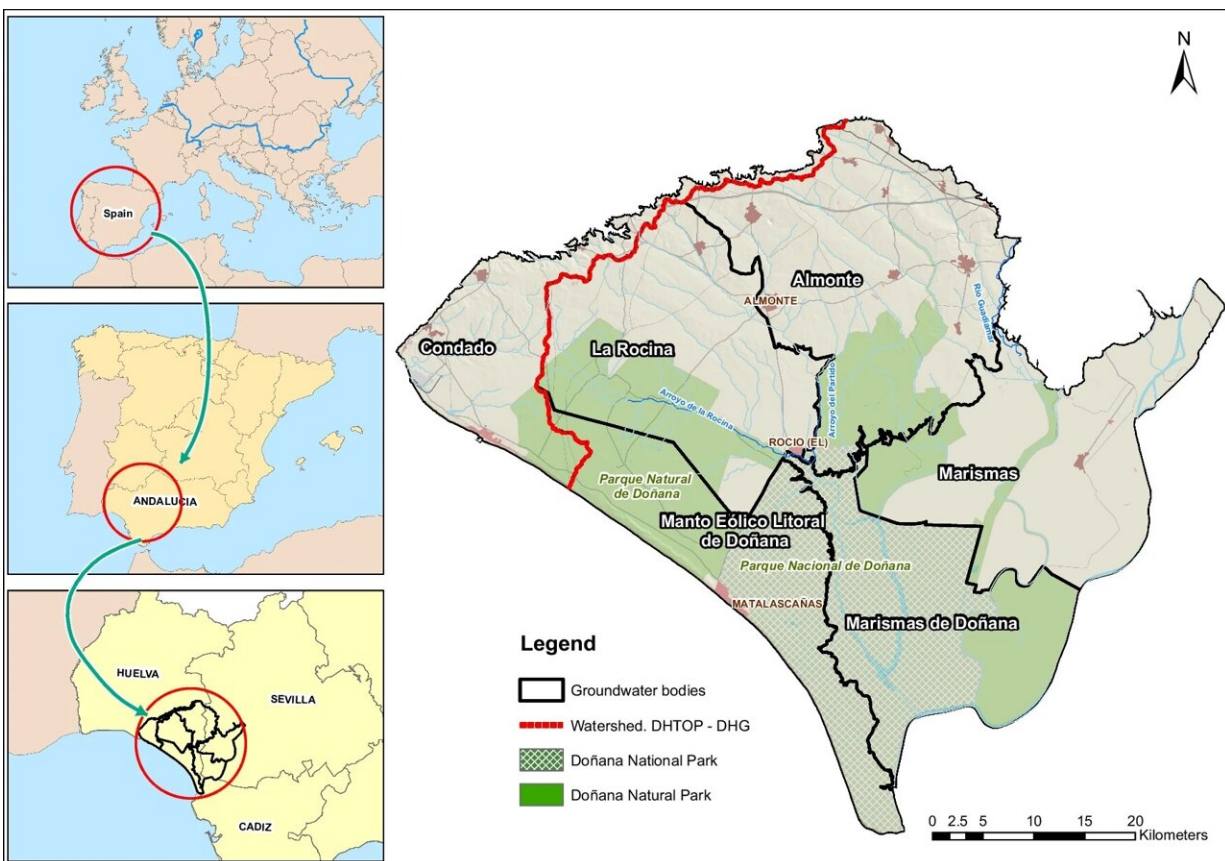


Clear evidence aquifer exploitation is causing serious impacts on the most iconic national park in Spain

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The Almonte-Marismas aquifer system underlying Doñana, the division between six groundwater bodies, and the areas protected within Doñana National and Natural Parks (which, combined, make up “Doñana Natural Space”). Credit: *Wetlands* (2024). DOI: 10.1007/s13157-023-01769-1

A team led by the Doñana Biological Station and the Geological and Mining Institute of the Spanish National Research Council has reviewed more than 70 studies related to groundwater and the conservation status of one of Europe's most iconic wetlands, Doñana, in southern Spain.

The research has shown that there is ample scientific evidence of serious impacts caused by groundwater abstraction. A total of 22 researchers from different institutes in both the fields of wetland ecology and hydrogeology, with extensive experience in research projects in Doñana, have participated in this study.

Data from the Confederación Hidrográfica del Guadalquivir (Guadalquivir River Basin Authority) show a general decline in water tables throughout the protected area over the last three decades, especially in the areas closest to where water is extracted for agricultural and urban use. In addition, numerous scientific studies have recorded impacts on the aquatic and terrestrial habitats of Doñana, as well as on [water quality](#).

"Since the 1970s, different scientists and technicians have reported that uncontrolled abstraction of groundwater would have very serious consequences for Doñana," says Carolina Guardiola Albert, CSIC researcher at the Geological Mining Institute. "Our impression is either that water and land managers involved in Doñana at different levels have been deaf to these warnings, or else they have failed to take effective action."

Despite the [scientific evidence](#), for years, no measures have been implemented to avoid successfully, or at least mitigate, these impacts on the protected area. Given the inaction of the administrations in this regard, the Court of Justice of the European Union condemned Spain in 2021.

A year later, the European Union warned Spain again with a new judgment if an agreement was not reached soon to withdraw a proposed law, presented in the Andalusian regional parliament, that sought to expand irrigation around Doñana.

"The actions of the European Court of Justice brought about a change of attitude, but we remain skeptical that the necessary measures will be implemented and, above all, that all the administrations and agents involved will be able to coordinate to effectively implement these measures," explains the scientist.

Impacts on both aquatic and terrestrial habitats

Scientific evidence of the impacts that agriculture is causing on Doñana is clear and abundant. There are several studies that show how the reduction in groundwater levels has led to the disappearance of many ponds, key for the conservation of many species. In one of the studies reviewed, published in 2001, a drop in the [water table](#) of up to 20 meters between 1972 and 1992 was detected.

The researchers also noted the disappearance of ponds that had been recorded in historical maps, especially in the northern area most affected by groundwater declines, largely due to irrigation. More recently, in a study published last year, the Doñana Biological Station identified a loss of almost 60% of the ponds that existed in the 1980s.

In addition, it was found that most of the new ponds flood less often and dry out earlier than expected based purely on climatic variation, especially in the areas closest to Matalascañas and the greenhouses, which have the greatest impact caused by overexploitation of the aquifer. This affects numerous animal species that depend on these ponds, as well as aquatic vegetation.

The extraction of water from the aquifer also has a strong impact on the marsh. Along with rainfall, surface water streams into the marsh receive inputs from the aquifer. However, these have been reduced in recent years. Several studies conducted in the Rocina area in the early 2000s suggest a 60% reduction in groundwater discharges to the streams circulating through the area. This trend has been exacerbated by the large expansion of intensive agriculture in the area since then.

In addition, the reduction in groundwater discharge explains changes in dominant species in the riparian forests, with a progressive decline in willows, which are more dependent on water, and an increase in ash trees, which need less moisture.

This problem is not only affecting aquatic habitats. It has also had an impact on terrestrial vegetation. For example, cork oaks that are hundreds of years old are now dying quickly in Doñana. According to ICTS-RBD data, 8% have already perished since 2009, and many are losing their leaf cover due to falling water tables.

Many other changes in vegetation are being recorded. Species such as *Erica scoparia*, a type of heather, are being replaced by more drought-tolerant species such as gorse *Ulex australis*. In addition, a recent study has recorded how pines and shrubs are colonizing the basins of many dry temporary ponds, which confirms wetland deterioration and disappearance.

Impacts on water quality

Groundwater-dependent agriculture is not only having serious impacts on terrestrial and aquatic biodiversity, but also on water quality.

"While we tend to think more about water quantity than water quality, the truth is that they are equally important," explains Andy J. Green,

CSIC research professor at the Doñana Biological Station. "Nutrient and contaminant loads to the marsh have been increasing with agricultural and urban expansion, especially around El Rocío." These issues have long been of concern to the scientific community, and numerous studies on water quality have been carried out on both surface and groundwater.

The impact on water quality is intimately connected to the use of agrochemicals for red fruit irrigated crops (including strawberries). A reduced flow rate leads to further increases in concentrations of contaminants and increased salinity through higher evaporation rates.

Climate change, with a strong increase in temperature, is favoring the proliferation of toxic algae and invasive plants under high nutrient concentrations. For example, phosphorus loading has increased sharply since 2000, which has, in turn, favored the expansion of the invasive aquatic fern *Azolla filiculoides* across the marsh and some ponds, negatively impacting amphibians and aquatic plants.

Recent data show extremely high nutrient loads in streams affected by groundwater pumping for agriculture. "We have transformed the National Park into a green filter to clean up stream water, which is now often toxic for fish and other wildlife," says Andy J. Green.

Pollution in the Doñana aquifer due to agricultural and urban activities dates back to the initial expansion of irrigation in the 1970s, and the deterioration of groundwater quality has been recognized by international institutions. "Measures are urgently needed to reduce the input of fertilizers into the aquifer and to clean the water before it enters the National Park," says the researcher.

One of the proposals most often heard when talking about implementing measures for the conservation of Doñana is to transfer water from other nearby watersheds. The scientific team considers, however, that this may

be unrealistic given the limited volume of surface water available and climate model predictions for southern Spain.

Furthermore, the supply of surface water from other watersheds could facilitate biological invasions and promote further eutrophication associated with expanding irrigated crops, as already seen in the Mar Menor wetland in south-eastern Spain.

"Thanks to the results of the scientific research carried out in Doñana, we can explain the relationship between the current state of the protected area and the effects of external agents acting on it, such as the direct actions of human beings and the effects of [climate change](#)" explains Carolina Guardiola. "This knowledge is fundamental to guide decisions on measures to protect and restore these ecosystems."

The paper is [published](#) in the journal *Wetlands*.

More information: Andy J. Green et al, Groundwater Abstraction has Caused Extensive Ecological Damage to the Doñana World Heritage Site, Spain, *Wetlands* (2024). [DOI: 10.1007/s13157-023-01769-1](https://doi.org/10.1007/s13157-023-01769-1)

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