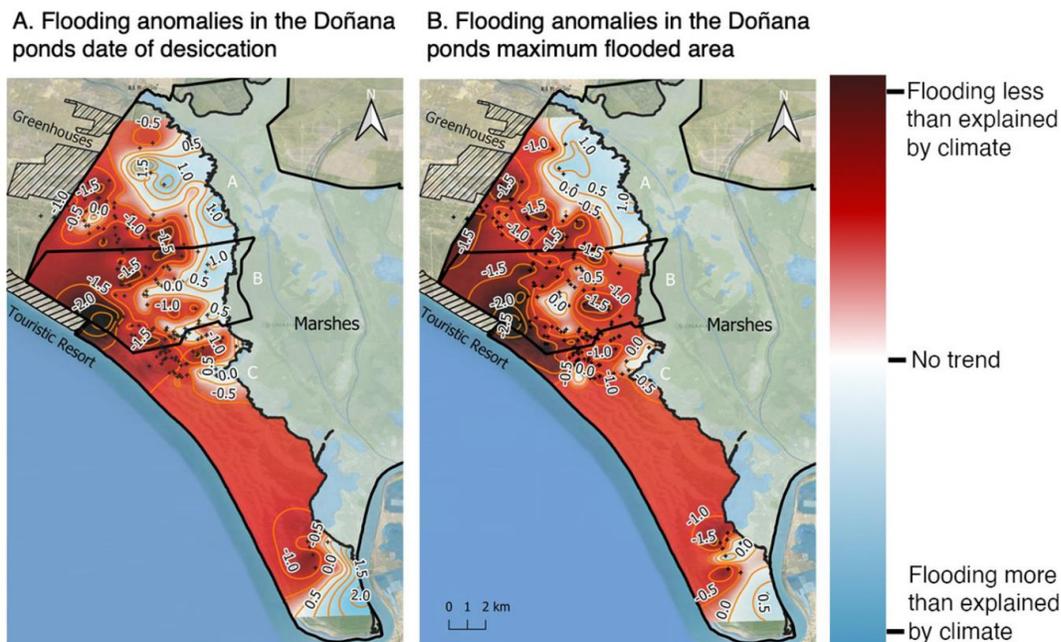


Figure 3. Spatial prediction of climate anomalies in the date of desiccation (left) and maximum flooded area (right) in the national park. A positive anomaly means for example that the area dries out later than expected by the climate while a negative anomaly is interpreted as the area has flooded less than expected by the climate. These anomalies are explained by the effect of human variables affecting the aquifer (de Felipe et al 2023).

We can expect that from 2018 to date the situation has further deteriorated. During direct field monitoring in 2021 and 2022 we have assessed the encroachment by terrestrial vegetation into the larger ponds.

Nineteen percent of the 267 lagoons sampled have been completely lost as they are now totally invaded by terrestrial vegetation (Figure 4). Among the lagoons that have disappeared are: the Moral, Charco del Toro, Zahillo, Ojillo, Taraje, Madroñas, Tardeo, Pajarillo, Pato, Mogea, Acebuche de las Palomas, Acebuche de Matalascañas, Pino, Brezo and Brecillo lagoons (Figure 5). In addition, another 19% of the lagoons have more than 50% of their basin invaded by scrubland and pine trees (e.g. Navazo del Toro lagoon). Only 10% are in good condition, mainly located in La Vera area.

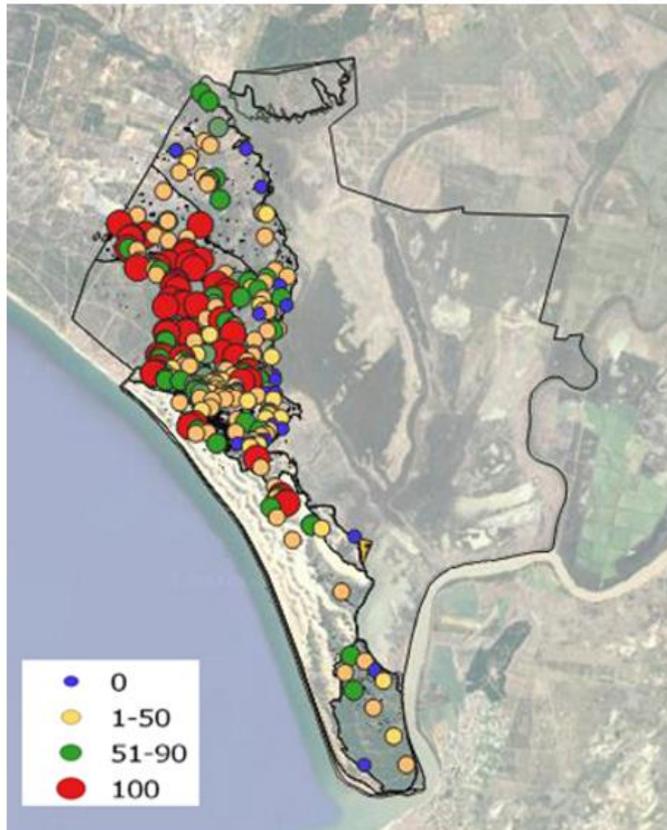


Figure 4. Spatial distribution of temporary lagoons in Doñana where habitat of Community interest has been lost through replacement by terrestrial vegetation. The values indicate the % of the lagoon that has been lost (between 0% and 100%).

The three lagoons that functioned as permanent ones have lost its permanency. The lagoons “Sopetón” and “La Dulce”, which only dried up occasionally, now dry out frequently. The Sopetón has dried up every year since 2012. The situation in Santa Olalla lagoon was extreme in the summer of 2022, when it dried up completely. This lagoon also dried up partially in 1983 and 1995, on both occasions after 4 successive years of drought. We are currently also in a dry period, but Santa Olalla is showing minimum values of its flooded surface area since 2012, despite the fact that both 2010 and 2011 were rainy years. The area of the basin that has flooded in the last decade in Santa Olalla is approximately 50% lower than the value of the map created in 2004 (37% lower in the case of La Dulce lagoon). Part of the basin of these lagoons are being occupied by other types of vegetation, following the typical process of temporary lagoons in face of disappearance.



Figure 4. Spatial distribution of temporary lagoons in Doñana where habitat of Community interest has been lost through replacement by terrestrial vegetation. The values indicate the % of the lagoon that has been lost (between 0% and 100%).

All these changes can be associated with the decrease in piezometric levels in the west and northwest of the Doñana Biological Reserve. For example, the Ojillo and Mogea piezometers show that the water table is now between 5 and 6 m deep, with even lower values than in 1995 (the minimum detected in the series). At the Ojillo area, the piezometer has dropped 65 cm below the historical minimum, with all values recorded since February 2021 being negative (Figure 6).

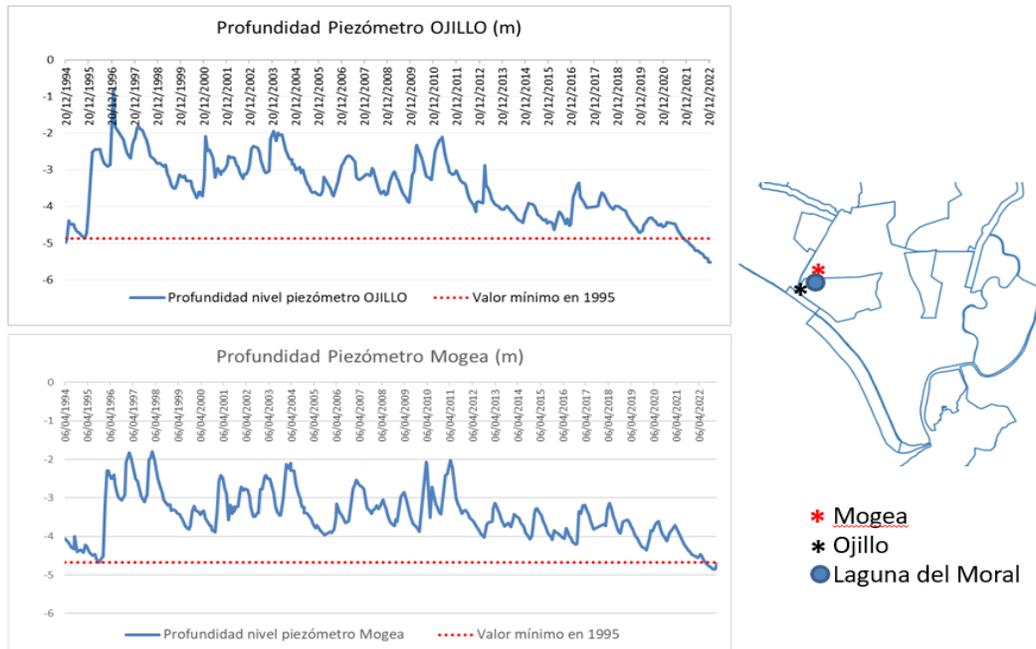


Figure 6. Profile of piezometric levels in the Ojillo and Mogea, west of the National Park between 1994 and 2022

Effects of the loss of habitats classified as temporary lagoons on biodiversity

Lagoons are the habitat of a unique fauna and vegetation, adapted to withstand the typical dry periods of Mediterranean areas. Not only large lagoons are important, small shallow ponds are

also critical for unique species due to their rarity and conservation status. These are for example the breeding habitat for amphibians and a large number of macroinvertebrates such as odonates. In addition, the grassy border of the temporary ponds is key to prolonging the rabbit breeding season until well into June, being one of the main factors explaining the critical situation of rabbit populations of Doñana.

Amphibians have lost a large number of their breeding sites as the flooding period for all amphibians has shortened, affecting species with a longer larval period, such as the spadefoot toad, that often cannot conclude reproduction successfully. Also affected are ephemeral pond species, which no longer form, or, if they do, do not persist long enough for larvae to complete development. Amphibian species richness has been reduced from an average of 4.3 species/km² in 2003 to 2.5 species/km² in 2021 (Figure 7).

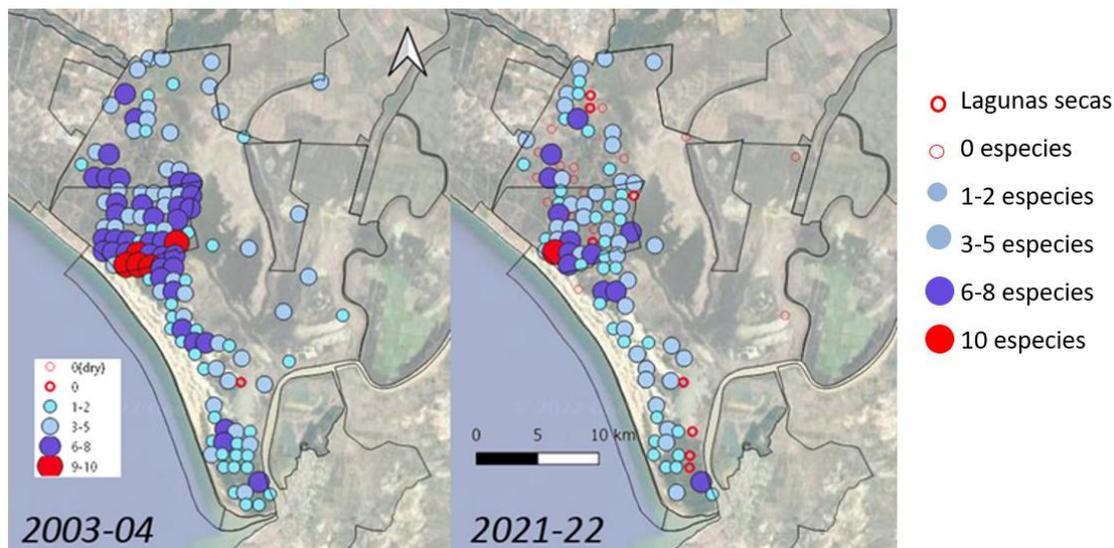


Figure 7. Variation in amphibian richness observed in Doñana National Park between 2003-2004 and 2021-2022, measured as number of species detected per square grid (species/km²).

The two species of freshwater turtles native to the Iberian Peninsula, both included in European red lists, are conserved in Doñana. The Doñana populations were considered to be among the best conserved. These species are found in the large lagoons, but they also used to be found in many of the small ponds that had puddles of water all year round. The decline of the European pond turtle in Doñana is worrying, as it is now present in only 33% of the squares it occupied in the 1990s.

The loss of aquatic habitats has had a notable effect on the species richness of dragonflies and damselflies (odonates). This group is an excellent indicator of the conservation status of aquatic environments due to the diversity of habitats that each species requires for reproduction. Doñana was considered a point of high odonate diversity, with a total of 43 species having been described since 1959. In the last decade, only 26 species have been detected, with solely 12 species observed in 2022.

Doñana conserves endangered fish species, such as the tusk, the salinette, or the European eel. These species were traditionally found in the creeks near La Vera, but in recent years these have dried up in summer, and have therefore disappeared (note that the creeks and the natural wells of the marsh are discharge points of the aquifer that are also disappearing from Doñana). The total drying up of Santa Olalla in 2022 has meant the death of the eels remaining in this last permanent lagoon.

The lagoons of Doñana are very important for the conservation of aquatic plants, some of which with restricted distributions and threatened. In general, the loss of flooding is mainly affecting species associated with long hydroperiod lagoons. Species of the genus *Utricularia* and those of the genus *Hydrocharis*, which were historically present in Martinazo, el Sopotón and el Hondón areas, have disappeared from Doñana for more than 20 years. Floating species have gradually restricted their area to man-made ponds and two of the large lagoons (Dulce and Sopotón). These include endangered species such as *Wolffia arrhiza* and *Ricciocarpos natans*. The regression of species of the genus *Potamogeton* is also very important: *P. crispus* and *P. polygonifolius*, which were recorded in the national park 20 years ago, have now disappeared, while *P. natans* and *P. lucens* are still present, thanks to marginal populations in some of the park's man-made ponds.

Other affected habitats

In addition to the temporary lagoons, there are other priority habitat types whose conservation depends directly on an aquifer in good condition, such as the case of the humid intradune depressions (HIC 2190), or heathlands, characterised by hygrophytic scrubland typical of Atlantic decalcified fixed dunes (HIC 2150) or by Atlantic wet heathland (HIC 4020). The wet heathland represents various serial stages of the cork oak forest, which in Doñana is currently in a highly degraded state of conservation.

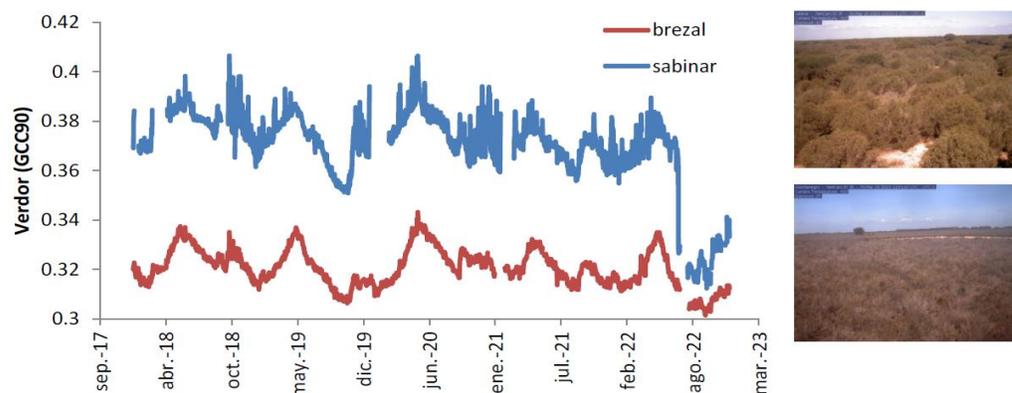


Figure 8. Variation in phenology obtained by phenocams in the long-term monitoring plots of juniper and wet heathland of the ICTS-RBD. The values correspond to the GCC90 index which indicates the degree of photosynthetic activity of the vegetation. Note the marked drop observed in 2022 (Díaz-Delgado in press).

Phenocam monitoring by the ICTS-RBD makes the effect of the decrease in water availability evident in the soil, causing the decline of the hygrophytic vegetation in Doñana (Figure 8). Its impact begins with a generalised loss of canopy, with a subsequent recovery centred on less demanding species, which increase their recruitment and cover and end up replacing the more hygrophytic species. In the period 2008-2022 we observed significant trends of systematic cover reduction in the *Erica scoparia* coppice plots in parallel with a significant increase in *Ulex australis*. We also observed a significant increase in the cover represented by low water-demanding tree species (junipers and stone pines).

Associated with the decline and loss of the black forest within the Natural Area, numerous trees are being defoliated and dying, including multi-centenary cork oaks, which is a good indicator of the exceptional nature of the current situation.

This spring we surveyed 121 cork oaks, of which 109 were centenarians, and the remaining 12 were younger, most of them from reforestation. Since their last survey in 2009/2010, 8.3% have died, while a further 10.7% are in very poor condition, with a generalised tendency towards defoliation (from an average of 3.22 in the leaf cover index (LCI) to 2.42, the maximum LCI being 5, with 100% leaf cover).

Oak mortality is mainly concentrated in the areas of El Moral, El Navazo del Toro and El Ojillo, that correspond to the highest part of the Doñana Biological Reserve (between 21-30 m above sea level). In this area, 27% of the cork oaks surveyed are dead, compared to between 3 and 5% of those located in lower areas. Those trees still alive present are in very bad shape. The cork oaks in these affected areas were in good condition at least until the autumn of 2021, so their decline and death has occurred abruptly during 2022 or 2023 (Figure 9).

Doñana is suffering a period of drought that is generating significant water stress in the cork oaks. In these situations, the trees depend on the water table for their survival. The levels recorded at the piezometer located in El Ojillo show a continuous decrease over the years. The minimum level measured in 2022 places the water table at a depth of 5.53 m, which, as we have already mentioned, is below the historical minimum recorded. In contrast, in the lower areas of the Doñana Biological Reserve (RBD) corresponding to La Vera, the water table has been more stable; being the cork oaks in this area in a better state (the piezometer of the “caño de la raya” also shows a minimum level at a depth of 1.26 m in 2022). In other areas of Doñana also significant drop in the water table have been detected, such as Coto del Rey, recording important cork oak mortalities as well.

The other causes associated with the death of large trees are senescence and the presence of *Phytophthora cinnamomi*. This pathogen was detected for the first time in the RBD in 2008, causing the proven death of several individuals. However, although it produces symptoms similar to those of water stress, it is active mainly in wet periods, causing root rot. The pathogen is widespread throughout the RBD, being present in 94% of the rhizosphere (soil) of the 169 cork

oak trees sampled during 2008-2021 (Life Adaptamed project), being present both in areas where mortality of cork oaks is being recorded and in those where it is not.



Figure 9. Example of cork oak trees collapsed during the year 2022. Left: cork oak 393 (El Moral), Right: cork oak 390 (El Moral). Doñana Biological Reserve

The Proposed Law

Like the rest of Andalusia, Doñana is suffering an intense period of drought. Climate change is changing rainfall patterns, changes that will intensify in the future and indicate a clear decrease in water availability. In addition, temperatures have risen and will continue to do so. We know that these extreme events are going to be longer in duration and more frequent. All these factors decrease water availability (Figure 10).

On the other hand, the demand for water in the Doñana region has continued to increase. For example, irrigation in the crown of the forest increased from 2162 ha in 2004 to 3543 ha in 2014 (an increase of more than 30%), and the area occupied today is even greater.

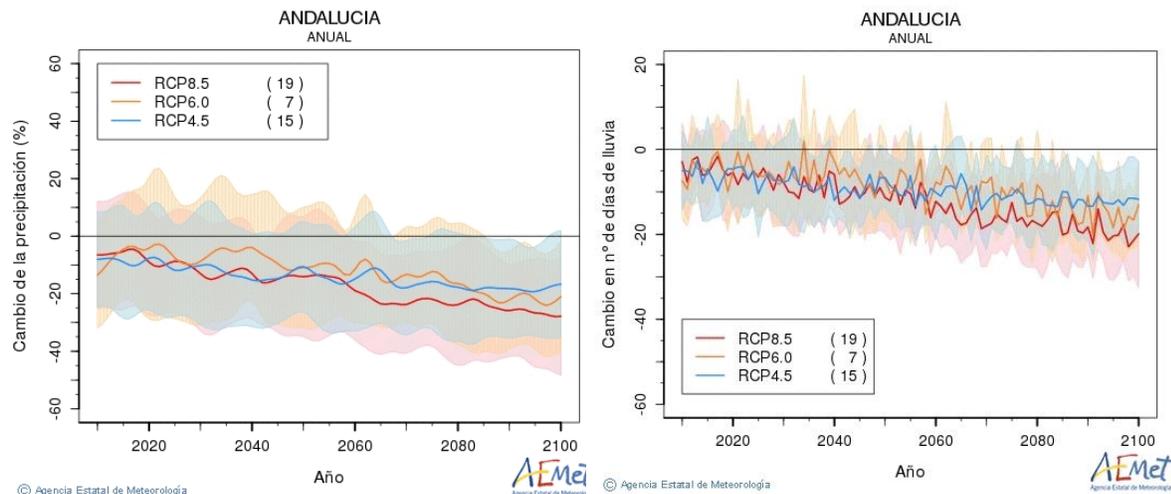


Figure 10. Regional climate projections for Andalusia under various climate change scenarios in the 21st century; assessment of the IPCC fifth report. Left: expected percentage change in precipitation, right: expected change in number of rainy days. Note that the IPCC 6th IPCC projections, not yet regionalised, are even worse than those presented in the graphs. Source: AEMET.

The proposed law includes several statements that need to be commented on.

"The aquifer will not to be touched".

The damage being suffered by habitats that are directly dependent on the aquifer and which are catalogued as a priority by Community law, make clear that the current exploitation of the aquifer is not sustainable. This means that more water resource is being used than is being regenerated annually through recharge by precipitation, which is variable and decreasing, depleting this natural resource. This situation has already been recognised by the CHG, which has declared several sectors of the aquifer to be at risk of not reaching good status.

"Doñana's irrigated crops are an example of sustainable development".

The uncontrolled proliferation of irrigated crops without the corresponding authorisations over the last two decades shows the unsustainability caused by a clear failure in governance by appropriate administrations. The lack of implementation of the Special Irrigation Management Plan for the northern forest crown of Doñana over several legislatures has intensified the problem of poor governance, showing a clear lack of political willpower to solve the problem, as recognised by the European Court of Justice ruling of 2021. This executive inaction is what has led us to the unsustainable critical point reached in Doñana's conservation status.

"Doñana is more protected than ever, being guaranteed preservation of natural resources".

The data presented show that the highest level of protection at state and European level is not serving to protect Doñana's threatened habitats and species. Part of the results presented today use data up to 2018 and 2021, so it is to be expected that after a year as difficult as 2022, or 2023 itself, which is not going to be any better, the situation will only have worsened rapidly.

The additional need to provide water to farms without concessions, as proposed in the new law, makes it even more difficult to find an urgent solution to the problem. The current situation in

Doñana is critical and does not allow to wait another decade for decisions to be taken to adjust water demand to availability. If this was done, we would be imposing, against current legislation, the complete loss of the temporary lagoon systems and other habitats dependent on the aquifer. In addition, if we do not act urgently, the depletion of the resource will mean that legal farms will have irrigation problems, as is already happening in this 2022-2023 campaign, putting at risk the economic activity that depends on the aquifer as a whole.

The problem we face is very complex, as will be its solution. The creation of false expectations, which we know beforehand cannot be met, only adds complexity to the problem. A childish dialectic of good guys and bad guys is used, which only seeks confronting different parts of society against each other, using absurd messages such as that river water reaching the sea is lost, or that environmental conservation is necessarily at odds with economic activity. This is not the moment to explain why such claims are false. However, it is important to remember that, to be economically, socially and environmentally sustainable, human activities, including economic activities, need a predictable and well-preserved environment.

What needs to be done:

- The total amount of water abstracted from the aquifer needs to be urgently reduced to levels that will allow starting recovery. Only then, its exploitation can be sustainable in the short, medium and long term.
- Annual assessments of the availability of water in the aquifer must be carried out to define the maximum quantities that can be extracted from the aquifer, depending on the annual recharge and its conservation status. In the meantime, it is necessary to establish restrictions on water consumption from the aquifer.
- The system for assessing the state of the Doñana aquifer needs to be updated, as the current system is so conservative that it only identifies poor states of the aquifer once permanent damage is detected to the natural systems that depend on it.
- It is necessary to urgently re-establish governance in the exploitation and management of water and land in Doñana and its region so that they are within the current legality.
- It is necessary to address the vulnerability of legal farmers in the face of the uncertainty created by the proposed law, the loss of brand value of their products and the unfair competition from illegal producers and the uncertainty for the future.
- The multilateral working commission titled “Doñana 2030” needs to be started up urgently, as was approved by the former Participation Council. This is the only way to make rapid and coordinated progress in improving the governance and conservation of Doñana and its region, depoliticising technical management decisions and allowing the critical situation of the aquifer to be addressed, as well as other important problems of Doñana such as water pollution, the loss of value of Doñana as a key site for breeding, migration and wintering of birds on a continental scale, or the intense overgrazing occurring due to overestimated carrying capacities for the current biomass production under today’s rainfall, to name but only a few.
- It is necessary to intensify the monitoring of natural systems and species affected by the profound changes that are occurring due to overexploitation of resources and climate change.

- It is necessary to carry out a socio-economic analysis in order to design the appropriate policies to develop sustainable agriculture in the region within the current climate change scenario, including the necessary measures to reconvert the sector and promote other sectors.
- It is necessary to respond to the legitimate interests and expectations of the region's population with incentives for diversification of economic activity that include investment in education, and in industry and value-added services that are sustainable in the environmental scenarios that we are going to face. The location is unbeatable, as are its human capital and infrastructures already in place. Moreover, the economic resources are currently available to undertake an ambitious programme in this direction. All we lack is the political willpower.

None of us present at this meeting is responsible for having created the problem. However, we have a legal, moral and social obligation to solve it. The future of Doñana and its region depends on our decisions, which, I have to remind you, is not only a local or regional value, but a universal heritage site of all humanity. You have to choose how you want to go down in history.

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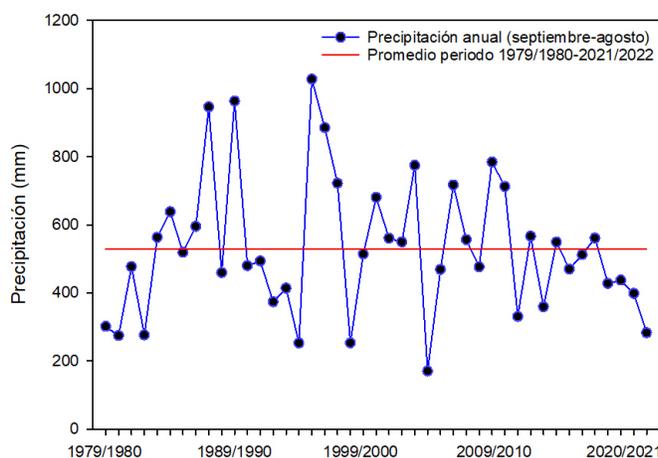


Figure Annex. Precipitation data collected at the Palacio de Doñana weather station (ICTS-RBD, EBD-CSIC and AEMET) between 1979 and 2021. Note the beginning of the series with low precipitation values at times when the temporary lagoons in Doñana were well conserved.