

# Basque Country Climate Change Adaptation Living Lab

#EUSKADIGLOBALA

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1936
2026

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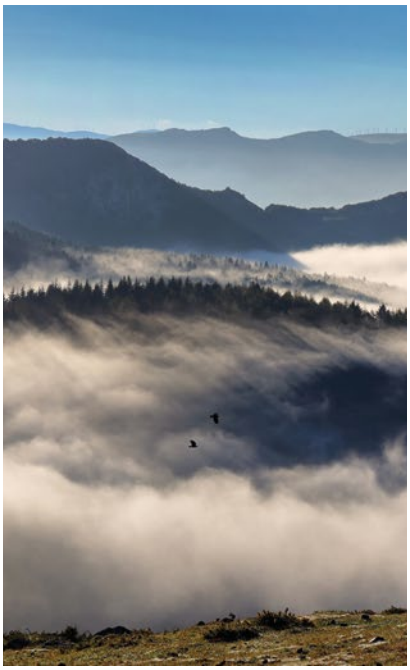
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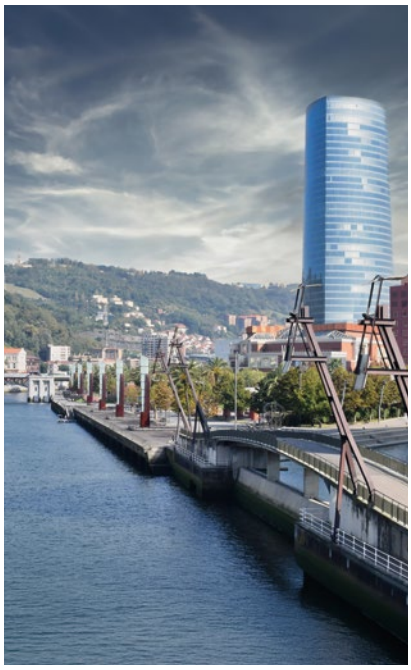
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# 01



# Resilience underpins competitiveness

## A competitive region must also be resilient

Adapting to climate change is a necessity. Basque Country —the Basque Country— must prepare for increasingly frequent and intense hazards affecting people, infrastructure, businesses and ecosystems. Within just 7,234 $km^2$, the region brings together coastlines, estuaries, river catchments, densely populated towns and cities, industry and vulnerable ecosystems. This diversity offers a manageable setting for addressing challenges shared by many regions: sea-level rise, extreme waves, river flooding, heavy rainfall and heatwaves. Acting early can reduce damage, improve safety and create opportunities for climate innovation. The **Basque Country: Climate Change Adaptation Living Lab,** a flagship initiative within the Basque Country 2030 Industry Plan, treats adaptation as a strategic investment in people's wellbeing and the region's competitiveness.

Basque Country has more than 2.2 million residents and a strong industrial economy. Its GDP exceeds €100 billion; industry accounted for 23.7% of total gross value added in 2023, above the levels reported for Spain, Europe and other major economies. Its export strengths and strategic infrastructure make climate resilience essential to future competitiveness. Approximately one in four residents is over 65. An ageing population increases the importance of protecting health and wellbeing during heatwaves and other extreme events. Against a background of energy transition, global competition and Europe's pursuit of greater strategic autonomy, managing climate risks helps protect investment, maintain business continuity and support development. Adaptation is therefore both an environmental priority and a strategy for innovation and regional resilience. Through the Climate Change Adaptation Living Lab, Basque Country aims to become a European reference point, testing how science, innovation and public–private collaboration can reduce Climate risks and generate knowledge that other regions can use.

## BASQUE COUNTRY



**7,234 $km^2$**

coastlines, estuaries, river catchments, densely populated towns and cities, industry and vulnerable ecosystems



**2.2 million inhabitants**



Industry accounted for **23.7%** of total gross value added in 2023

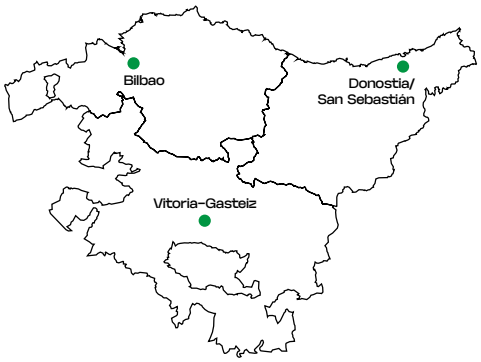
# 02

# Basque Country

A distinctive culture, an innovative region



## LOCATION OF THE BASQUE COUNTRY IN EUROPE




Located in northern Spain, Basque Country combines a distinctive cultural identity with a dynamic economy and a commitment to innovation and sustainability. Covering **7,234 km²,** it has approximately **2.2 million residents** and is one of Spain's most densely populated regions. The sea has long shaped the region's economy and culture. Most residents live in or around Bilbao, Donostia-San Sebastián and Vitoria-Gasteiz, the administrative capital. Around 75% live close to the coast.

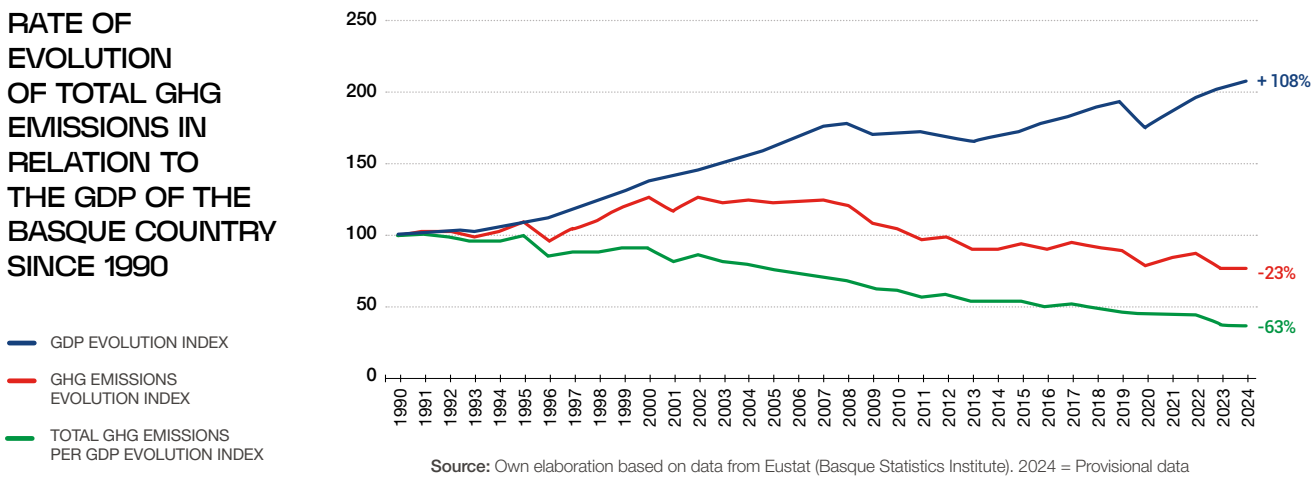
Basque Country's development model brings together public–private collaboration, advanced industry, social cohesion and the green transition. It supports the region's ambition to lead in innovation, sustainability and regional governance. Strong institutions, active civil society and an extensive research and knowledge network help Basque Country address major challenges, including climate change.

Basque Country is reducing greenhouse gas emissions while growing its economy. Preliminary inventory figures put 2024 emissions at 15.8 million tonnes of $CO_2$ equivalent: 38% below 2005 and 1% below 2023. GDP grew by an estimated 2.2% in 2024, while emissions per unit of GDP were 51% below 2005. This trend illustrates how economic growth can be separated from emissions growth. These results support the message that a more competitive and prosperous economy can also reduce emissions and strengthen climate resilience.

Basque Country has a varied climate. Its Atlantic-facing areas have moderate temperatures and high rainfall, supporting green landscapes and rich biodiversity. The southern, Mediterranean-facing areas experience greater temperature variation and less rainfall. These differences matter for land-use planning, water management, agriculture and adaptation.

This geographical and climatic diversity, together with the region's urban and economic structure, creates exposure to a wide range of climate impacts. It also makes Basque Country a valuable testing ground for **innovative adaptation solutions that can be used elsewhere in Europe.**

## RATE OF EVOLUTION OF TOTAL GHG EMISSIONS IN RELATION TO THE GDP OF THE BASQUE COUNTRY SINCE 1990




**Source:** Own elaboration based on data from Eustat (Basque Statistics Institute). 2024 = Provisional data

# 03



# A changing climate

## Shared governance, knowledge and investment



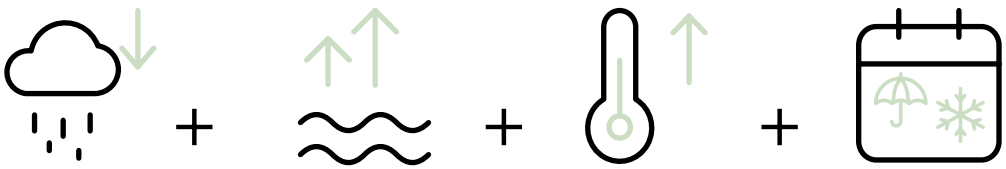
Climate change is a major environmental, social and economic challenge for Basque Country. Scientific evidence shows rising average temperatures, fewer cold days and more warm days. These changes affect people, ecosystems and economic activity. Heatwaves pose growing public-health risks, particularly for older people, children and people with chronic health conditions.

In addition, a slight decrease in annual precipitation has been observed, although it is concentrated in fewer episodes, which increases the risk of extreme phenomena such as torrential rains and both pluvial and river floods. Intense rainfall can overwhelm urban drainage and increase flooding from rivers and surface water, affecting built-up areas and natural ecosystems. Rising sea levels add to coastal flood and erosion risks, particularly for low-lying communities and businesses.

**Heatwaves pose growing public-health risks, particularly for older people, children and people with chronic health conditions.**

## THE BASQUE COUNTRY AND CLIMATE CHANGE +

### Hazards of climate change



Slight decrease in rainfall, concentrated in fewer events.

Rising sea levels.

Rise in the average temperature.

Increase in the number of warm days and decrease in the number of cold days.

**Strengthening adaptation is a priority for protecting people, infrastructure and businesses.**

## River flooding in towns and cities

River flooding will remain a major climate risk. The source anticipates gradual impacts and greater vulnerability from heavy rainfall, especially in upper catchments. Around 100,000 people currently live in potentially flood-prone areas.  Strengthening adaptation is a priority for protecting people, infrastructure and businesses.



## Coastal flooding and erosion

Sea-level rise poses a growing threat to the Basque coast. The climate scenarios give end-of-century estimates of 0.5–1 metre of sea-level rise, 22,000–40,000 people potentially affected, a 40–60% reduction in beach area, and economic losses equivalent to 0.9–2% of annual gross value added. Saltmarshes and other coastal ecosystems also face progressive degradation.

## Heatwaves and health

Heatwaves are another major adaptation challenge. Climate scenarios project an increase in days above 35°C from around five per year today to around twenty by the end of the century. This would increase health risks, particularly for older people and other vulnerable groups.

## Drought, water resources and the economy

Higher temperatures, lower rainfall and increased water loss from soils and vegetation can intensify drought. The different climate scenarios project high or very high water-scarcity risk in 68 Basque municipalities by the end of the century. Water resources, ecosystems and agriculture could all be affected.

Together, these risks affect urban and natural environments, public health and key economic sectors. They call for flexible planning grounded in science, early action and coordination across the region.

The six demonstration projects presented here respond to these challenges by testing innovative solutions in real settings. They aim to build evidence, accelerate learning and support wider action to reduce climate risks.

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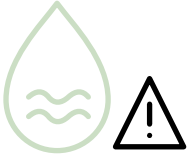
**100,000 people**
currently live in potentially flood-prone areas



**0.5–1 metre**
of sea-level rise



Heatwaves
**>35°C**
increase from 5 to around 20 days/year



**68 municipalities**
high or very high water-scarcity risk

# 04



# From plans to action

## Acting today to prepare for tomorrow

For more than twenty years, the Basque Government has developed climate policies, knowledge tools and governance arrangements. This work has progressively moved from setting objectives to delivering demonstration projects with the potential to transform places and inspire action elsewhere.

Key milestones include the 2002 Basque Environmental Strategy for Sustainable Development, which connected economic development, territorial cohesion and environmental protection, and the 2008 Basque Plan to Combat Climate Change, which addressed both emissions reduction and adaptation.

Climate and energy policy have since become increasingly integrated. Emissions reduction, the energy transition, adaptation and regional resilience now form part of a shared approach to economic and social transformation. Law 1/2024 on Energy Transition and Climate Change provides a framework for incorporating these aims into public policy.

The next step is to embed climate considerations across land-use planning and sector policies. Adaptation must inform decisions on infrastructure, energy, industry, water management, health and ecosystem protection—not just environmental policy.

This approach relies on continuing scientific research and cooperation between public authorities, researchers, businesses and wider society. Local authorities play a central role in planning and managing their areas. Information, practical tools and coordination support their action while respecting each institution's responsibilities and autonomy.

The Basque Country 2030 Industry Plan takes this further by linking the energy transition, decarbonisation and climate resilience to industrial policy. Adaptation becomes a strategic factor in competitiveness and sustainable economic development, alongside its environmental role.

Basque Country's adaptation work now faces a practical challenge: testing solutions on the ground and expanding those that work. The KAIA coordination forum supports this transition by bringing institutions together and helping promising initiatives share knowledge and experience.

Six demonstration projects form a regional **Climate Change Adaptation Living Lab:** a network where solutions are tested in real places. Together, they are a flagship initiative of the **Basque Country 2030 Industry Plan.** Their purpose is to assess effectiveness and make successful approaches easier to adopt across Basque Country and other European regions.

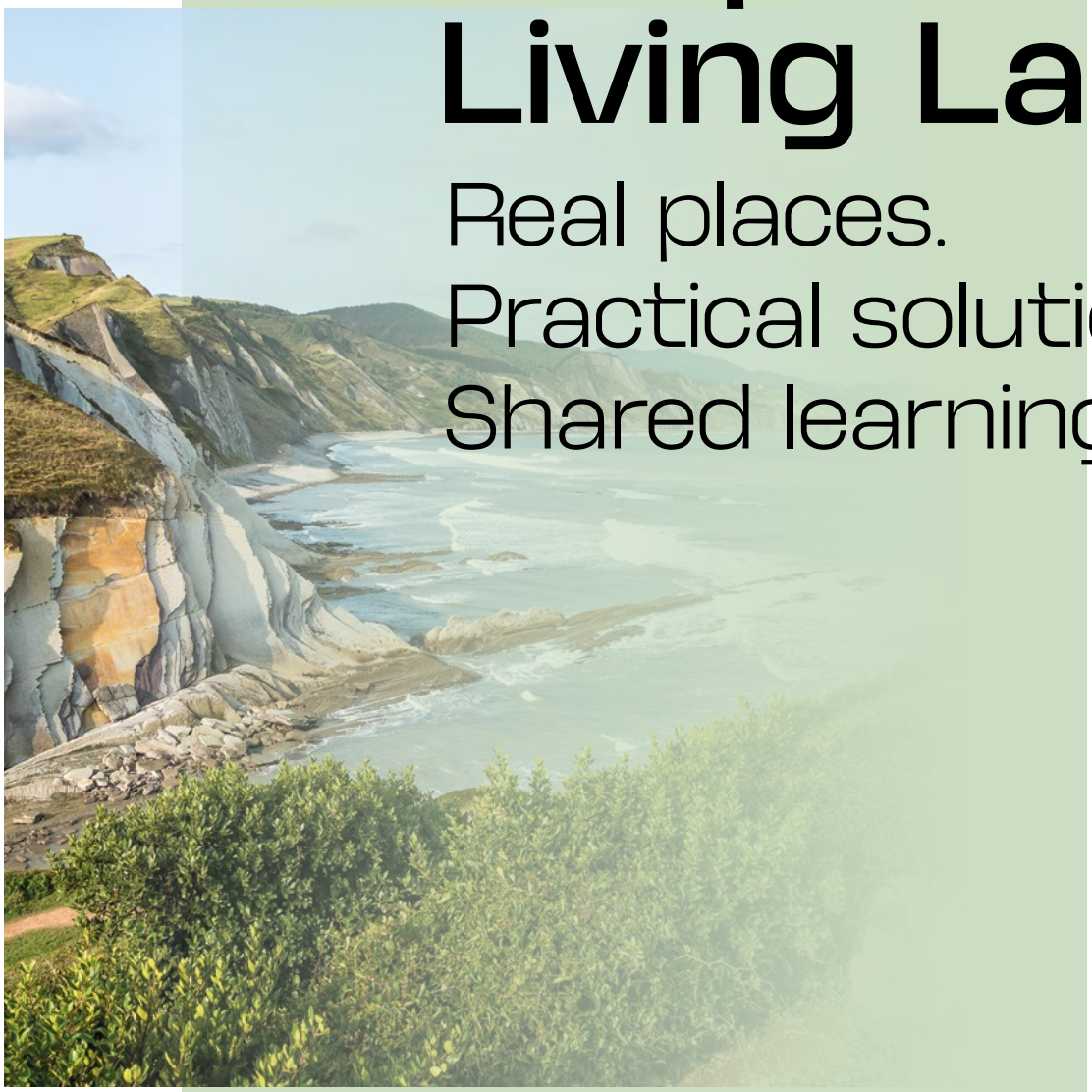
The projects bring together scientific expertise, coordinated governance and the involvement of local organisations, public authorities, researchers and residents. Their shared ambition is to turn adaptation planning into visible improvements on the ground.

# 05

# Climate Change Adaptation Living Lab

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Real places.
Practical solutions.
Shared learning.



The Living Lab works across sites that reflect Basque Country's main climate challenges, from exposed coastlines and estuaries to river floodplains and urban public spaces.

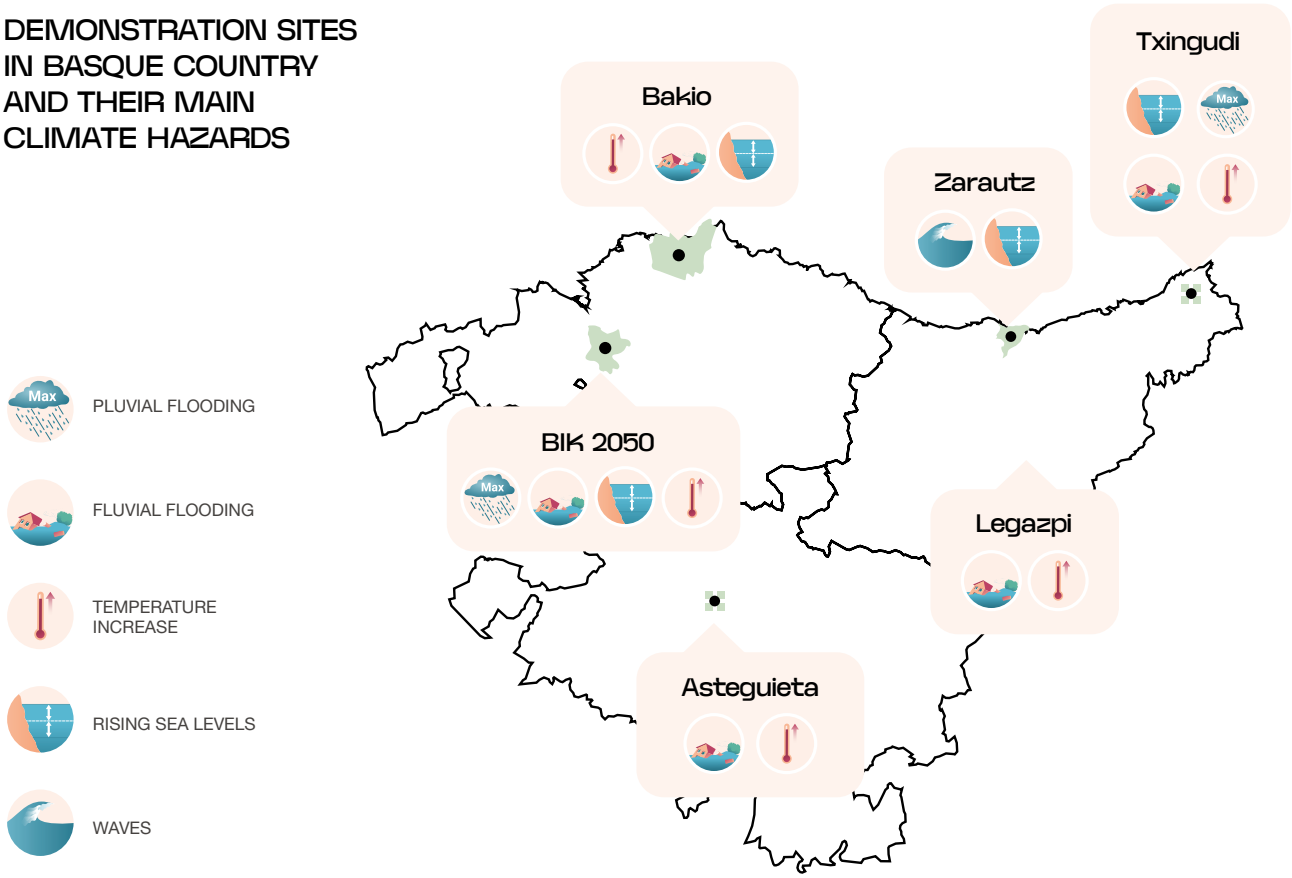
The Living Lab is described as one of 20 flagship projects in the Basque Country 2030 Industry Plan. It places adaptation within the region's competitiveness and industrial transformation strategy, creating opportunities for applied innovation, new markets and business capabilities. More than a collection of projects, it is a network in which public authorities, research and technology organisations, companies and municipalities design solutions, test them in real settings and assess their results.

On the coast, Zarautz and Txingudi address sea-level rise and coastal storms. In river catchments, Bakio and Astegieta make more space for water and restore natural processes to reduce flood risk. In Legazpi, greener public spaces will help protect an area serving a school, nursery and health centre. Bilbao river and climate change 2050 (BIK2050) connects coastal, river and urban adaptation across the Bilbao estuary.

The portfolio combines coastal and estuary restoration in Bakio, Zarautz and Txingudi with river restoration in Astegieta, metropolitan adaptation along the Bilbao estuary and urban greening in Legazpi. Together, the six sites will help identify solutions that other towns and regions can adapt to their own needs.

The following profiles introduce the six sites: Zarautz, Bakio, Txingudi, the Bilbao estuary, Astegieta and Legazpi. Each sets out the climate challenge, objectives, planned actions, indicative timetable and estimated funding needs.

## DEMONSTRATION SITES IN BASQUE COUNTRY AND THEIR MAIN CLIMATE HAZARDS



# Zarautz

## Adapting the seafront

Zarautz is a key site for testing coastal adaptation. Sea-level rise, storms and extreme waves threaten its beach and nearby infrastructure. The project aims to reduce erosion and flooding while helping the beach adapt to future conditions. It will also generate practical knowledge for other coastlines along the Bay of Biscay and Europe's Atlantic seaboard.




### Location

Zarautz,
on the Basque coast,
on the Bay of Biscay.





## Climate challenge

High exposure to sea-level rise and extreme waves, with associated erosion and flooding, especially along built-up sections and hard-edged seafront defences.

## Main objectives

+ Design and deliver measures that reduce climate impacts on the beach and surrounding area.
+ Support safe, sustainable use of the beach by reducing erosion and flood risk.
+ Develop solutions that can be adapted to other Atlantic coastal settings.
+ Improve understanding of how Bay of Biscay beaches can withstand climate change.

## Indicative timetable

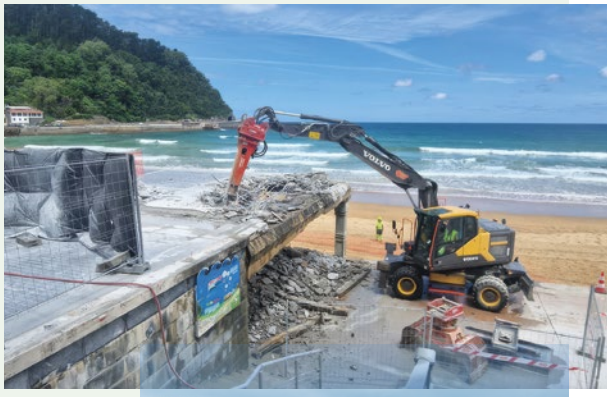
+ Narros-Munoa works and beach access redesign: completion expected in December 2026.
+ Dune restoration design and delivery: an estimated four months from project start.
+ Roadside wave-reflection measures and secondary breakwater: an estimated eight months for design and delivery.
+ Monitoring and maintenance: an estimated five years after completion.

## Estimated funding needs

Approximately €4.5 million.

## Planned actions

+ Protect Narros-Munoa by raising the promenade, adding measures to limit waves washing over it, and improving beach access.
+ Reduce waves reflecting off the wall along the Zarautz–Getaria road (N- 634).
+ Redesign western beach access points to let wave water pass more freely and reduce the ramp effect that channels waves upwards during storms.
+ Replace existing defences between the urban seafront and adjacent golf course with more effective coastal protection, including assessment and possible testing of new designs that dissipate wave energy.
+ Restore and conserve dunes to strengthen their role as a natural barrier against erosion and coastal flooding.






# Bakio

## Restoring saltmarsh and floodplain woodland

Bakio shows how working with nature can help reduce flooding. Development close to the Estepona river, loss of river space and historical channelisation have increased local vulnerability. The project will restore space for water along the river's lower reaches, recover river and estuary ecosystems and create resilient public spaces. It aims to reduce flood impacts while restoring natural processes and delivering environmental, social and urban benefits.




### Location

Bakio,
on the Basque coast,
in the Estepona river
catchment.



## Climate challenge

High vulnerability to river flooding, especially in built-up areas near the Estepona river, aggravated by limited river space and channelisation.

## Main objectives

+ Reduce flood impacts by giving the river more space.
+ Improve the environmental quality of the Estepona river and its surroundings.
+ Restore natural river processes, channel movement and native vegetation.
+ Connect the restored natural area with the town through an accessible, resilient public park.

## Indicative timetable

+ **Phase I—river and wetland works:** 6 months: 3 for Bakea saltmarsh and 3 for Solozarre floodplain woodland.
+ **Phase II—public park:** 4 months.
+ **Estimated overall duration:** 10 months, with phases potentially delivered together or separately; completion expected in December 2026.
+ **Recommended works window:** October–March, for ecological, technical and social reasons.

## Estimated funding needs

Approximately €3 million.

## Planned actions

+ Create floodplain woodland and a secondary channel at Solozarre to increase capacity for floodwater.
+ Widen the channel and create a river–saltmarsh transition zone that can flood regularly.
+ Restore tidal saltmarsh at Bakea using vegetation suited to saline conditions.
+ Excavate beneath Santa Catalina bridge to improve water flow.
+ Design a public park with sustainable drainage, pedestrian walkways, vegetation-based engineering and improved habitats.

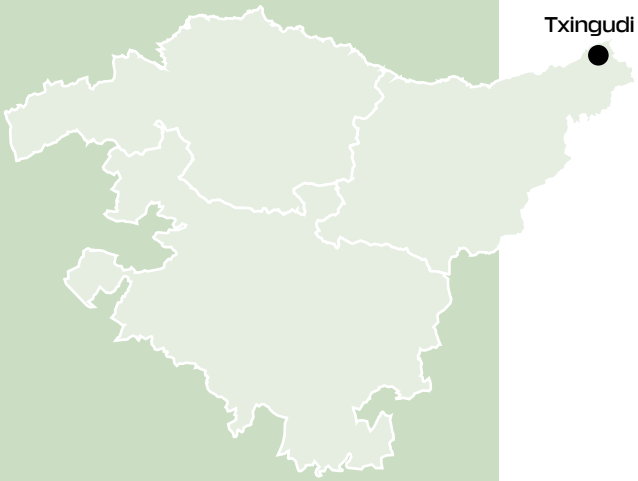




# Txingudi

## A resilient estuary

Txingudi is a valuable coastal estuary where wildlife habitats, infrastructure and urban areas share limited space. Sea-level rise and extreme events increase flood risk. The project will restore natural saltmarsh and tidal processes to reduce risks, protect biodiversity and help the estuary adapt. Ecological restoration, advanced water-flow modelling and early-warning systems will generate learning for other Atlantic estuaries and coastal wetlands.




### Location

Txingudi estuary, at the mouth of the Bidasoa river, between Irun and Hondarribia on the Basque coast.





## Climate challenge

Highly vulnerable to flooding from sea-level rise and extreme events. Intertidal habitats and biodiversity are at risk, with potential impacts on nearby communities and built-up areas.

## Main objectives

+ Improve flood resilience by expanding saltmarsh at Plaiaundi.
+ Restore natural estuary processes in areas between high and low tide.
+ Protect biodiversity and strengthen the role of Special Protection Areas for birds as refuges from climate impacts.
+ Develop detailed models of water movement to support better decisions.
+ Monitor the interventions and assess how effectively they reduce climate risks.

## Indicative timetable

+ **Workstream 1—modelling:**
  - Stages 1 and 2: delivery over two consecutive years.
  - Stage 3: review and improvements in year five of the project.
+ **Workstream 2—design and implementation:**
  - Phase I: one year.
  - Phase II: duration in years to be confirmed.
  - Phases III and IV: duration in months to be confirmed.
+ **Workstream 3—monitoring: an estimated five years.**
+ **Workstream 4—governance: ongoing throughout the project.**

## Planned actions

+ Analyse historical data and the characteristics of past floods.
+ Develop water-flow and forecasting models.
+ Design and introduce early-warning systems.
+ Integrate forecasting systems into operational platforms such as Euskalmet, the Basque meteorological service.
+ Expand San Lorenzo saltmarsh through ecological restoration.
+ Remove the rugby pitch and restore the area as saltmarsh.
+ Assess engineered flood-defence options for protecting the Mendelu neighbourhood.
+ Assess the feasibility of expanding Jaizubia saltmarsh.
+ Regularly assess flood indicators, biodiversity and the effectiveness of the measures.

## Estimated funding needs

Approximately €9.8–11.3 million.

# Bilbao river and climate change 2050

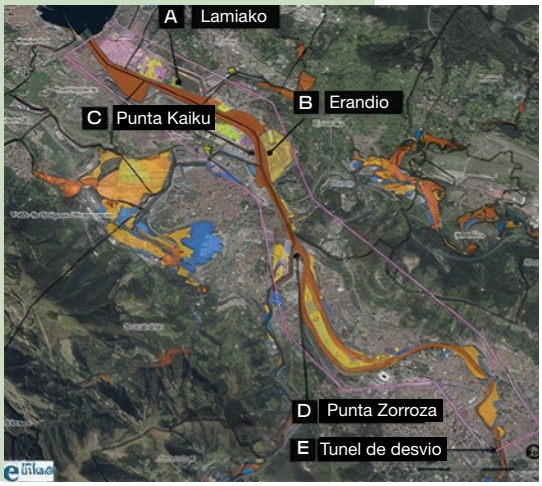
The densely built-up Bilbao estuary is a major centre of population and economic activity, exposed to flooding from rivers, tides and heavy rainfall. Bilbao river and climate change 2050 (BIK2050) combines scientific knowledge, nature-based solutions and flood protection to strengthen resilience. A high-resolution digital twin—a virtual model of the estuary—will help decision-makers test adaptation options. Restoring natural spaces, improving drainage and identifying future opportunities will help reduce vulnerability. The project aims to provide a model for climate adaptation in highly urbanised estuaries.




## Location

The Bilbao estuary corridor in Bizkaia, Basque Country, covering Barakaldo, Bilbao, Getxo, Portugalete, Santurtzi, Sestao, Erandio, Zierbena and Leioa.





## Climate challenge

Exposure to river, tidal and surface-water flooding in a densely urbanised area with a high concentration of people and economic activity. Rising temperatures and more frequent heatwaves also threaten health and wellbeing, particularly among vulnerable residents.

## Main objectives

+ Improve scientific and technical understanding of climate impacts on the Bilbao estuary.
+ Develop a high-resolution digital twin to simulate adaptation scenarios.
+ Establish robust governance with active stakeholder involvement.
+ Reduce flood risk in the most exposed municipalities.
+ Restore natural riverbanks and use nature-based solutions to create cooler spaces during hot weather.
+ Identify suitable spaces for future adaptation measures.

## Indicative timetable

+ Eight years in two phases: 2028–2031 and 2032–2035.

## Estimated funding needs

Approximately €26 million.

## Planned actions

+ Develop the estuary's digital twin for forecasting and decision-making.
+ Create a connected network of urban green spaces in Barakaldo.
+ Regenerate the Ibaizabal riverside park in Bilbao.
+ Assess the feasibility of a flood-relief tunnel between La Peña and Olabeaga.
+ Adapt Erandio's urban drainage system to improve climate resilience.
+ Restore Astrabudua wetland in Erandio.
+ Introduce adaptation measures at Ereaga beach in Getxo.
+ Restore ecosystems along the Gobela river in Leioa.
+ Bring more nature into San Roque square in Portugalete.
+ Develop a landscape action plan for Santurtzi's seafront.
+ Bring more nature into Kasko square in Sestao.
+ Restore the El Lastrón coastal area in Zierbena.

# Astegieta

## Restoring the river's natural course

Astegieta is an ambitious river restoration project designed to support climate adaptation. Urban development and infrastructure have altered this stretch of the Zadorra river, limiting its ability to accommodate high flows and increasing flood risk. The project proposes restoring the original river meander, giving the river more space and helping it slow and temporarily store floodwater during extreme events. It will also restore riverbank ecosystems and valuable habitats, turning a developed site into green infrastructure with environmental, water-management and social benefits. Astegieta aims to offer a model for river adaptation and ecological restoration in urban areas and on their outskirts.




### Location

Astegieta, around the Zadorra river, in Vitoria-Gasteiz, Alava, Basque Country.






## Climate challenge

River flood risk during high flows, aggravated by changes to the natural channel and urban infrastructure that obstructs water movement.

## Main objectives

+ Restore the original Zadorra river bend and its natural processes.
+ Remove obstacles to river flow to reduce flood risk.
+ Restore riverbank ecosystems and support native biodiversity.
+ Create natural habitats and increase the diversity of the river ecosystem.
+ Establish medium-term monitoring and maintenance.

## Indicative timetable

+ Project design and tendering: six months.
+ Required sector-specific approvals: six months.
+ Construction: an estimated maximum of twelve months.
+ Monitoring and maintenance: an estimated five years after completion.

## Planned actions

+ Demolish the disused hypermarket and remove the adjoining unused developed surfaces.
+ Manage waste generated by demolition.
+ Excavate the original Zadorra river channel.
+ Reuse excavated material on site.
+ Replant the new riverbanks and adjoining areas.
+ Create natural habitats and restore the surrounding ecosystems.

## Estimated funding needs

Approximately €4 million.

# Legazpi

## A cooler, greener public space

Legazpi is transforming Latxartegi park and square into an urban climate shelter: a public space offering relief during hot weather. The site connects everyday educational, health, cultural and care services. The project combines existing and new trees, shaded seating, light-coloured permeable paving, sustainable drainage, better access and new spaces for play and social interaction. The redesign aims to improve comfort in hot weather, slow surface-water runoff during intense rainfall and strengthen connections between nearby facilities and public spaces.




### Location

Latxartegi park and square in Legazpi, Gipuzkoa. The area connects Haztegi Ikastola school, the health centre, day centre, Latxartegi Aretoa auditorium and cultural centre.



## Climate challenge

Exposure to hot weather and heat retained by urban surfaces, alongside risks from intense rainfall, surface-water runoff and potential overloading of the sewer system.

## Main objectives

+ Turn Latxartegi square into an urban climate refuge.
+ Improve comfort in hot weather through shade, vegetation and light-coloured paving.
+ Use sustainable drainage to slow surface-water runoff and reduce pressure on the sewer system.
+ Improve accessibility, everyday use and connections between the square and nearby facilities.
+ Create inclusive spaces for relaxing, playing and meeting, suitable for different ages.

## Indicative timetable

+ **Redesign of Latxartegi square and Santikutz street.**
  Estimated duration: 36 months.

## Estimated funding needs

Approximately €2.9 million.

## Planned actions

+ Redesign Latxartegi square, retaining mature trees compatible with the new layout, selectively transplanting others and planting new trees.
+ Position trees and seating together to create shaded places to relax.
+ Install light-coloured, permeable paving and surfaces that allow rainwater to soak into the ground or collect temporarily, slowing runoff.
+ Install a modular stormwater storage tank to collect rainwater and release it gradually, together with a hydrocyclone separator to remove solid particles.
+ Create accessible walking routes, ramps, wider pavements and shared spaces where pedestrians have priority.
+ Replace the dividing wall with stepped seating and create spaces for people of different ages to play and meet.
+ Improve connections and access to the health centre, day centre and cultural centre.





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