



ANDALUSIA

Identification and assessment of the
main coastal tourism-related issues
concerning climate change mitigation
and adaptation

The Consortium:



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Project Overview

The Mediterranean region is one of the most vulnerable hotspots in the current biodiversity and climate crises, warming 20% faster than the global average and being the second biodiversity hotspot in the world. The increase of severe climate events are also likely to influence the choice of destinations and time to travel for its over 510 million inhabitants. The effects of climate change will put additional pressure on already strained ecosystems and vulnerable economies and societies, with Tourism being one of the most affected economic sectors.

The recent Transition Pathway for Tourism and the Glasgow Declaration are building a global momentum for Climate Action in Tourism, but policymakers and destinations need support to better develop efficient climate mitigation and adaptation policies using ecosystem-based approaches and improved multi-level governance structures, including robust planning and ensure the long-term engagement of the private sector and citizens. Indeed, ecosystem-based management is considered a good practice to effectively deal with these threats as it considers the different stakeholders and factors affecting ecosystems and the mechanisms involved, in order to find solutions.

NaTour4CChange builds on and capitalizes on successful experiences at the Mediterranean and global level to test solutions for increasing the resilience of coastal destinations in the Mediterranean. The project will aim to set common methods to allow participating regions to assess their tourism-related climate adaptation and mitigation priorities, and take climate action via plans and strategies, supported by cooperative governance.

In coastal destinations, cross-sector teams will deliver specific tourism climate Action Plans, focusing on climate adaptation, where Nature-based Solutions (NbS) will be tested to ensure their feasibility. At the same time, innovative destination marketing and communication approaches will engage private stakeholders, visitors, and residents in climate action.

The project will also ensure cross-fertilisation among participating regions and destinations, to achieve common methods and to compare the different tested plans and solutions, leading to lessons, best practices, and policy.



Glossary

Climate Change Adaptation (CCA) means anticipating the adverse effects of climate change and taking appropriate measures to prevent or minimise the damage they may cause, or to take advantage of the opportunities that may arise.

Climate Change Mitigation (CCM) means making the impacts of climate change less severe by reducing the sources of emission of greenhouse gasses (GHG) into the atmosphere or by improving the storage of these gasses.

Ecosystem Services (ES) are the benefits that an ecosystem brings to society and that improve people's health, economy, and quality of life.

Ecosystem-based Approaches (EbA) focus on managing biodiversity and ecological systems in a holistic way to maintain and enhance ecosystem services benefits and functions.

Nature-based Solutions (NbS) encompasses all actions that rely on ecosystems and the services they provide to respond to various societal challenges such as climate change, food security, resource management, or disaster risk.



1. INTRODUCTION

Tourism plays a pivotal role in Andalusia's socio-economic structure, positioning the region as a prominent global destination. Its rich offerings, including historical sites, natural landscapes, and cultural experiences, draw millions of visitors each year. In 2022, the sector contributed approximately €25.34 billion to the local economy, marking a 12.3% increase from the previous year and supporting around 416,900 jobs—a 0.9% growth over the previous year. However, 27% of these jobs remained temporary, reflecting a continued seasonal dependency (Plan de Marketing, 3.1.1; Seguimiento Plan Meta 2022-2023).

Environmental impacts from tourism are considerable, particularly in coastal and mountainous areas where visitor numbers are high. The Andalusian Climate Action Plan 2021-2030 highlights several key environmental issues tied to tourism, including overconsumption of water and energy resources, as well as increased pressure on natural areas, particularly the coastline. Rising temperatures and prolonged droughts, worsened by the effects of climate change, exacerbate water scarcity, requiring intensified resource management efforts. Coastal tourism, specifically, has accelerated problems like beach erosion and biodiversity loss, with an anticipated need to expand desalination initiatives to address water shortages during peak tourism periods (Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible, 2021).

Additionally, the influx of 34.2 million tourists in 2022, a 10.8% increase from 2021, puts a significant strain on local infrastructure and resources. High energy and water demand to meet visitor needs intensify during peak seasons, requiring comprehensive measures to enhance sustainability practices across the tourism sector. According to the 2012 Basic Study on Climate Change Adaptation for the Tourism Sector, intensified tourism in coastal zones also heightens the vulnerability of these areas to climate impacts, including sea level rise and salinization of water supplies. Despite these pressures, visitor satisfaction remains high at 94%, indicating successful management efforts to maintain a quality experience for tourists (Plan de Marketing, 3.1.1; Estudio Básico de Adaptación al Cambio Climático. Sector Industria Turística, 2012).

In summary, tourism in Andalusia represents both a crucial economic pillar and an environmental challenge. The region's dual focus on growth and sustainability reflects a balanced approach to addressing these pressures, especially as climate impacts intensify.



REGULATORY POLICY FRAMEWORK IN ANDALUCÍA

Andalusia's commitment to climate action is supported by regulatory and policy frameworks, primarily the Andalusian Climate Action Law (Ley 8/2018 de Medidas Frente al Cambio Climático y para la Transición hacia un Nuevo Modelo Energético en Andalucía) and the Andalusian Climate Action Plan (PAAC) 2021-2030. The Climate Action Law, enforced in 2018, establishes a comprehensive legal framework that mandates emission reductions, promotes sustainable resource use, and enhances the resilience of vulnerable sectors, including tourism. It emphasizes the importance of integrating climate considerations into all levels of governance and economic activities. Progress under this framework includes the development of climate adaptation strategies tailored to high-risk sectors and the establishment of monitoring systems to track the implementation of climate actions (Ley 8/2018, Andalucía).

The PAAC, building on the foundations of the Climate Action Law, provides a strategic roadmap for the region as a whole for the period 2021-2030. It identifies tourism as one of the key sectors affected by climate change and focuses on improving resilience through sustainable practices and infrastructure. This plan is informed by detailed climate projections, leveraging data from the Andalusian Environmental Information Network (REDIAM) of over 2,300 monitoring stations, which track critical variables such as temperature, precipitation, and sea level rise. The PAAC emphasizes the integration of climate adaptation into strategic tourism planning, as outlined in the Andalusian Sustainable Tourism Strategy. Key initiatives include adapting tourism resources to the effects of climate change, increasing the resilience of the Andalusian tourism sector by transitioning to more sustainable and adaptive tourism models, and expanding knowledge on climate impacts for improved tourism management. Specific progress includes the implementation of pilot projects to enhance the sustainability of tourism operations and the dissemination of best practices for climate adaptation within the sector (PAAC 2021–2030).

ALIGNMENT WITH NATIONAL AND INTERNATIONAL CLIMATE INITIATIVES

Andalusia's climate policies align closely with international, European, and Spanish frameworks, reflecting its commitment to global climate goals while addressing region-specific challenges in sectors such as tourism.

At the international level, Andalusia's climate strategies are informed by key agreements such as the *Paris Agreement* (2015), which sets the goal of limiting global temperature increases to below 2°C, with efforts to remain under 1.5°C.



The region also aligns with the *2030 Agenda for Sustainable Development*, particularly Sustainable Development Goal (SDG) 13, which calls for urgent action to combat climate change, and SDG 8, which promotes sustainable tourism as a driver of economic and cultural development. Furthermore, Andalusia signed the Glasgow Declaration in 2024, reinforcing its firm commitment to advancing climate action. As part of this pledge, the region is dedicated to developing a comprehensive climate action plan within the next year to accelerate its efforts in reducing emissions and promoting resilience.

At the European level, Andalusia contributes to the goals outlined in the *European Green Deal* (2019), which aims for carbon neutrality by 2050. Andalusia also supports the objectives of the *EU Adaptation Strategy* (2021), emphasizing smarter and more systemic climate adaptation measures, as well as the *Tourism Transition Pathway* (2022), which focuses on circularity, data sharing, and skills development to enhance sustainability and resilience in the tourism sector. These European initiatives provide funding and policy guidance that Andalusia leverages to advance its climate goals in tourism and beyond.

Nationally, Andalusia aligns with Spain's *Integrated National Energy and Climate Plan (PNIEC)*, which sets mechanisms to meet the European Green Deal's targets. The *Spanish National Plan to Adapt to Climate Change (PNACC) 2021-2030* complements Andalusia's regional strategies by providing a coordinated framework to reduce climate risks. Additionally, the *Spanish Sustainable Tourism Strategy 2030* supports the transition to competitive, sustainable, and inclusive tourism, ensuring alignment between regional and national tourism policies.

These alignments demonstrate Andalusia's integration within broader climate governance structures, ensuring that its regional strategies contribute to global objectives while addressing the unique vulnerabilities of its tourism sector.

STAKEHOLDERS INVOLVED IN CLIMATE ACTION PLANNING, DATA COLLECTION AND ANALYSIS OF HISTORICAL CLIMATE DATA

The development of the Andalusian Climate Action Plan (PAAC) adopted a participatory and transparent governance approach, reflecting Andalusia's commitment to inclusive and collaborative climate planning as outlined in *Ley 7/2017 de Participación Ciudadana* and *Ley 8/2018 on Climate Change and Energy Transition*. This approach ensured that the plan was systematically informed by diverse perspectives, fostering transparency, collaboration, and coherence across sectors and administrative levels.



Central to the governance framework was the Comisión Interdepartamental de Cambio Climático (Interdepartmental Committee on Climate Change), established under Decreto 44/2020, which coordinated climate policies across all regional ministries to ensure alignment and consistency in mitigation and adaptation measures. Complementing this was the Consejo Andaluz del Clima (Andalusian Climate Council), a participatory body designed to facilitate input from civil society, economic actors, and public institutions, currently in advanced stages of formalization. The Instituto Andaluz de Administración Pública (IAAP) provided technical guidance on participatory methodologies, employing tools such as the Guía para el análisis de la evaluabilidad previa de los planes de carácter estratégico, which ensured rigorous and inclusive planning processes.

The participatory process was a cornerstone of the PAAC's development, incorporating input from over 100 representatives of 79 entities through workshops and consultations, such as the Documento de Diagnóstico y Alcance (DDA) sessions held in 2020. These sessions brought together representatives from local governments, universities, research centers, businesses, NGOs, and professional associations, with a focus on identifying vulnerabilities, assessing risks, and designing localized solutions to Andalusia's specific climate challenges. Innovative tools and methodologies, supported by collaborators like Climate-KIC and JASPERS, facilitated this process, while international projects such as Life Blue Natura, Life Adaptamed, and Espon Titan provided valuable insights and best practices, enhancing the technical quality of the plan.

Local governments played a critical role in the process, given their proximity to communities and responsibilities in urban planning, water management, and waste systems. The PAAC emphasized the importance of empowering municipalities to address specific territorial challenges, such as water scarcity and coastal resilience, ensuring that solutions were tailored to local contexts. Advanced tools, such as the Evaluación Ambiental Estratégica (EAE), were employed to integrate environmental criteria into planning, and a dedicated online platform facilitated public consultation, yielding 140 contributions during the review of key documents.

The participatory and governance frameworks resulted in a climate action plan that is both inclusive and adaptive, aligning with regional priorities and international climate goals. By leveraging diverse stakeholder input, innovative tools, and global expertise, the PAAC establishes a robust foundation for mitigating and adapting to the impacts of climate change in Andalusia. This comprehensive and inclusive process ensures that the measures outlined in the



plan are effective, contextually relevant, and capable of addressing the unique challenges faced by the region.





2. COLLECTION AND ANALYSIS OF HISTORICAL CLIMATE DATA

The *PAAC 2021-2030* outlines a comprehensive approach to climate data collection in Andalusia, leveraging both historical and modern methods. Key components include:

- **Paleo-climatic Studies:** Analysis of paleo-climatic data provides insights into historical climate variations, offering a long-term perspective on climate trends.
- **Historical Document Archives:** The use of historical documentation has added depth to the understanding of past climate conditions, supplementing instrumental data.
- **Instrumental Climate Series:** Modern data series are primarily integrated through the Environmental Climatology Information Subsystem within the *Red de Información Ambiental de Andalucía* (REDIAM). This network consolidates data from approximately 2,300 observation stations distributed across five observation networks, allowing for the continuous monitoring of variables such as temperature, precipitation, and humidity across diverse spatial scales.
- **Temporal and Spatial Scales:** Data gathered span varying temporal scales, from historical records to high-frequency data from modern stations, allowing for both long-term and real-time analysis. Spatially, the networks cover Andalusia's diverse climate zones, from coastal areas to mountainous regions, ensuring that the collected data are regionally representative.

DATA SOURCES USED FOR COLLECTION AND ANALYSIS OF HISTORICAL CLIMATE DATA

The *PAAC 2021-2030* outlines a comprehensive system for climate data collection, integrating various data sources to support Andalusia's climate monitoring and adaptation strategies. These sources include:

1. **Public Data from Institutional Networks:**
 - **Agencia Estatal de Meteorología (AEMET):** AEMET's data serves as a cornerstone for the region's climate observations. As the national meteorological agency, AEMET supplies long-term meteorological data for Andalusia, which includes daily and



monthly averages for variables like temperature, humidity, and precipitation.

- **Red de Información Ambiental de Andalucía (REDIAM):** REDIAM consolidates climate data from a total of five observation networks and 2,300 stations across Andalusia. This network covers diverse environments, ensuring wide geographical representation, and focuses on tracking essential climate variables for ongoing regional assessments.

2. Modeling Data:

- **Global and Regional Climate Models:** The PAAC employs climate projections based on scenarios aligned with the IPCC, which include multiple global and regional climate models. These models are instrumental for forecasting potential climate impacts in Andalusia over medium to long-term periods. Such projections consider factors like greenhouse gas concentrations, enabling planners to anticipate risks associated with climate variability and extreme weather events.
- **Paleo-climatic Modeling:** Paleo-climatic reconstructions are used to extend the climate timeline back beyond the instrumental period, adding depth to the understanding of climate variability over centuries. This is achieved through climate proxies, such as sediment records and other environmental indicators, which are interpreted in collaboration with academic and research institutions.

3. Local Observations and Remote Sensing:

- **Ground-based Stations:** REDIAM's local networks capture real-time and high-frequency data across Andalusia, which are invaluable for understanding the climate dynamics at a local level. This includes rural, urban, coastal, and mountainous areas, each characterized by distinct climate patterns.
- **Remote Sensing and Satellite Data:** Remote sensing technologies, such as satellite imagery, are used to track broader climate indicators. For example, satellite data helps monitor vegetation cover, sea surface temperatures, and land use changes. These technologies provide a macro view of environmental trends that might not be captured through ground-level observations



alone.

4. **Historical Archives and Documented Records:**

- Andalusia's climate monitoring also incorporates historical records, such as agricultural yields, water resource usage, and local weather patterns, as documented over centuries. These archives provide context for the climatic changes observed today and help in constructing longer-term climate baselines, aiding in the identification of emerging climate trends.

LIMITATIONS ON DATA SOURCES USED FOR COLLECTION AND ANALYSIS OF HISTORICAL CLIMATE DATA

The development of climate diagnostics and adaptation strategies for Andalusia, has faced several data gaps and challenges in the collection and management process.

Missing Data

1. **Spatial Coverage Gaps:**

While Andalusia benefits from an extensive observation network through the *Red de Información Ambiental de Andalucía (REDIAM)*, certain remote or mountainous areas have limited monitoring station coverage. This creates spatial gaps in climate data, reducing the accuracy of vulnerability assessments in these regions (PAAC 2021-2030).

2. **Temporal Continuity:**

There are challenges in creating seamless time series data. Historical datasets, often derived from paleo-climatic studies and historical archives, lack consistency with modern instrumental records. This misalignment makes it difficult to construct continuous datasets needed for robust trend analysis (Informe de Medio Ambiente en Andalucía 2023).

3. **Data Integration and Granularity:**

Combining data from various sources—such as satellite observations, local monitoring stations, and climate models—is complex. Differences in temporal and spatial scales, formats, and levels of precision hinder the integration and analysis of these datasets. Specific challenges arise when projecting long-term



trends across different sectors, such as tourism and agriculture (TEMA 4 TURISMO_V2, 2024).

4. Economic and Behavioral Indicators:

There is limited data on how climate change impacts economic variables in tourism, such as visitor spending patterns, seasonal shifts, and the cost of adaptation measures. Additionally, behavioral data, such as tourists' preferences and willingness to adapt to new tourism practices, is underrepresented (PAAC 2021-2030).

Difficulties Encountered

1. Standardization Issues:

Different methodologies used across networks complicate standardizing climate variables. For instance, integrating data from global models with local observations requires significant adjustments to ensure compatibility (PAAC 2021-2030).

2. Resource Constraints:

Data collection efforts are limited by financial and technical resources, especially in less accessible regions. The lack of real-time monitoring tools and high-resolution modeling capacity hampers timely and precise data generation (Informe de Medio Ambiente en Andalucía 2023).

3. Stakeholder Coordination:

Ensuring collaboration among diverse stakeholders, including local governments, research institutions, and international partners, poses logistical challenges. Varying levels of technical capacity and priorities among stakeholders further complicate data harmonization (TEMA 4 TURISMO_V2, 2024).

EXISTING CLIMATE DIAGNOSTICS IN ANDALUSIA

Andalusia counts with many tools for climate diagnostics, integrating observational data, climate modeling, and analytical tools to inform adaptation and mitigation strategies. These diagnostics have been critical to support strategic climate action planning such as the Plan Andaluz de Acción por el Clima (PAAC).



1. Observed Climate Variables and Trends

The region monitors key climate variables, including temperature, precipitation, and extreme weather events, through the Red de Información Ambiental de Andalucía (REDIAM). This network incorporates over 2,300 observation stations, enabling the tracking of historical and current climate conditions. Observations indicate significant trends such as rising temperatures, decreasing precipitation, and an increased frequency of extreme events like droughts and heatwaves. These trends provide critical insights into the region's climate evolution (PAAC 2021-2030).

2. Regional Climate Scenarios

Updated to align with the IPCC AR6, Andalusia's regional climate scenarios offer detailed projections under various emissions pathways. These scenarios model over 80 climate-related variables, including temperature, precipitation, and hydrological balances, segmented into four thematic layers: climate, water balance, biodiversity, and thermal comfort. The data is derived from ten global circulation models (CMIP6) and is projected over different 30-year periods throughout the 21st century. These scenarios serve as a foundational tool for long-term planning and adaptation strategies.

3. GIS-Based Visualization Tools

Andalusia has developed GIS-based map viewers that allow for easy visualization of climate projections. These tools enable spatial analysis of climate impacts, helping policymakers and stakeholders identify vulnerable areas and prioritize adaptation measures. This user-friendly interface enhances accessibility and facilitates evidence-based decision-making.

4. Sectoral Impact Analysis

The PAAC evaluates climate vulnerabilities across critical sectors, such as agriculture, tourism, and urban planning. These diagnostics focus on key stressors, including water scarcity, heat stress, and sea-level rise, providing tailored adaptation strategies for each sector. By addressing sector-specific risks, the diagnostics support the region's efforts to build climate resilience and economic sustainability (PAAC 2021-2030).

5. Methodological Guide for Climate Risk Assessment

The Guía Metodológica para la Evaluación y Seguimiento de los Riesgos Climáticos en el Marco del PAAC serves as a structured framework for assessing



climate risks. This guide standardizes methodologies for evaluating vulnerabilities and monitoring risk progression, ensuring alignment with national and international frameworks. It also facilitates transparency and consistency in risk assessments, reinforcing the effectiveness of Andalusia's climate strategies (PAAC 2021-2030).

The mentioned tools for climate diagnostics for Andalusia can be easily tied to the tourism sector, providing valuable insights that can inform adaptation strategies and help identify vulnerabilities due to climate change impacts in the region.

ANALYSIS OF PAST EXTREME WEATHER EVENTS

As already analysed in the Climate Action Plan, Andalusia has experienced significant changes in its climate patterns, characterized by a marked increase in the frequency and intensity of extreme weather events. These trends, observed over recent decades, align with global climate change patterns but exhibit regional particularities that pose specific challenges.

- Heatwaves

Heatwaves have become more frequent and intense in Andalusia, with longer durations and higher maximum temperatures. The average temperature in 2022 was 1.3°C above the 1991–2020 baseline, with heatwaves contributing to a significant portion of this increase. These events place considerable strain on public health, agriculture, and energy systems, particularly during peak summer months, when energy demands for cooling escalate (Consejería de Sostenibilidad, Medio Ambiente y Economía Azul, 2023).

- Droughts

Drought conditions are increasingly prevalent in Andalusia, exacerbated by declining precipitation levels and rising temperatures. The hydrological year of 2022 was one of the driest on record, with water reservoirs at critical levels. This trend severely impacts agriculture, water supply for tourism, and natural ecosystems, particularly in arid zones where water scarcity is most acute (IMA 2023; PAAC 2021-2030).

- Torrential Rain and Floods

Paradoxically, while overall rainfall is decreasing, torrential rain events have become more frequent and intense, leading to flash floods. These events are particularly damaging in urban and coastal areas, disrupting infrastructure,



transportation, and tourism activities. Flooding from these intense rainfall events is classified as a high-risk hazard for Andalusia's economy, particularly affecting urban planning and coastal tourism sectors (PAAC 2021-2030; Junta de Andalucía, 2012).

- Sea-Level Rise and Coastal Flooding

Coastal flooding due to sea-level rise is an emerging concern, particularly in low-lying areas. While gradual, the rise in sea levels compounds the effects of storm surges, increasing the vulnerability of coastal infrastructures, including those critical for tourism. Coastal erosion and saline intrusion are additional impacts that threaten both natural habitats and human activities (Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible, 2021).

To clarify the significance of various extreme weather events in Andalusia, the following classification highlights their relative priority based on observed impacts and risks:

High Priority: Droughts and Heatwaves

This classification is strongly supported by both the *PAAC 2021-2030* and the *Informe de Medio Ambiente en Andalucía 2023*. Both documents highlight that droughts and heatwaves are among the most persistent and severe climate risks in Andalusia. The PAAC identifies these events as having chronic impacts on water availability, which directly affect agriculture, tourism, and public health. Moreover, the increasing intensity and frequency of heatwaves lead to heightened energy demands for cooling, further stressing the region's energy infrastructure (PAAC 2021-2030; Consejería de Sostenibilidad, Medio Ambiente y Economía Azul, 2023).

Moderate Priority: Torrential Rain and Flash Floods

Torrential rain and flash floods are emphasized in the PAAC and the environmental report as acute events that cause significant damage to infrastructure and pose safety risks. The PAAC specifically notes that urban areas with inadequate drainage systems are particularly vulnerable to these events, which can lead to costly repairs and temporary displacements (PAAC 2021-2030). Flash floods are also classified as high-risk hazards due to their immediate and localized impacts on Andalusia's economy, particularly in urban and coastal areas (Consejería de Sostenibilidad, Medio Ambiente y Economía Azul, 2023).



Emerging Priority: Coastal Flooding from Sea-Level Rise

Coastal flooding, driven by sea-level rise and intensified storm surges, is identified as an emerging threat in the PAAC and other studies. While the impacts are long-term, the PAAC emphasizes that these events pose significant risks to coastal infrastructure, biodiversity, and tourism activities. The classification as an emerging priority reflects the relatively gradual but potentially devastating nature of these risks, which require proactive adaptation strategies to mitigate (PAAC 2021-2030; TEMA 4 TURISMO_V2, 2024).

This classification framework is consistent with the findings and priorities detailed in the PAAC, the 2023 environmental report, and other supporting documents like the *TEMA 4 TURISMO_V2*. The prioritization reflects the urgency and magnitude of these events as outlined in regional climate diagnostics and strategic planning documents.

IMPACTS OF EXTREME EVENTS ON LOCAL ECOSYSTEMS, INFRASTRUCTURES AND COMMUNITIES

The following sections provide a detailed exploration of these impacts, showcasing how ecosystems, infrastructure, and communities are uniquely affected and the interconnected nature of these challenges. This analysis underlines the urgent need for adaptive strategies to mitigate the long-term effects of climate change in Andalusia.

Ecosystems

- **Heatwaves and Droughts:** These events exacerbate water stress in natural habitats, particularly in arid and semi-arid regions. Vegetation in these areas, especially in high mountain and dryland ecosystems, shows significant signs of decline, affecting overall biodiversity. Drought conditions also lead to habitat fragmentation, reduced wetland areas, and disruptions in the life cycles of many species, including aquatic and terrestrial fauna (Consejería de Sostenibilidad, Medio Ambiente y Economía Azul, 2023; Junta de Andalucía, 2012).
- **Coastal Flooding:** Rising sea levels and storm surges contribute to the salinization of freshwater systems and soil, altering coastal ecosystems. These changes endanger species dependent on brackish and freshwater habitats and accelerate the erosion of dunes and estuaries critical for biodiversity (PAAC 2021-2030).

Infrastructure



- **Urban and Transport Infrastructure:** Torrential rains and flash floods cause widespread damage to roads, bridges, and urban drainage systems, leading to costly repairs and disruptions. Cities with inadequate drainage systems face frequent inundation, increasing the vulnerability of urban centers to extreme rainfall events (Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible, 2021).
- **Tourism Infrastructure:** Coastal hotels, promenades, and recreational facilities are particularly susceptible to flooding and erosion. This damages property, reduces the attractiveness of tourist destinations, and increases maintenance and reconstruction costs (PAAC 2021-2030).

Communities

- **Public Health:** Heatwaves elevate risks of heat-related illnesses, particularly among vulnerable groups such as the elderly, children, and those with pre-existing health conditions. Prolonged exposure to extreme heat also exacerbates respiratory and cardiovascular diseases (IMA 2023).
- **Economic Livelihoods:** Droughts and floods disrupt agricultural productivity, impacting communities dependent on farming and related activities. This has downstream effects on food prices, employment, and rural economies. Similarly, the tourism sector suffers economic losses from decreased visitor numbers and damaged infrastructure (Consejería de Sostenibilidad, Medio Ambiente y Economía Azul, 2023).
- **Social Displacement:** In extreme cases, floods and coastal erosion force communities to relocate, particularly in low-lying coastal areas. This leads to social and economic dislocation, with long-term implications for regional planning and resource allocation (Junta de Andalucía, 2012).

PERCEPTION OF IMPACTS OF EXTREME EVENTS BY DESTINATION STAKEHOLDERS

The impacts of extreme weather events in Andalusia are perceived differently across various stakeholder groups, reflecting their specific interests and vulnerabilities.

Tourists often perceive these impacts through disruptions to their travel experiences, such as damage to coastal attractions, infrastructure failures, or discomfort from extreme heat. For instance, prolonged heat waves can deter tourists from visiting during peak summer months, while extreme rainfall and flooding might lead to cancellations or negative experiences. Despite high



satisfaction rates reported in general tourism metrics, climate-induced challenges are increasingly seen as risks to Andalusia's reputation as a comfortable year-round destination (Consejería de Sostenibilidad, Medio Ambiente y Economía Azul, 2023).

Residents express growing concerns about the direct impacts on their daily lives, particularly those living in flood-prone urban or rural areas. Heatwaves exacerbate health issues, especially for vulnerable populations like the elderly. Additionally, water shortages during prolonged droughts create tensions, as residents must balance personal consumption with the needs of tourism and agriculture. There is also an increasing awareness among communities about the long-term risks of sea-level rise and coastal erosion, which threaten their homes and local infrastructure (PAAC 2021-2030).

Businesses, especially those in tourism and agriculture, perceive these impacts primarily in economic terms. Tourism operators face rising costs for repairing and maintaining infrastructure damaged by floods or coastal erosion. Seasonal shifts in visitor patterns due to extreme heat may also reduce revenues during peak periods. Similarly, agricultural businesses suffer from reduced crop yields and water scarcity, which increase production costs and threaten livelihoods. Businesses are becoming more aware of the necessity for adaptive strategies, such as investing in more resilient infrastructure and water-saving technologies, to mitigate these risks (Junta de Andalucía, 2012; PAAC 2021-2030).

These varied perceptions highlight the complex challenges Andalusia faces in balancing economic development, environmental conservation, and community well-being amidst increasing climate pressures.



3. IDENTIFICATION OF VULNERABILITIES

IDENTIFIED CLIMATE RISKS IN TERMS OF REGIONAL VULNERABILITY

Andalusia faces significant climate risks that impact its ecosystems, socio-economic sectors, and infrastructure. The *Andalusian Climate Action Plan (PAAC) 2021-2030* identifies several key climate vulnerabilities

1. Rising Temperatures and Heatwaves:

- Andalusia has experienced consistent temperature increases, with the average temperature in 2022 reaching 17.5°C—1.3°C higher than the average of the reference period 1991-2020. These temperature rises intensify heatwave events, affecting health, increasing energy demands for cooling, and diminishing comfort levels for tourists and locals (Consejería de Sostenibilidad, Medio Ambiente y Economía Azul, 2023).
- This trend places high pressure on ecosystems, particularly in mountain and arid zones where vegetation stress is more pronounced. The *Millennium Ecosystem Assessment* notes that these regions have shown marked vulnerability to climate changes, which alter their ecosystems and reduce biodiversity (Junta de Andalucía, 2012).

2. Water Scarcity and Quality Degradation:

- Water scarcity remains one of the most pressing issues in Andalusia, with precipitation levels falling significantly, further aggravating drought conditions. These shortages directly impact agriculture, water-dependent industries, and tourism. Additionally, decreased water quality from overuse and reduced inflows threatens both human health and ecosystem resilience (Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible, 2021).
- Drought conditions have become widespread in Andalusia, affecting not only the vegetation's physiological state but also the availability of potable water. An estimated 30% of productive sectors, including coastal and rural tourism, are at high risk from drought and water scarcity (IMA 2023; PAAC 2021-2030).

3. Sea Level Rise and Coastal Flooding:

- Coastal areas in Andalusia are among the most vulnerable to sea-level rise in the Mediterranean region. The PAAC 2021-2030 highlights flooding and



salinization risks for coastal zones, threatening tourism infrastructure, urban developments, and natural habitats. Specifically, beach erosion, saltwater intrusion, and flooding risks require adaptation strategies, such as reinforced coastal defenses and the restoration of natural barriers (Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible, 2021).

- The Ley 8/2018 identifies tourism as one of the high-risk sectors in coastal areas, due to the compounded threats of sea-level rise and extreme weather, which together erode the attractiveness and viability of coastal tourism sites (PAAC 2021-2030, Figure 69).

4. Increased Frequency of Extreme Weather Events:

- Andalusia faces a heightened occurrence of extreme weather events, such as torrential rainfall and flash floods. These events pose significant risks to human safety and infrastructure, and they severely impact agriculture by disrupting crop cycles. The frequency of such events is projected to increase under current climate scenarios, with rainfall extremes already recorded in various areas (Consejería de Sostenibilidad, Medio Ambiente y Economía Azul, 2023).
- According to the *Andalusian Climate Action Plan*, over 30% of impacts from extreme events are classified as high-risk for Andalusia's economy, particularly affecting the productivity of sectors like tourism, agriculture, and livestock (PAAC 2021-2030).

5. Desertification and Land Degradation:

- Desertification poses an acute risk across Andalusia, exacerbated by declining rainfall and high evapotranspiration rates. The Index of Hydric Stress (IHS) and the Vegetation Stress Indicator reveal that 22% of Andalusian vegetation experienced water stress in 2022, with higher impacts observed in the Guadalquivir Valley and eastern regions (Consejería de Sostenibilidad, Medio Ambiente y Economía Azul, 2023).
- Desertification has long-term implications for soil health, agricultural productivity, and natural habitats. In the agricultural sector, both irrigated farming and pastoral activities are particularly vulnerable, further emphasizing the need for sustainable resource management in these regions (PAAC 2021-2030).

These climate risks emphasize the urgent need for adaptive measures across Andalusia's socio-economic sectors. Comprehensive responses, including water management, coastal resilience efforts, and sustainable land use, will be

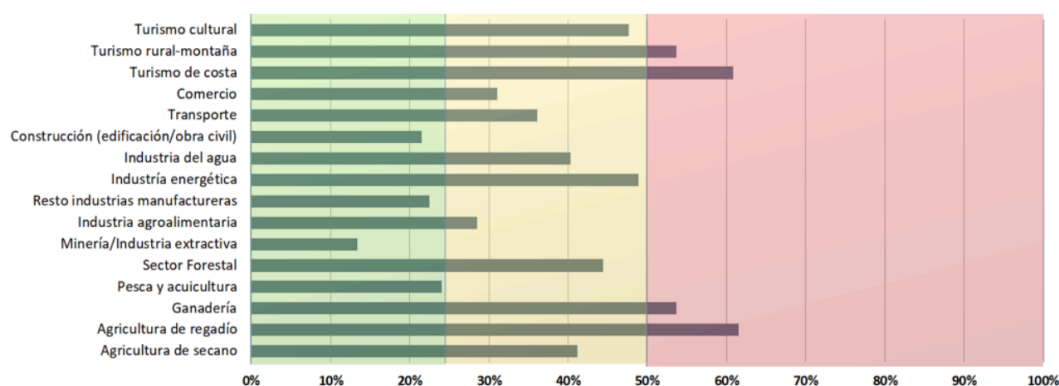
essential to mitigate the adverse effects of climate change on the region's vulnerable areas and resources.

EXPOSURE OF TOURISM TO CLIMATE HAZARDS

Tourism-related sectors in Andalusia face varying degrees of vulnerability to climate hazards, which are fueled by the region's dependence on natural resources and the increasing intensity of extreme weather events.

The *Plan Andaluz de Acción por el Clima (PAAC 2021-)* includes a risk assessment (*Evaluación del riesgo de los principales sectores económicos*) where tourism emerges as the economic sector facing the highest climate risks. And out of all the types of tourism activity that have been analysed, coastal tourism is the one which is showcasing the highest risk. This evaluation highlights the sector's acute vulnerability to key hazards such as droughts, heatwaves, coastal flooding, and extreme rainfall events, which poses significant challenges. The image accompanying this analysis illustrates tourism's elevated risk level compared to other sectors, emphasizing the urgent need for targeted adaptation and mitigation strategies to safeguard its long-term sustainability and resilience.

Image 1. Risk assessment of the main economic sectors. Source: PAAC 2021-2030



Coastal tourism, a cornerstone of Andalusia's economy, is particularly at risk due to sea-level rise, coastal erosion, and storm surges. These hazards threaten beaches, waterfront infrastructure, and natural habitats, which are essential to the region's appeal as a tourist destination. The Plan Andaluz de Acción por el Clima (PAAC) emphasizes the economic and environmental costs of these



changes, necessitating adaptive measures like shoreline reinforcement and sustainable urban planning.

Water-intensive tourism activities, including hotels, resorts, and recreational facilities, also face critical challenges from prolonged droughts and declining water availability. These pressures are particularly acute in semi-arid regions, where tourism competes with agriculture and local communities for limited water resources. The Informe de Medio Ambiente en Andalucía 2023 highlights the growing need for sustainable water management practices to mitigate these vulnerabilities.

Transport infrastructure, essential for connecting tourists to destinations, is another sector heavily impacted by climate hazards. Torrential rains and flash floods frequently disrupt roads, railways, and airports, reducing accessibility and causing financial losses. The TEMA 4 TURISMO_V2 document underscores the importance of enhancing the resilience of transport systems to ensure the continued flow of visitors to Andalusia.

Rural and nature-based tourism, often centered in mountain and arid areas, is also at risk from heatwaves, wildfires, and droughts. These events degrade natural landscapes, diminishing their attractiveness and reducing the viability of activities such as hiking and eco-tourism. According to the Millennium Ecosystem Assessment for Andalusia, these vulnerabilities are particularly pronounced in high-mountain and arid ecosystems, which are already under significant ecological stress.

Agritourism, which combines tourism with agricultural experiences, faces challenges from reduced water availability, soil degradation, and heat stress. These impacts threaten crop yields and the availability of local products, which are often integral to culinary tourism experiences. The PAAC 2021-2030 highlights the importance of integrating sustainable resource management into agricultural practices to support this sector's long-term resilience.

These interconnected vulnerabilities across tourism-related sectors highlight the need for comprehensive adaptation strategies. However, understanding the impacts of climate change on vulnerable populations is also critical to developing equitable and effective adaptation measures.

Low-income groups and the elderly are identified as particularly vulnerable populations, as highlighted in the Plan Andaluz de Acción por el Clima (PAAC). Low-income communities often lack the resources necessary to adapt to or recover from climate-related impacts such as extreme weather events,



heatwaves, and droughts. Their limited access to air conditioning, healthcare, or adequate housing exacerbates their exposure to climate hazards. Similarly, elderly populations are highly sensitive to heat stress and other climate-induced health risks. The Informe de Medio Ambiente en Andalucía 2023 underlines that prolonged heatwaves and rising temperatures significantly increase health risks for older adults, especially those with pre-existing conditions or limited mobility.

Coastal communities and those dependent on climate-sensitive livelihoods, such as agriculture and tourism, are also particularly at risk. Many of these individuals are concentrated in rural areas where access to adaptive infrastructure and services is limited. The Millennium Ecosystem Assessment for Andalusia notes that the impacts of climate change, including water scarcity and ecosystem degradation, disproportionately affect communities reliant on natural resources, further compounding their vulnerability.

MAPPING ANDALUSIA'S AT RISK AREAS TO DEFINE VULNERABILITY

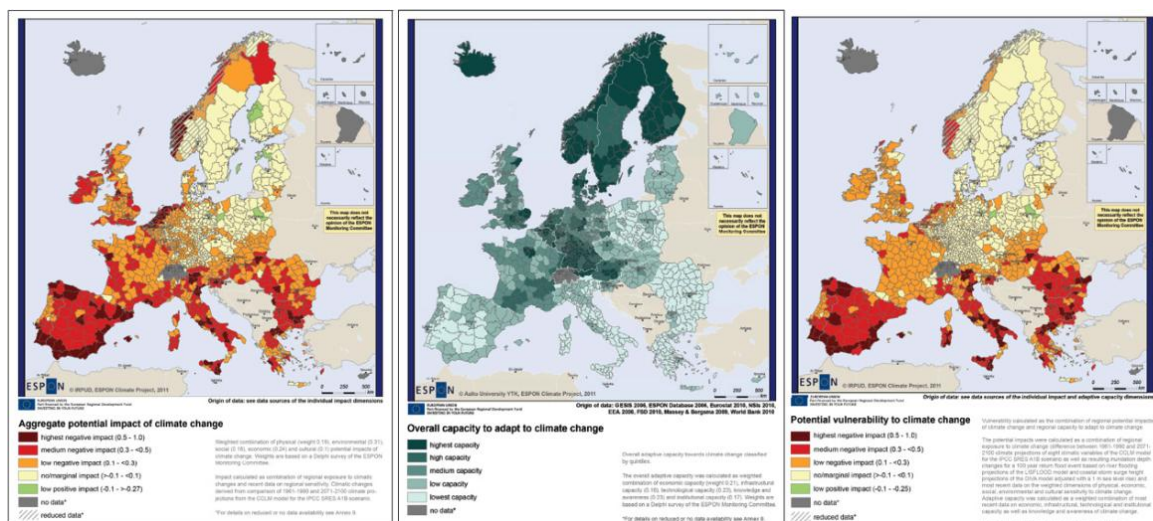
Vulnerability to climate change in Andalusia is defined as the interaction of exposure to climate hazards and perturbations, sensitivity of the affected systems, and adaptive capacity. This is important to understand which areas and sectors face the highest risks and why. The PAAC 2021-2030 applies this methodology to assess and categorize vulnerabilities across the region, focusing on specific geographical areas and socio-economic sectors (Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible, 2021).

Projection and Determination of Hazards and Sensitivity Andalusia, as a Mediterranean region, is exposed to multiple climate hazards including prolonged droughts, increased heatwaves, more frequent torrential rains, and rising sea levels.

Climate change vulnerability assessment studies at European level, such as the ESPON Climate project, have enabled the identification of regional typologies of exposure to climate change. This approach is extremely useful for the decision or selection of tailor-made adaptation options, in the face of specific regional patterns, for the development of territorial policies that are sensitive to climate change (Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible, 2021).

According to the findings of this project on climate change and territorial effects on regions and local economies in Europe, the aggregate potential impacts vary considerably, with hotspots mainly located in southern Europe.

This study also analyses the vulnerability of regions from the perspective of expected impacts and the capacity of a region to adapt to climate change. The results of this second analysis show an even stronger south-north gradient than in the case of the aggregate impacts (Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible, 2021).



Regional climate projections, developed through IPCC-aligned models, highlight significant warming trends of up to +2.6°C under moderate scenarios by mid-century, alongside a marked reduction in annual precipitation, particularly in the Guadalquivir Basin and eastern provinces. These changes escalate existing pressures on water resources, agriculture, and coastal systems, leading to heightened sensitivity in these areas (PAAC 2021-2030).

Andalusia's Adaptive Capacity

On the one hand, adaptive capacity across Andalusia varies significantly based on socio-economic and institutional factors. Coastal cities and municipalities with strong governance frameworks and higher investment in infrastructure exhibit greater adaptive capacity. On the other hand, rural areas with limited access to financial and technical resources face lower adaptive capacity, making them particularly vulnerable to climate-induced impacts such as water scarcity and land degradation (PAAC 2021-2030).

Integration and Mapping of Vulnerability

Using tools like Geographical Information Systems (GIS), the PAAC combines spatial data on climate hazards, sensitivity, and adaptive capacity to create vulnerability maps. These maps reveal that:



- Coastal regions, particularly around the provinces of Cádiz, Huelva, and Málaga, are highly vulnerable due to exposure to sea-level rise, storm surges, and erosion.
- The Guadalquivir Basin is a hotspot for water scarcity and agricultural stress due to reduced precipitation and increased evapotranspiration.
- Mountainous regions in eastern Andalusia face significant vulnerabilities from rising temperatures, reduced biodiversity, and higher wildfire risks.

Adaptation Operations

The PAAC outlines adaptation measures tailored to address identified vulnerabilities. These include:

- **Water Resource Management:** Investment in desalination plants, efficient irrigation systems, and wastewater reuse.
- **Coastal Protection:** Development of natural barriers, beach nourishment, and stricter zoning laws for infrastructure near vulnerable coastlines.
- **Agricultural Adaptation:** Promotion of drought-resistant crops, agroecological practices, and financial support for farmers transitioning to sustainable methods.
- **Heat Mitigation:** Urban greening initiatives, heat-resilient infrastructure, and public awareness campaigns to reduce heat stress in urban areas (PAAC 2021-2030).

This integrated approach, supported by GIS mapping, provides a comprehensive framework for identifying high-risk areas, planning targeted interventions, and monitoring progress toward reducing Andalusia's climate vulnerabilities.

ASSESSMENT OF CURRENT IMPACTS ON TOURISM

Climate change is already having notable impacts on tourism activities in Andalusia, manifesting in several ways that challenge the sector's sustainability and long-term viability:

1. Changes in Seasonality

Rising temperatures and the increasing frequency of heatwaves are shifting the traditional seasonality of tourism. The summer months, previously the peak tourist season, are becoming less appealing due to uncomfortable heat conditions, particularly in inland and urban areas. As a result, visitors are increasingly favoring the spring and autumn months, creating a more



dispersed but less predictable demand pattern. This shift affects business operations in the tourism sector, which has historically relied on the concentration of activity during summer months (PAAC 2021-2030; TEMA 4 TURISMO_V2, 2024).

2. Infrastructure Damage and Maintenance Costs

Extreme weather events, such as torrential rains and coastal storms, are causing significant damage to tourism infrastructure. Coastal flooding and erosion threaten beachfront properties, promenades, and recreational areas, leading to costly repairs and, in some cases, the relocation of facilities. Similarly, flash floods disrupt transportation networks, including roads and railways, reducing accessibility to key tourist destinations and creating additional costs for infrastructure maintenance (Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible, 2021).

3. Pressure on Water Resources

Tourism activities, particularly in arid and semi-arid zones, place substantial pressure on already scarce water resources. Hotels, resorts, and recreational facilities are heavily dependent on water, and prolonged droughts exacerbate competition for this critical resource. This issue is particularly acute during peak seasons, when demand from both tourists and residents is highest, necessitating the adoption of water-saving technologies and stricter resource management practices (Informe de Medio Ambiente en Andalucía 2023).

4. Ecosystem and Landscape Degradation

Climate-induced stress on ecosystems, such as coastal erosion, habitat loss, and desertification, reduces the aesthetic and recreational appeal of natural tourism hotspots. Protected areas and rural landscapes, which attract nature-based tourism, are experiencing biodiversity declines and increased vulnerability to wildfires. These changes diminish the quality of the visitor experience and require significant investment in conservation and restoration efforts (Junta de Andalucía, 2012; PAAC 2021-2030).

5. Economic and Social Impacts

The combined effects of climate change on infrastructure, resources, and seasonality lead to financial instability for businesses in the tourism sector. Small and medium-sized enterprises, which dominate the industry in Andalusia, are particularly vulnerable due to limited resources for adaptation. Additionally, changes in employment patterns driven by shifting seasonality



and reduced visitor numbers in summer months affect local communities reliant on tourism for their livelihoods.

These impacts have significant direct and indirect economic repercussions, influencing both immediate operational costs and long-term economic stability. Direct costs include the financial burden of repairing and maintaining tourism infrastructure damaged by extreme weather events such as floods and coastal storms. Coastal tourism, a key economic driver, faces escalating expenses related to beach restoration, reinforcement of waterfront structures, and the mitigation of erosion and sea-level rise. Similarly, transport disruptions caused by torrential rains increase costs for maintaining roads, railways, and airports, reducing the accessibility of tourist destinations and affecting revenue streams for local businesses (Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible, 2021).

Indirectly, climate change affects the broader local economy through shifts in tourist behaviour and reduced revenue from key tourism activities. Rising temperatures and increased heatwaves discourage summer tourism, traditionally a peak period, leading to income loss for businesses heavily reliant on seasonal visitors. This shift in seasonality creates unpredictable demand patterns, challenging business planning and workforce management. Furthermore, water scarcity and resource competition during peak tourism periods increase operational costs for hotels, restaurants, and recreational facilities, which must invest in water-saving technologies and sustainable practices to maintain operations (Informe de Medio Ambiente en Andalucía 2023).

The economic strain also extends to local communities that depend on tourism for employment. Small and medium-sized enterprises, which dominate Andalusia's tourism sector, are particularly vulnerable to the analysed climate-impacts. Reduced visitor numbers during critical periods and increased operational costs threaten job stability and income for workers, increasing socio-economic inequalities. (TEMA 4 TURISMO_V2, 2024).

These direct and indirect costs underscore the urgency of integrating climate resilience into Andalusia's tourism strategy to mitigate risks and sustain the sector's vital contributions to the regional economy.

ADAPTION OF TOURISM STAKEHOLDERS TO TOURISM IMPACTS



Hotels, resorts, and other tourism-related enterprises in Andalusia are implementing measures such as water-saving technologies and renewable energy systems. These adaptations align with the sustainability goals outlined in the Plan Andaluz de Acción por el Clima (PAAC), which emphasizes improving resource efficiency in tourism operations, particularly in water-scarce and energy-intensive areas. The PAAC mentions specific efforts to integrate renewable energy sources and enhance resource management in response to climate pressures (PAAC 2021-2030).

In terms of community engagement, rural communities, particularly those involved in agritourism, are shifting to agroecological practices and drought-resistant crops as part of their adaptation strategies. These measures address the vulnerabilities highlighted in the *Informe de Medio Ambiente en Andalucía 2023*, which underscores the importance of transitioning to sustainable practices in regions most affected by water scarcity and heat stress. Public awareness campaigns and local initiatives further reinforce community-level resilience, as noted in the PAAC and supported by participatory workshops (Informe de Medio Ambiente en Andalucía 2023; PAAC 2021-2030).

FUTURE PROJECTIONS AND ANTICIPATED RISKS

Climate projections for Andalusia reveal a range of future risks for the region's tourism sector, with varying intensity depending on the emissions scenarios modeled. The *Plan Andaluz de Acción por el Clima (PAAC)* and supporting documents highlight the key anticipated risks, their long-term implications, and the measures planned or implemented to mitigate their impacts.

Anticipated Future Risks for Tourism

Under moderate to extreme emissions scenarios, Andalusia faces rising temperatures, prolonged droughts, and an increased frequency of extreme weather events. By mid-century, average temperatures are projected to rise by up to +2.6°C, with significant reductions in annual precipitation. These changes will exacerbate heatwaves and water scarcity, which directly threaten the region's attractiveness as a summer tourist destination. Coastal areas face additional risks from sea-level rise and increased storm surges, which threaten beaches and waterfront infrastructure critical to Andalusia's tourism economy. Rural and nature-based tourism sectors are also at risk, as higher temperatures and reduced biodiversity impact the appeal of mountain and natural landscapes (PAAC 2021-2030; Informe de Medio Ambiente en Andalucía 2023).

Long-Term Impacts on Tourism



In the long term, these risks could significantly alter the dynamics of Andalusia's tourism sector. Rising temperatures are likely to shift seasonal tourism patterns, with fewer visitors during peak summer months and increased demand in spring and autumn. This change will challenge businesses that rely on concentrated summer activity. Coastal tourism, a cornerstone of the regional economy, faces the long-term degradation of beaches and natural barriers, which may reduce visitor satisfaction and result in declining revenues. Rural tourism may also suffer due to landscape degradation and increased wildfire risks, which could diminish the appeal of Andalusia's natural heritage. Combined, these risks threaten not only the viability of individual businesses but also the broader economic stability of communities dependent on tourism (PAAC 2021-2030; Junta de Andalucía, 2012).

Planned and Existing Mitigation Measures

To address these risks, Andalusia has adopted a multi-faceted approach outlined in the PAAC and related initiatives. Key measures include:

- **Water Resource Management:** Investments in water-saving technologies, desalination plants, and the reuse of treated water aim to alleviate water scarcity during peak tourism seasons.
- **Coastal Resilience:** Projects focusing on beach nourishment, the restoration of natural coastal barriers, and the regulation of coastal development are designed to protect vulnerable shorelines from erosion and flooding.
- **Seasonality Adjustments:** Efforts to promote off-season tourism, such as cultural and gastronomic tourism, aim to balance the demand across the year and reduce the pressure on resources during the summer months.
- **Sustainable Infrastructure:** Municipalities are implementing green infrastructure projects, such as urban greening and improved drainage systems, to mitigate heat island effects and flash flooding in tourist hubs.
- **Renewable Energy and Efficiency:** The tourism sector is being encouraged to adopt solar energy and energy-efficient systems to reduce greenhouse gas emissions and operational costs.
- **Public Awareness and Collaboration:** Initiatives involving local communities, businesses, and international partners, such as Climate-KIC, focus on knowledge-sharing and capacity-building for resilience.

4. GENERAL RECOMMENDATIONS FOR THE CLIMATE ACTION PLAN (ACT.2.5)

Andalusia has made significant advances in measuring sustainable tourism indicators, particularly through its participation and leadership in the *TSI Spain* project funded by the European Commission and supported by the OECD. A key achievement of this project has been the integration of environmental indicators to assess tourism sustainability.

Image 2. Core indicators to measure the sustainability of tourism. Source: OECD (2024), *Measuring and Monitoring the Sustainability of Tourism at Regional Level in Spain: Indicator Framework and Compilation Guide*.

Dimension	Policy issue	Indicator	Compilation readiness before pilot	Compilation readiness after pilot
Governance	Sustainable tourism management	A.1 Sustainable tourism development strategy	●	●
Economic	Benefits to the local economy	B.1 Tourism employment	●	●
		B.2 Tourism value-added	●	●
		B.3 Tourism expenditure	●	●
		B.4 Accommodation occupancy	●	●
	Reduced seasonality	B.5 Tourism seasonality	●	●
	Reduced vulnerability	B.6 Market dependency	●	●
Socio-cultural	Local community sentiment	C.1 Residents' perception of tourism	●	●
		C.2 Tourism pressures on local population	●	●
	Attraction of visitors	C.3 Tourist satisfaction	●	●
	Inclusive tourism employment	C.4 Gender equality	●	●
		C.5 Youth employment	●	●
		C.6 Job security	●	●
	Accessibility in tourism	C.7 Accessibility in tourism	●	●
Environmental	Climate change mitigation	D.1 Carbon emissions	●	●
		D.2 Green mobility infrastructure	●	●
		D.3 Renewable energy use	●	●
	Water management	D.4 Tourism water use	●	●
		D.5 Bathing-water quality	●	●
	Protected areas management	D.6 Tourism pressure in protected areas	●	●
		D.7 Management of natural parks	●	●

Colour coding for compilation readiness:

●	Indicator can be measured (data is available for all metrics)
●	Data sources have been identified, but methodology needs refinement
●	Data sources and methodology still need to be identified

During the TSI project, strong efforts have been made to gather comparable and reliable data, including use of resources such as water consumption, carbon emissions, and environmental impacts. However, during the development of



the TSI project challenges rose such as data granularity or data availability particularly for specific locations or specific industries as well as the need to further develop methodologies such as carbon footprint calculation for destinations. Addressing these gaps will further enhance the effectiveness of tourism-related climate diagnostics and adaptation measures.

The analysis conducted in the present report highlights vulnerabilities related to climate identified in Andalusia's tourism sector through different sources. Geographic diagnostics identify vulnerable areas, especially coastal zones, which face increased risks from sea-level rise and storm surges. These coastal regions, integral to Andalusia's tourism economy, rely on attractive beaches and waterfront infrastructure that are increasingly threatened by erosion and flooding.

Temperature and precipitation projections suggest changes in seasonal tourism patterns. With rising temperatures and extended heatwaves, summer tourism may become less attractive due to uncomfortable heat, potentially shifting visitor preferences toward spring and autumn. Diagnostics also reveal escalating water scarcity in Andalusia—a key consideration for tourism given the sector's heavy reliance on water resources. By forecasting water availability and stressing sustainable resource management, these diagnostics aid in balancing tourism needs with local resource conservation.

Additionally, the diagnostics highlight the frequency of extreme weather events like flash floods, which can disrupt tourism infrastructure and pose safety risks. This understanding supports resilience planning, including the enhancement of drainage systems in tourist areas and the development of early warning systems. Altogether, Andalusia's climate diagnostics offer a comprehensive view that helps shape climate-resilient policies for the tourism sector, ensuring that infrastructure, resources, and visitor experiences are maintained in the face of ongoing climate challenges.

These vulnerabilities emphasize the need for coordinated climate action that aligns with regional, national, and international initiatives to strengthen the regions resilience. For this, as mentioned in the introduction for context, as a signatory of the Glasgow Declaration on Climate Action in Tourism in 2024, Andalusia has committed to developing a Climate Action Plan for the region of Andalusia following the Glasgow Declaration's 5 established pathways—Measure, Decarbonise, Regenerate, Collaborate, and Finance—which provide the categorisation for the preliminary recommendations to be presented below.

Building on (i) the analysis of vulnerabilities, (ii) the alignment with the *Plan Andaluz de Acción por el Clima (PAAC)* for ensuring consistency with Andalusia's regional priorities while addressing climate risks specific to the tourism sector, (iii) previous Nature4CChange deliverables, (iv) the Glasgow Declaration and also (v) additional desk research on other destination's climate action plans, the table below outlines the proposed preliminary actions, highlighting their alignment with the Glasgow Declaration's pathways, the PAAC, and the relevant criteria for climate change mitigation and adaptation as identified in Deliverable 1.4.

It is important to note that these actions are subject to change during consultation phase with relevant stakeholders within the public administration as these have yet to be validated.

Table 1. Proposed preliminary actions for Andalusia's Climate Action.

Proposed preliminary actions	Alignment with PAAC	Glasgow Pathway	Alignment with Criteria from D.1.4
Define and measure adaptation indicators for climate change in tourism		Measure	Adaptation - Monitoring and Evaluation
Promote carbon footprint calculation and reduction measures among tourism organizations	PAAC	Measure	Mitigation - Carbon Footprint Reduction
Report publicly each year on progress toward intermediate and long-term goals		Measure	Mitigation - Reporting and Transparency
Implement annual carbon footprint measurement for activities of Andalusia's Public Tourism Company		Measure	Mitigation - Monitoring and Accountability
Develop a protocol for sustainable events and measure		Measure	Mitigation - Event Sustainability



carbon footprint of public events			
Reduce fluorinated gas emissions in tourism, commercial sectors, and public buildings	PAAC	Decarbonise	Mitigation - GHG Emission Reduction
Improve energy savings and efficiency in tourism, commercial, and public-use buildings	PAAC	Decarbonise	Mitigation - Energy Efficiency
Include environmental sustainability criteria in the new Marketing Plan 2023-2027		Decarbonise	Mitigation - Strategic Planning
Integrate environmental aspects into tourism promotion and information tools		Decarbonise	Mitigation - Awareness and Education
Promote consumption of local, seasonal, and low-environmental-impact products		Decarbonise	Mitigation - Sustainable Consumption
Apply circular economy principles in tourism, commercial buildings, and public infrastructure design	PAAC	Regenerate	Adaptation - Circular Economy
Integrate climate adaptation into strategic tourism planning (Sustainable Tourism Strategy of Andalusia)	PAAC	Regenerate	Adaptation - Strategic Planning



Adapt tourism resources to the effects of climate change	PAAC	Regenerate	Adaptation - Resource Management
Develop climate impact management plans for ski stations		Regenerate	Adaptation - Sector-Specific Planning
Include GHG mitigation and energy efficiency in urban planning policies	PAAC	Collaborate	Mitigation - Policy Integration
Apply circular economy principles in restaurant and hotel management	PAAC	Collaborate	Adaptation - Circular Economy
Raise public awareness about climate change and promote sustainable tourism behaviors	PAAC	Collaborate	Adaptation - Awareness and Behavioral Change
Develop awareness actions for tourism sector stakeholders		Collaborate	Adaptation - Stakeholder Engagement
Promote registrations in the Andalusian Emissions Compensation System (SACE)		Collaborate	Mitigation - Emissions Compensation
Encourage key tourism sector actors to obtain ECOLABEL certification		Collaborate	Mitigation - Certification and Standards
Reformulate Andalusia's tourism model to enhance climate resilience	PAAC	Collaborate	Adaptation - Strategic Reform
Expand and update knowledge on	PAAC	Collaborate	Adaptation - Research and



climate impacts in tourism management			Knowledge Dissemination
Report annually on progress made by Andalusia's Climate Commission in tourism matters		Collaborate	Mitigation - Monitoring and Reporting
Organize workshops on climate action, focusing on regeneration and financing pathways		Collaborate	Adaptation - Capacity Building
Introduce environmental impact reduction measures into tourism grant evaluation criteria	PAAC	Finance	Mitigation - Funding Mechanisms
Include energy efficiency criteria in public procurement processes	PAAC	Finance	Mitigation - Procurement Practices
Offer mentoring for tourism companies to implement decarbonization measures		Finance	Mitigation - Capacity Building
Identify and attract funding for climate action commitments		Finance	Adaptation and Mitigation - Funding and Resource Mobilization
Identify funding sources for mitigation and adaptation in the tourism sector		Finance	Adaptation and Mitigation - Funding Strategy



Finally, to enhance the cohesion of Andalusia's initiatives, both in climate action and in measuring the overall sustainability of tourism, it is recommended to incorporate additional indicators from the key indicators identified in Deliverable 1.4. in the TSI monitoring tool so that climate action indicators are be measured and evaluated at the same time as the core tourism sustainability indicators established in the TSI Project. By integrating these indicators, Andalusia can strengthen its ability to track progress in climate action and assess the actions being developed during a specific time frame.

Indicators:

1. Physical and Environmental Indicators

- Ind 1.1 Change in Annual Temperature
- Ind 1.2 Number and Frequency of Hot Days
- Ind 1.3 Sea-Level Rise
- Ind 1.4 Extreme Precipitation Days

2. Sociocultural Indicators

- Ind 3.1 Tourist Satisfaction (already being measured)

3. Governance and Policy Indicators

- Ind 4.2 Funding for Adaptation Projects
- Ind 4.3 Stakeholder Involvement

4. Biodiversity and Ecosystem Health Indicators

- Ind 5.3 Water Quality (already being measured)
- Ind 5.4 Protected Areas (already being measured)

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