FACT SHEET

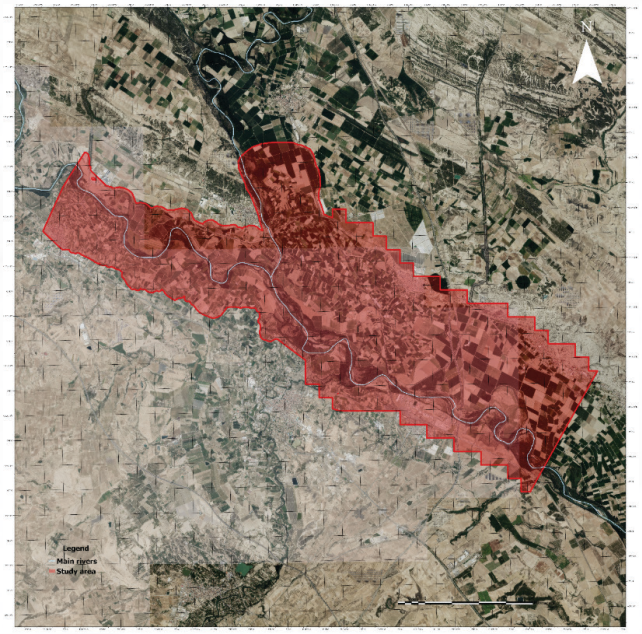
# Ebro River Floodplains: Sotos de Alfaro

Aniela Stachnik Perez, Camila Kuncar, Cesar Gonzalez

**Organisation responsible for the site:**
Iberian Center for River Restoration (CIREF)

**Country:** Spain
**Region:** La Rioja - Navarra
**Type of Sponge territory:** Floodplain
**Geographic coordinates of the site centroid point:**
42.209438, -1.723583 (ETRS 1989)

The Ebro River in Spain is well known for its historical floods. Its highly variable Mediterranean flow regime ranges from around 300 m³/s under ordinary conditions at the Castejón gauging station to approximately 3,000 m³/s during major floods. This section of the middle Ebro crosses a broad, relatively flat valley bordered by mountain ranges and is dominated by agriculture. Extensive cultivation of the floodplain, together with irrigation infrastructure[1], levees and other flood-protection structures, has reduced the space available for river mobility and altered its natural dynamics. Over the past century, the river has lost approximately 50% of its natural space due to channelisation, embankments and the occupation of the floodplain by farmland and infrastructure. These changes have contributed to greater flood impacts, particularly in areas such as Sotos de Alfaro. Major floods in 2015, 2018 and 2021 caused damages estimated at around €100 million per decade.




To address these challenges, the LIFE Ebro Resilience project, launched in 2021, is implementing restoration actions aligned with the Flood Risk Management Plan and the National Strategy for River Restoration. Measures include removing levees and protective dams, constructing relief channels, and applying the CURAGE technique to recover lost river branches, all supported by intensive public participation with stakeholders and local communities.[2] Building on these efforts, SpongeBoost will quantify the effects of these Nature-based Solutions (NbS) on flood risk reduction and groundwater recharge by assessing hydrological connectivity, measuring water infiltration and retention in restored and unrestored sites, and conducting surveys to evaluate the effectiveness of NbS and their potential application as a business model.

1 Source: Cuartero, N., Moral, R., Ollero, A., & Pirchi, V. N. (2022). EVALUACIÓN HIDROMORFOLÓGICA TRAS LA APLICACIÓN DE LA TÉCNICA "CURAGE" EN EL CURSO MEDIO DEL EBRO (Nos. 2021-GM-131). Confederación Hidrográfica del Ebro.

2 Source: EBRO RESILIENCE: Estrategia general de actuaciones. (2020).

Funded by the European Union

SpongeBoost receives funding from the European Union's Horizon Europe research and innovation programme under grant agreement No.101112906.

# Site characteristics

## Climate[3]

The study area is located within the Mediterranean macroclimate, in the Ebro Depression, where surrounding mountain formations block rain-bearing fronts and eliminate the moderating effect of the sea. This results in:

- Markedly continental climate, with cool to cold winters, scarce precipitation (386 mm/year), and pronounced aridity.
- Rainfall peaks in spring and autumn, while winter often records a minimum due to continental influence.
- High sunshine duration and a prolonged frost-free period (May–September), though it is frequently affected by strong, cold, dry northwesterly winds (Cierzo) that intensify along the Ebro Valley.
- Winter fogs are common near the river due to frequent thermal inversions, contributing to high evapotranspiration, particularly in the lower basin.

## Soil[4]

- Located within the physiographic unit of the Tertiary Ebro Basin, mainly composed of Miocene continental evaporitic sediments, and closely associated with the current Ebro River bank, resulting in a fluvial geomorphology within the Ebro Corridor.
- Characterised by gentle relief typical of an alluvial plain, where river erosion and sedimentation dominate the geomorphological processes.
- Underlain by Quaternary (Holocene) deposits, with most of the surface consisting of the active river channel and lateral accretion bars, including meander deposits formed through fluvial lateral accretion; deposits mainly comprise sands, gravels, and silts.
- Features extensive alluvial plains formed by the active meandering dynamics of the Ebro River, creating and abandoning meanders.

## Hydrology[5]

As it flows through Castejón, the Ebro River exhibits a pluvio-nival regime, with significant influence from storm events originating in the Cantabrian region. The contribution of spring snowmelt from the Pyrenees, primarily through the Arga and Aragón rivers, is only moderately evident due to the mid-course location of this river segment and the orographic characteristics of the tributary catchments. The nival component plays a minor role, as frequent heavy rainfall events in the Alavesa mountain range and the western Pyrenees tend to accelerate snowmelt, preventing substantial snow retention.

However, this component becomes critical during specific flood events when the Arga-Aragón system acts simultaneously with the Ebro's headwaters, potentially leading to discharge rates exceeding 3,000 $m^3/s$. Additionally, an analysis of monthly flow values indicates that peak discharges typically occur in February, while the low-flow period extends from July to October.

## Natural protected area

The Special Areas of Conservation (SAC) "Sotos y Riberas del Ebro" is a Special Area of Conservation that covers several sections of the Ebro River in La Rioja, including the best-preserved riverbanks of 17 municipalities. This protected area spans 2,385 hectares, representing 0.47% of the regional area.[6]

The Natural Reserve of Sotos del Ebro in Alfaro is located in the middle stretch of the Ebro River in Rioja Baja, covering an area of 476 hectares. This protected area extends over approximately 7 kilometres of the river, from the confluence with the Aragón River to the railway bridge.[7]

Photo credit: LIFE EbroResilience Project

3 Source: Gobierno de La Rioja, Consejería de Turismo, Medio Ambiente y Política Territorial. (2007). Reserva Natural Sotos de Alfaro: Guía de campo.

4 Source: España, I. G. y M. de. (n.d.). IELIG - EB008: Barras fluviales y meandros en los Sotos de Alfaro. Retrieved August 5, 2026, from https://info.igme.es/ielig/LIGInfo.aspx?codigo=EB008#valoraciones

5 Source: Ollero, A. (1990). Régimen y Comportamiento hidrológico del río Ebro en la Ribera Tudelana. Lurralde, 13, 117–128.

6 Source: Sotos y riberas del Ebro—Medio ambiente—Portal del Gobierno de La Rioja. (n.d.). Retrieved August 5, 2026, from https://www.larioja.org/medio-ambiente/es/espacios-naturales-protegidos/red-natura-2000/red-natura-rioja/espacios-rioja/sotos-riberas-ebro

7 Source: Ficha técnica de la Reserva Natural Sotos de Alfaro—Medio ambiente—Portal del Gobierno de La Rioja. (n.d.). Retrieved August 5, 2026, from https://www.larioja.org/medio-ambiente/es/espacios-naturales-protegidos/reserva-natural-sotos-alfaro/ficha-tecnica/ficha-tecnica-reserva-natural-sotos-alfaro

# RESTORATION EFFORTS

## Restoration program[8]

- Restoration actions on the Ebro River were designed within the framework of the Ebro Resilience Strategy and subsequently implemented and financed through the **LIFE EbroResilience project** along the stretch between the Aragón River confluence and Castejón, one of the main flood-prone sectors of the middle Ebro River.
- Interventions across 7 sites along an approximately seven-kilometre stretch focused on morphological adaptation and environmental restoration on both banks to recover fluvial space and floodplain.
- Actions included Levee setback, reconnecting former channels, and creating riparian wetlands to enhance habitat diversity.
- Implemented between 2016 and 2024, the works recovered 133 hectares of fluvial space and improved environmental conditions, river functionality, and flood resilience, reducing flood risk and increasing water retention.

## Economic investment

The study area benefits from an economic investment of €13 million, co-financed through LIFE projects and the Ebro Basin Administration.

# SPONGEBOOST'S ROLE

The specific objective for the Ebro River case study area is to understand the benefits of the implemented actions in the water retention capacity of floodplains.

## Monitoring program

- No specific monitoring infrastructure has been deployed within the SpongeBoost, but the project uses existing data from other institutions.
- LiDAR-derived topography and pre- and post-intervention bathymetric surveys from the Ebro River Basin Authority are integrated to construct comparable Digital Elevation Models for hydraulic analysis with IBER.
- Two-dimensional hydraulic simulations are conducted for a range of representative discharges, with particular emphasis on frequent and moderate flows. Pre- and post-intervention scenarios are compared under identical conditions to assess changes in water depth, flow velocity, inundation patterns and cumulative infiltration.
- The results provide a relative estimate of how levee setback, channel reconnection and floodplain reconfiguration influence water redistribution, temporary storage and infiltration potential, rather than directly quantifying groundwater dynamics.

8 Source: EBRO RESILIENCE: Estrategia general de actuaciones. (2020).

Photo credit: LIFE EbroResilience Project

## Collaboration

The Department of Geography at the University of Zaragoza, which is currently leading a research project on the opportunities associated with flood risk management plans. Although their focus differs from SpongeBoost, their ongoing analysis of the hydrological implications of flood management measures in the Ebro corridor presents several points of convergence.

## Interpretation and analysis

The Ebro River exhibits a markedly Mediterranean hydrological regime; consequently, while high-magnitude events are considered in the analysis, they are expected to provide limited insight into sponge function, as system response may be constrained by soil saturation and storage exceedance during prolonged high-flow conditions. In contrast, more frequent and moderate flows (up to approximately T50) are anticipated to play a more relevant role in governing cumulative infiltration, groundwater recharge and baseflow regulation, and are therefore prioritised in the analysis.

Ebro river from Sotos de Alfaro riverbanks.
Photo credit: Aniela Stachnik (CIREF)

| | Technique |
|---|---|
| Water flow | 5 minutes; Flow gauge station |
| Surface elevation | Before and after; DEM and bathymetries |