CLIMAAX
climate ready regions

Deliverable Phase 1 – Climate risk assessment

Climate Risk Analysis and Adaptation strategy for the mediterranean county of La Foia de Castalla (CLIMAAX4CAST)

Spain, Excma. Diputacion Provincial de Alicante

HORIZON-MISS-2021-CLIMA-02-01 - Development of climate change risk assessments in European regions and communities based on a transparent and harmonised Climate Risk Assessment approach

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Document Information

Deliverable Title	Phase 1 – Climate risk assessment
Brief Description	The document analyzes climate risks in the Castalla basin, Spain, as part of the CLIMAAX project. Droughts and heatwaves are identified as the main threats due to rising temperatures and changes in precipitation. The report highlights the involvement of key stakeholders in the risk assessment and the need for adaptation measures, such as improving irrigation and community education. The conclusions emphasize the urgency of proactive actions to mitigate these risks and protect vulnerable populations, paving the way for a future Adaptation Plan.
Project name	Climate Risk Analysis and Adaptation strategy for the mediterranean county of La Foia de Castalla
Country	Spain
Region/Municipality	Excma. Diputacion Provincial de Alicante (DPA)
Leading Institution	Excma. Diputacion Provincial de Alicante (DPA)
Supporting subcontracting Institutions	Research association of the toy industry and related (AIJU)
Author(s)	• Débora Sorolla Rosario (AIJU) • Joaquín Vilaplana Cerdá (AIJU) • Dionisio Cartagena González (AIJU) • Miguel Fernandez Mejuto (DPA)
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5.0	27/05/2025	AIJU	Reviewed version

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Abbreviations and acronyms

Abbreviation / acronym	Description
CLIMAAX	CLIMAte risk and vulnerability Assessment framework and toolboX
CLIMAAX4CAST	Climate Risk Analysis and Adaptation strategy for the mediterranean county of La Foia de Castalla
IPCC	Intergovernmental Panel on Climate Change
TGA	Thermogravimetric Analysis
DSC	Differential Scanning Calorimetry
AIJU	Research Association of the Toy Industry and Related
ISO	International Organization for Standardization
SCADA	Supervisory Control and Data Acquisition
PLA	Programmable Logic Array
FPGA	Field-Programmable Gate Array
CRA	Climate Risk Assessment
RAST	Regional Adaptation Support
ERDF	European Regional Development Fund
NGO	No Governmental Organization
AFEM	Adaptation Fund for the Forest Ecosystem and Management
RCP	Representative Concentration Pathways
EURO-CORDEX	European COordinated Regional climate Downscaling Experiment
XCLIM	Python library designed for climate assessment and research related to climate and its effects
LST	Land Surface Temperature
C.V.	Comunitat Valenciana
WASP	Water Availability and Simulation Program
WHEA	Water and Energy Health Assessment

1. Executive summary

This report presents the findings from the first phase of the Climate Risk Assessment (CRA) for the Castalla basin, part of the CLIMAAX project. The initiative aims to identify vulnerabilities within the community and the natural environment, focusing specifically on their exposures to climate risks such as droughts and heatwaves. The deliverable addresses the pressing need for evidence-based strategies to enhance resilience against the adverse effects of climate change in this region of Spain.

The assessment revealed that the Castalla basin is likely to experience significant impacts due to predicted increases in mean temperatures and alterations in precipitation patterns. The analysis identified droughts and heatwaves as the most critical hazards affecting local agriculture, public health, and overall community well-being. In response, the project has established key objectives that include evaluating risks, fostering community participation, and developing comprehensive adaptation strategies.

Several main actions were undertaken during this phase. Stake

holder engagement activities were conducted to ensure the inclusion of diverse perspectives in addressing climate risks. Two primary workflows were applied to assess heatwave and drought risks, leading to the identification of vulnerable populations and areas at greatest risk. The results underscore the necessity of implementing adaptation measures, such as improved irrigation infrastructure, community education on climate change impacts, and sustainable agricultural practices.

The findings contribute to the overall project by establishing a foundation for future phases of the CLIMAAX initiative. The information gathered will inform the development of a detailed Adaptation Plan, tailored to the specific needs of the Castalla basin. Continuous monitoring and evaluation of climate risks are crucial for the successful implementation of adaptive strategies.

In conclusion, the Climate Risk Assessment has highlighted the urgent need for proactive measures to mitigate climate risks in the Castalla basin. Local authorities, stakeholders, and the community must collaborate to implement recommended strategies to foster resilience against climate change and protect vulnerable populations. These efforts are essential for safeguarding the environmental and socioeconomic integrity of the region in the face of impending climate challenges.

1 Introduction

1.1 Background

The Castalla basin, is a natural and historical subregion located in the interior of the province of Alicante, in the Valencian Community. It is formed by the municipalities of Ibi, Onil, Castalla, and Tibi, and has a total population of approximately 44,856 inhabitants. The region is characterized by its mountainous landscape, with sierras such as Maigmó, Castalla, Menejador (Ibi), Onil, and Peña Roja (Tibi). The valley is located at an altitude between 550 and 800 meters, while the surrounding mountains exceed 1000 meters. Historically, the economy of the Castalla basin was based on dryland agriculture, but since the 1950s and 1960s, the region experienced rapid industrialization, especially in the manufacturing of toys and dolls in Ibi and Onil. Currently, the industry has diversified towards sectors such as plastics, steel, and molds.

1.2 Main objectives of the project

The forecasts of the Intergovernmental Panel on Climate Change (IPCC) indicate that the Castalla region is likely to suffer a drastic increase in mean temperatures and in extreme rainfall events during next years. This fact increases the probability of serious, widespread and irreversible impacts for species, people and ecosystems, thus affecting biodiversity, economic development, food and human security. In addressing the challenges posed by climate change, it is imperative to pursue both mitigation and adaptation strategies. While mitigation efforts aim to curtail the root causes of climate change, particularly at a global scale, it is equally, if not more, crucial to prioritize adaptation measures at the local level.

The climate change risk assessment study by CLIMAAX will provide a solid basis to reduce vulnerability and increase the resilience of Castalla basin to climate impacts.

In order to adequately manage the scarce resources that the area has, it is essential to correctly predict the climatic trend, focusing on heatwaves and droughts, since due to climate change rainfalls have been significantly reduced in recent years, to the time that temperatures have increased, favoring desertification of certain areas, which in turn affects the productivity of the land and biodiversity.

The CLIMAAX approach can be an effective tool to improve local knowledge and awareness of climate risks in several ways, such as:

- Community participation, as CLIMAAX focuses on the active participation of the community in the identification, understanding and addressing of local climate risks.
- Education and training, as it offers educational programs and training to improve understanding of climate risks and available adaptation and mitigation measures.
- Vulnerability and risk assessment, conducting evaluations of this type. This information can be used to inform decision-making and prioritize adaptation and resilience actions.
- Development of climate action plans adapted to our specific needs and circumstances, which may include measures to reduce vulnerability, improve resilience and mitigate climate impacts, which contributes to increasing preparedness and response capacity to extreme events.

1.3 Project team

Débora Sorolla Rosario**:** PhD in Materials Science from the University of Alicante. Specialist in gas chromatography-mass spectrometry and thermal techniques (TGA and DSC). She is currently a project technician, developing her activities within the area of environment and circular economy, as well as the energy sector at AIJU. She has extensive research experience in various sectors, including water, automotive, textiles, and toys, focusing on Environmental Decontamination, the development and validation of analytical techniques under ISO 17025, polymer analysis, Circular Economy, process efficiency, and Advanced Energy Technologies. She also has a strong outreach activity through numerous talks, courses, and participation in national and international conferences, as well as the publication of 5 articles in high-impact scientific journals.

Joaquín Vilaplana Cerdá: PhD in Chemistry and current Director of Innovation and Sustainability at AIJU, he has over 30 years of experience in this organization. His career has focused on the development of environmental technical solutions for the needs of industrial companies, as well as the management and development of R&D and innovation projects. He has played a prominent role as the coordinator of the Technical Secretariat of the Innovative Companies Cluster of the Toy Valley and the National Technological Platform for Traditional Manufacturing Companies.

Dionisio Cartagena González*:* Industrial Engineer. Currently completing a Master's in Automation and Robotics at the University of Alicante. He is currently working as a Project Technician in the Advanced Manufacturing Department, where he has gained experience in various key areas, including system modeling and control, programming of automation systems and SCADA, as well as the design and fabrication of power supplies. Additionally, he has skills in programming PLAs and FPGAs, as well as in robotics and artificial vision, and has also specialized in the design of photovoltaic systems. His technical training and practical experience in these fields make him a competent professional in the area of industrial engineering and automation.

Miguel Fernandez Mejuto: Head of the Water Technologies Unit of the Water Cycle Department of the Alicante Provincial Council.

Associate Professor in the Department of Earth and Environmental Sciences at the University of Alicante.

1.4 Outline of the document's structure

The document is structured into several clearly defined sections, providing a comprehensive overview of the climate risk assessment project for the Castalla basin in Spain.

Document Information: This section includes the title, description, authors, submission dates, and the nature of the deliverable. It establishes the foundational information pertinent to the report.

Table of Contents: It outlines the subsequent sections of the document, enabling readers to navigate through the report efficiently.

Lists of Figures and Tables: These lists provide an organized view of the visual data included in the report, facilitating easy reference.

Abbreviations and Acronyms: This section defines the various abbreviations and acronyms used throughout the document, aiding in the reader's understanding.

Executive Summary: A concise section summarizing the key elements, objectives, and findings of the report without delving into details. It highlights the significance of the project.

Introduction: This section provides context, outlines the main objectives of the project, introduces the project team, and briefly explains the document's structure.

Climate Risk Assessment – Phase 1: Detailed analysis is presented in subsections covering aspects such as:

> **Scoping**: Defining the objectives, context, and stakeholder participation.
>
> **Risk Exploration**: Identifying and analyzing key climate risks such as droughts and heatwaves.
>
> **Risk Analysis**: Discussing methodologies and workflows used in assessing these risks.

Conclusions Phase 1: This section summarizes the key findings from the risk assessment and discusses both addressed and unaddressed challenges.

Progress Evaluation and Contribution to Future Phases: This segment evaluates the progress made in the project and discusses the contributions of the findings to future phases.

Supporting Documentation: Includes additional documents that support the assessment conducted.

References: A section listing all sources and references used throughout the report.

Managing the Formats of the Template - Title Styles: Guidelines on how to format different headings and manage tables and figures in the document.

2 Climate risk assessment – phase 1

2.1 Scoping

2.1.1 Objectives

The main objective of this project is to carry out a Climate Risk Assessment (CRA) in the Castalla basin to identify vulnerabilities, assess potential impacts, and develop adaptation strategies that enhance the resilience of communities, infrastructure, and ecosystems to the effects of climate change. The goal is to determine the most vulnerable areas, sectors, and communities, analyze how different climate scenarios may affect natural resources, infrastructure, the economy, and public health, and provide evidence-based information to support planning and policy formulation related to adaptation and mitigation.

The purpose of the CRA is to inform decision-making, raise awareness of climate risks, and develop adaptation strategies that propose measures to reduce vulnerabilities. The expected outcome includes generating detailed reports and recommendations to implement effective adaptation strategies, thereby improving the capacity of communities and ecosystems to withstand and recover from climate impacts. Systems will also be established for continuously monitoring and evaluating climate risks and the effectiveness of adaptation measures.

Integrating the objectives of the CRA into policy formulation is essential for effective climate adaptation and mitigation, allowing for the development of evidence-based policies that address identified risks and prioritize the most vulnerable areas. Involving key stakeholders in this process will ensure inclusive policies that have broad support. A baseline will be established to monitor and evaluate the effectiveness of climate policies, facilitating continuous improvement based on real outcomes and new data.

However, there are limitations in conducting a CRA, such as the limited availability of consistent high-quality data, the difficulty of effective stakeholder engagement, the inherent uncertainty of climate models, and the significant financial and human resources required. Additionally, the lack of standardization in methodologies may lead to inconsistencies in assessments, and effective implementation requires strong political support.

2.1.2 Context

In the Castalla basin, climate hazards such as droughts and heavy rainfall have been assessed and managed through environmental diagnostics, the establishment of protected areas, and the development of renewable energy projects. However, there is an urgent need to intensify these efforts in the face of increasing climate change impacts.

The project aims to address the growing vulnerability of the region to climate change, which poses significant risks to water resources, agriculture, and community well-being. This approach is situated within a broader context of regional and national development, aligning with Spain's climate change adaptation and mitigation strategies and contributing to the National Adaptation Plan.

Regarding governance, the Castalla basin is influenced by policies such as the National Climate Change Law and the Natura 2000 network, as well as regulations that require climate risk assessments and adaptation strategies. Environmental Impact Assessments are mandatory for new projects, and tools such as the Regional Adaptation Support (RAST) provide practical guidance.

Relevant sectors include industry, agriculture, and tourism. The industry represents 67% of the region's revenue and encompasses sectors such as plastics and metals. Agriculture is crucial as it depends on local climatic conditions, and although tourism is not the dominant sector, its relationship with protected areas makes it significant. All these sectors could face disruptions in production, reduced agricultural productivity, and ecosystem degradation.

External influences impact climate issues in the basin, such as national initiatives like the Integrated National Energy and Climate Plan, along with support from the European Union through the Green Deal and the European Regional Development Fund (ERDF). These initiatives provide resources and backing to address climate challenges.

Possible adaptation interventions include improving water management, upgrading irrigation infrastructure, promoting the use of local renewable energies, restoring ecosystems, and encouraging sustainable agricultural practices. The importance of education about climate change and community involvement in the planning and execution of these projects is also emphasized.

2.1.3 Participation and risk ownership

The process of engaging stakeholders in the Castalla basin began with the identification of key actors, which include various levels of government (the municipalities of Ibi, Onil, Castalla, and Tibi, as well as the Provincial Council of Alicante), NGOs, citizens, the private sector (industrial companies and small and medium-sized enterprises), and academia. These entities are fundamental to the management and development of the region, contributing both funding and technical support.

Among the vulnerable groups are the elderly, represented by associations for retirees, and individuals with chronic illnesses, organized in groups like AFEM. Additionally, farmers and ranchers, through cooperatives, are prioritized due to their dependence on natural resources and their exposure to extreme climatic phenomena.

Risk management is regulated through the collaboration of multiple entities, where local councils implement climate change adaptation policies. The management plans developed by municipalities identify specific risks and establish mitigation strategies.

The acceptable level of risk for the community is determined through a participatory process that identifies specific climate risks and assesses the community's vulnerability, particularly taking into account the views of vulnerable groups.

Various collaborative actions will be carried out involving all key stakeholders in the region, including local councils, the Alicante Provincial Council, citizens, public and private companies, as well as farmers. A collaboration agreement will be established between the local councils and the Provincial Council with the aim of implementing initiatives focused on sustainability and resilience in the face of climate change. Additionally, workshops and events will be organized to address a range of relevant topics, such as environmental protection, the circular economy, and the impact of climate change on the community. These activities will not only foster the exchange of knowledge and experiences but also promote active participation from citizens and other stakeholders in creating a more sustainable future.

2.2 Risk Exploration

2.2.1 Screen risks (selection of main hazards)

In the Castalla basin, the most significant climate hazards are droughts and heatwaves, whose intensity has notably increased in the region. Prolonged droughts affect the availability of water for agriculture, human consumption, and ecosystems, causing water stress for wildlife and the local population, especially among farmers and rural communities. Heatwaves also impact public health and infrastructure, putting vulnerable groups such as the elderly and individuals with chronic illnesses at risk, leading to an increase in heat-related illnesses and energy demand.

The current situation indicates that these phenomena are intensifying, with expectations of changes in precipitation patterns that could include heavy rains followed by extended droughts. The average annual temperature may also rise, exacerbating both droughts and heatwaves. Furthermore, an increase in extreme weather events, such as storms and high winds, is anticipated, posing additional risks to infrastructure and community safety.

To address these risks, it is crucial to establish mitigation and adaptation measures that include continuous monitoring of climate indicators, accurate hydrological modeling, and thorough vulnerability assessments. Collaboration among various stakeholders, such as local governments and the private sector, is essential to implement effective strategies that enhance the resilience of the Castalla basin.

Regarding the risk assessment, the most relevant climate hazards, such as droughts and heatwaves, that primarily affect farmers and rural communities have been selected. More information is needed on the impact of these phenomena and continuous monitoring is necessary to better understand the magnitude of the risks and the vulnerability of the region.

2.2.2 Workflow selection

In the context of the climate risk assessment for droughts and heatwaves, specific workflows have been identified to effectively address these hazards. For droughts, a comprehensive hazard assessment is conducted, analyzing the likelihood of severe precipitation deficits during historical periods and projecting this into the future using monthly precipitation data and future projections to better understand the trend and potential impact of water scarcity. A detailed risk assessment related to agriculture is also carried out, considering potential income losses due to decreased crop yields as a result of water scarcity and inadequate irrigation.

Regarding heatwaves, one of the workflows focuses on assessing the hazard of these extreme events, taking into account factors such as frequency, duration, and intensity under different climate scenarios, using daily maximum and minimum temperature data to understand the magnitude of heatwaves and their impact on the region. Additionally, a health risk assessment during heatwaves is conducted, focusing on the potential impacts on vulnerable groups such as the elderly, children, individuals with chronic illnesses, and low-income communities.

Vulnerable groups and areas exposed to these risks include farmers and ranchers, rural communities that depend on water for their daily activities, as well as the elderly and children, who are particularly susceptible to the effects of heatwaves.

2.2.3 Choose Scenario

For the Castalla Basin region, it is essential to consider various scenarios that address both climate change and socioeconomic development, considering their short-, medium-, and long-term effects. The interaction between these factors will influence the capacity for adaptation and mitigation in the face of climate and socioeconomic risks. Therefore, the RCP 4.5 and RCP 8.5 scenarios were selected to analyze the effects of heat waves, and an RCP of 2.6 for droughts.

The choice to use the RCP 4.5 and RCP 8.5 scenarios for analyzing risks related to heatwaves, and the RCP 2.6 for droughts, is based on the different characteristics and projections of each of these scenarios in relation to the climatic phenomena being studied.

The RCP 4.5 and RCP 8.5 scenarios represent greenhouse gas emission trajectories that lead to significant increases in global temperatures, which is particularly relevant for the analysis of heatwaves, as these extreme events are directly linked to rising temperatures. Under these scenarios, projections suggest a considerable increase in the frequency and intensity of heatwaves, which could have severe implications for public health, agriculture, and infrastructure.

On the other hand, the RCP 2.6 scenario is used for droughts because it represents a more optimistic approach to climate change mitigation, where significant reductions in greenhouse gas emissions are achieved. Including RCP 2.6 for the drought analysis allows for an evaluation of a future where mitigation actions are effective, thus exploring the impacts of drought in a context where efforts have been made to limit global warming. This can provide valuable insights into the resilience of natural and human systems in the face of drought under a successful mitigation scenario.

In summary, the combination of different RCP scenarios enables a more precise and comprehensive assessment of the risks associated with various climatic phenomena, adapting the analysis to the specific characteristics of each one.

In the socioeconomic sphere, in the short term, population growth and the intensification of economic activities will increase the demand for basic resources like water and energy. In the medium term, urbanization and the expansion of infrastructure will influence water management and land use planning, generating challenges in resource distribution. In the long term, continuous population growth and economic activities will increase pressure on natural resources, necessitating the adoption of adaptation measures and sustainable management.

Within the CLIMAAX workflows, the most useful scenarios for the Castalla basin include the assessment of droughts, heatwaves, and risks for vulnerable groups and exposed areas. Regarding droughts, the hazard and agricultural risk related to reduced crop yields due to lack of precipitation and irrigation are evaluated. For heatwaves, the hazard related to their frequency, duration, and intensity is analyzed, as well as health risks for vulnerable populations.

2.3 Risk Analysis

2.3.1 Workflow #1

Heatwaves

Table 2-1 Data overview workflow #1

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
EURO-CORDEX data are processed using the XCLIM methodology. Temperature thresholds were set between 22 and 29.4°C (recommended for Mediterranean regions[1]) and lasted for 5 days.	Vulnerability data include information on the susceptibility of the population and urban infrastructure to heat waves. Data from WorldPop are used by sex and age, using data for men and women aged 0, 1, 5, 10, 15, 60, 65, 70, 75, and 80.	From 15/06/2024 to 12/09/2024	Heatwave index, heatwave frequency and total number of heatwave days
Euroheat data	World pop		

2.3.1.1 Hazard assessment

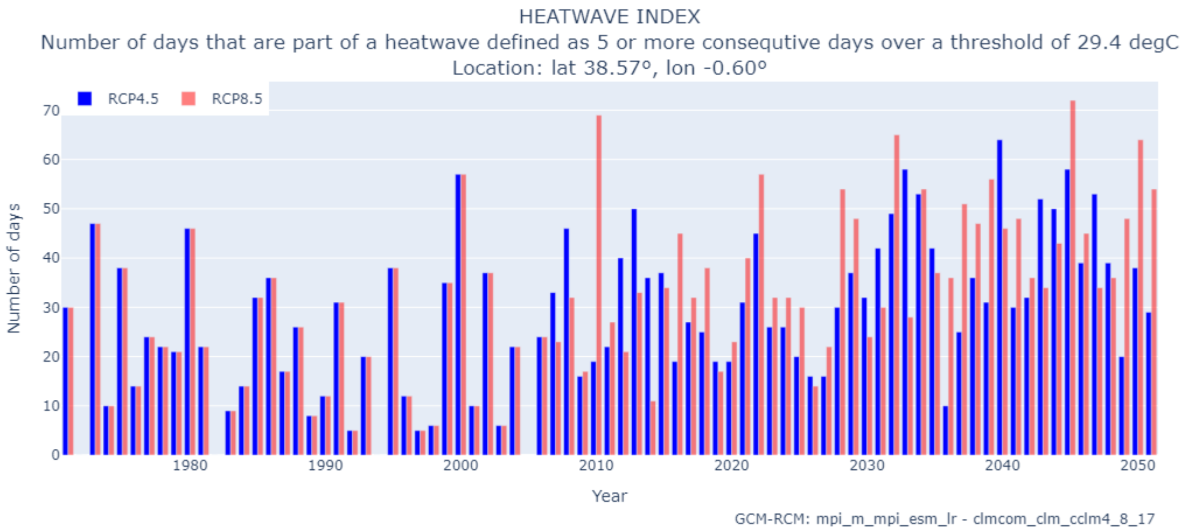

Figure 2-1 Heatwave Index (HWI) for the Castalla basin region.

It is noteworthy that starting from 2020, the prediction yields a series of values with an upward trend in the days belonging to heat waves, despite some years of decline. The worst-case scenario RCP 8.5 reaches historical highs while exceeding, in most cases, the data of RCP 4.5.

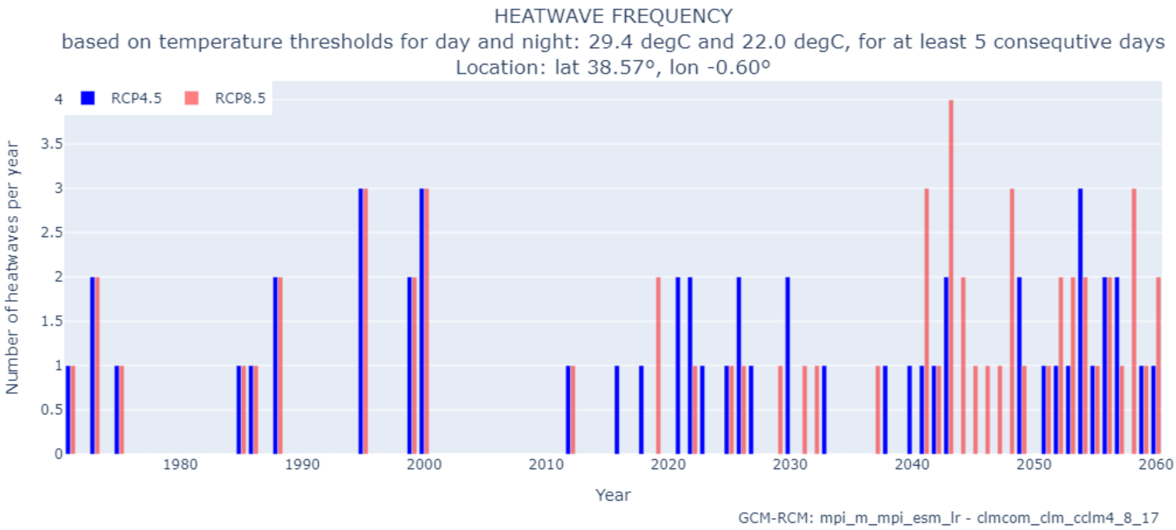

Figure 2-2 Heatwave frequency for the Castalla basin region.

In the prediction for the number of heat waves per year, the forecast shows a similar trend to the data collected before 2000, but with higher and more frequent maximum values for RCP 8.5.

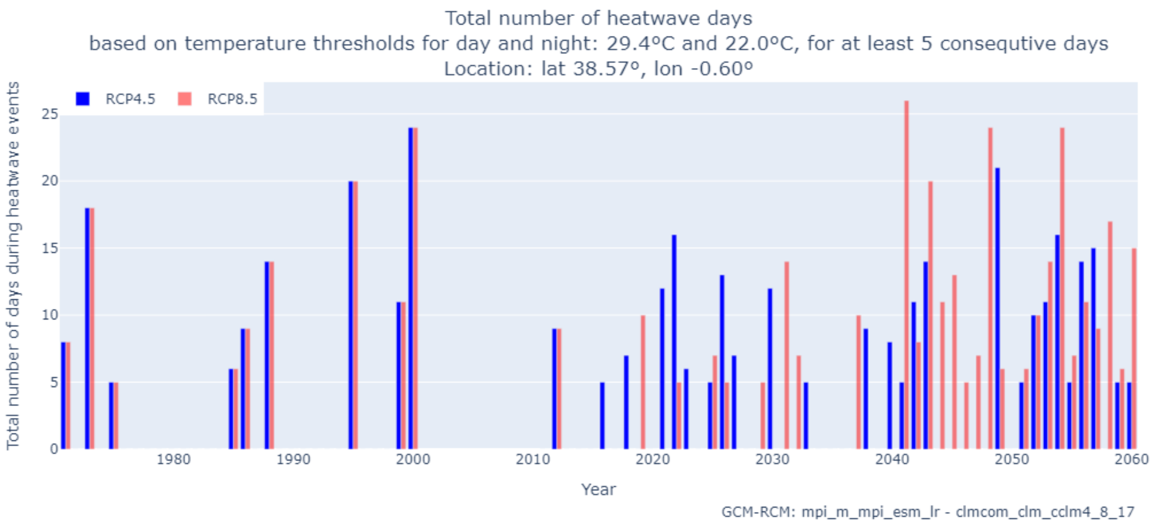

Figure 2-3 Heatwave total length for the Castalla basin region.

Regarding the total number of days during a heat wave event, despite the absence of data for several years, we can see that the prediction results in values similar to those recorded before 2020; however, we find more frequent peaks in RCP 8.5 that even surpass the previous data.

2.3.1.2 Risk assessment

2.3.1.2.1 Risk assessment for heatwaves based on satellite-derived data

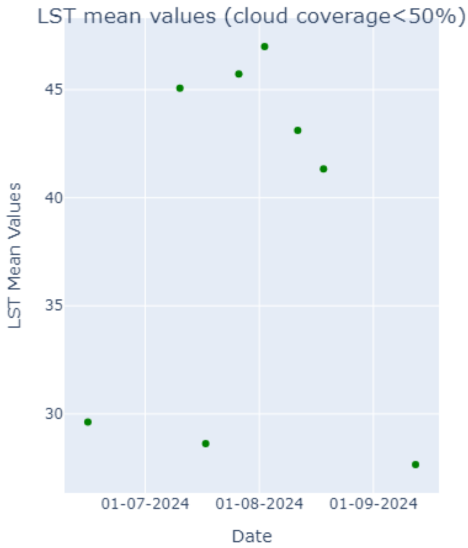

Figure 2-4 LST mean values for the summer of 2024 from the Castalla basin region.

This graph shows the average land surface temperature values for the selected area, based on the Landsat 8 image. Only days with less than 50% cloud cover from the LST images are represented. The summer period of 2024 was selected, where more than 60% of the days have an average temperature above 40 degrees, most of them above 45 degrees.

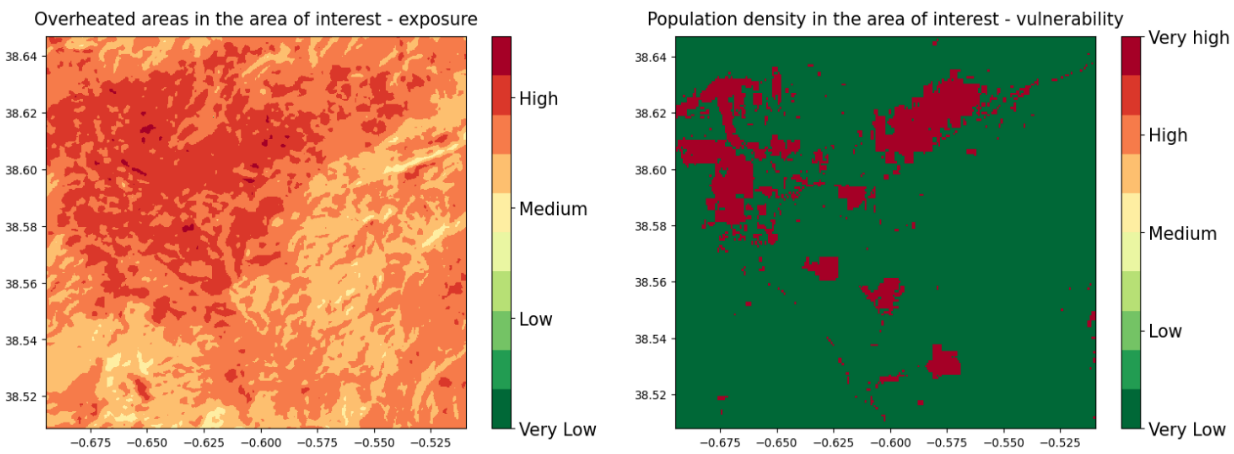

Figure 2-5 Overneated areas and vulnerability of the population in the Castalla basin region.

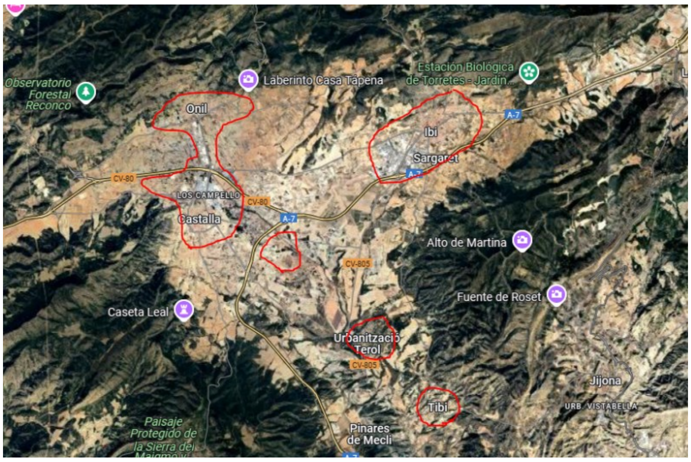

Figure 2-6 Populated areas in the Castalla basin region.

The maps above show the most overheated regions (2-4 on the left) along with the population density of vulnerable population groups (2-4 on the right). Figure 2-5 shows a map of the region highlighting populated areas. It can be seen that these areas coincide with a very high vulnerability index and areas of very high overheating.

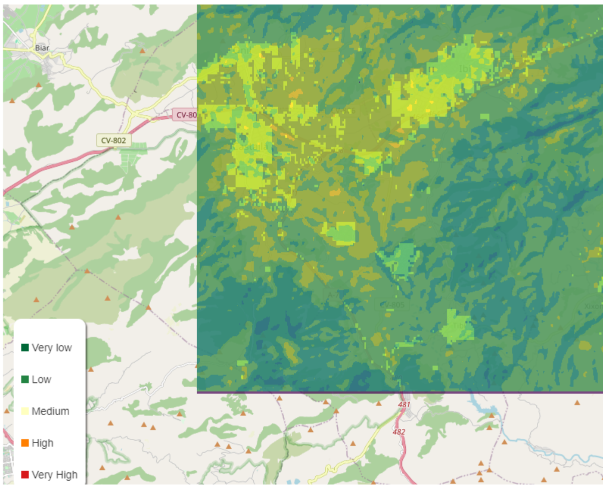

Figure 2-7 Possible heat risk level to vulnerable population.

This map shows how, when combining exposure (LST - areas that heat up most) and vulnerability (density of vulnerable population), populated areas have a medium risk to heat, with some areas where the risk is high. It should be noted that this map does not include critical infraestructures in urban centers.

2.3.1.2.2 Heatwave risk under the climate change

These maps show the evolution of heat waves in the region of L'Alcoià in the province of Alicante, to which the Castalla basin belongs, for the periods 2016-2045 and 2046-2075 compared to the reference period of 1986-2015 and for the RCP 4.5 and 8.5.

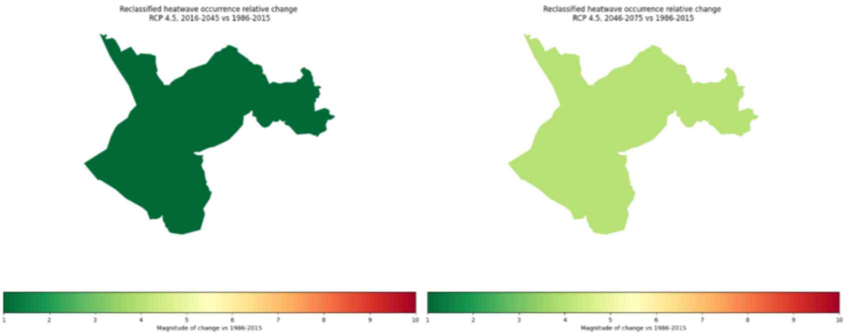

Figure 2-8 Heatwave occurrence relative change for RCP 4.5.

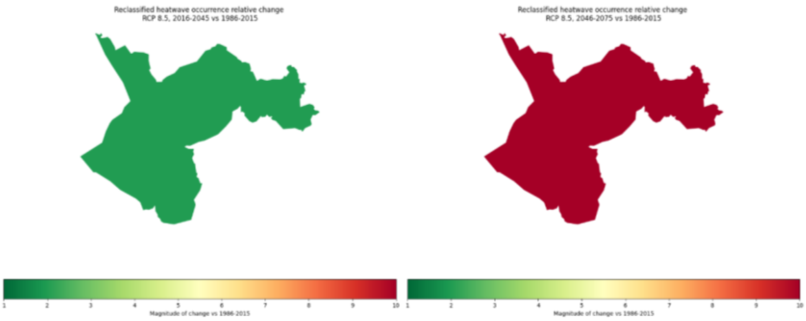

Figure 2-9 Heatwave occurrence relative change for RCP 8.5.

It can be seen that for an RCP 4.5 scenario, the increase in heatwaves could be up to 5 times more frequent in the period from 2046 to 2075. Meanwhile, in an RCP 8.5 scenario, during the period from 2016 to 2045, heatwaves could be between 2 to 3 times more frequent than the reference period, whereas in the period from 2046 to 2075, heatwaves could increase by up to 10 times.

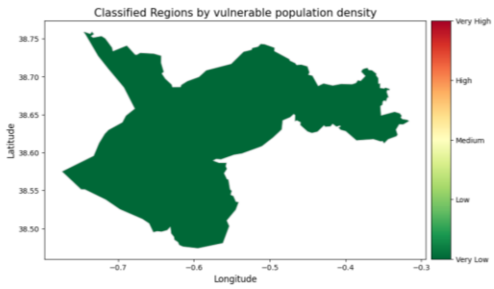

Figure 2-10 Classified regions by vulnerable population density.

The population density of vulnerable individuals in the Castalla basin area is very low, as this region consists of small urban centres, and most of the territory is designated as natural space.

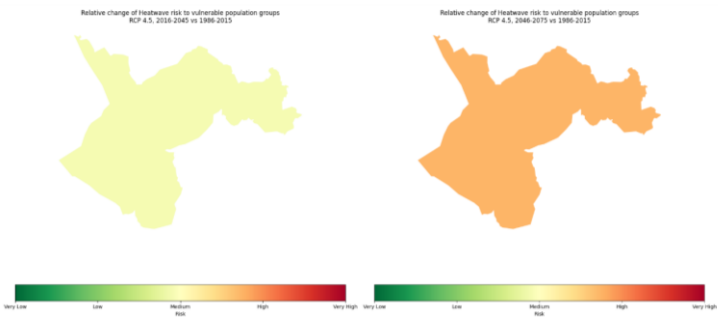

Figure 2-11 Relative change of heatwave risk to vulnerable population groups, RCP 4.5.

From 2016 to 2045, the risk of heatwaves is classified as medium. This implies that even under a moderate emissions scenario, climate change is expected to increase the frequency, duration, or intensity of heatwaves, which would have a greater impact on vulnerable populations. For the period from 2046 to 2075, this risk rises to high, indicating a trend toward a greater impact of heatwaves in the future. Even with a moderate mitigation approach, this may require the implementation of additional adaptation and mitigation measures to protect at-risk populations.

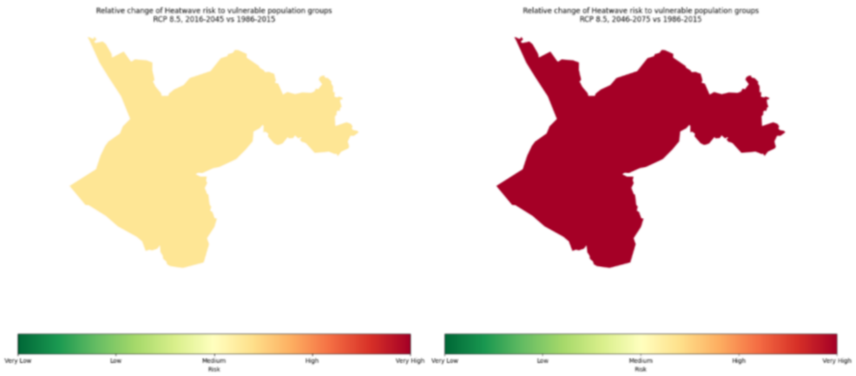

Figure 2-12 Relative change of heatwave risk to vulnerable population groups, RCP 8.5.

For the period from 2016 to 2045, similar to the RCP 4.5 scenario, the risk of heatwaves is considered medium. This implies that even in the early years under a high emissions scenario, the impact of heatwaves is significant. In the period from 2046 to 2075, the risk increases to very high, meaning that without significant efforts to reduce greenhouse gas emissions, the region could face extremely severe heatwaves. This would endanger different sectors of the population and require urgent and effective adaptations.

2.3.2 Workflow #2

Droughts

Table 2-2 Data overview workflow #2

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
WASP values	Irrigation availability	Valencian Community	AWC, Cumulate precipitation intensity and cumulate standard evapotranspiration. Maize yield loss and yield loss from precipitation deficit

2.3.2.1 Hazard assessment

2.3.2.1.1 Agricultural Drought Risk Assessment Description

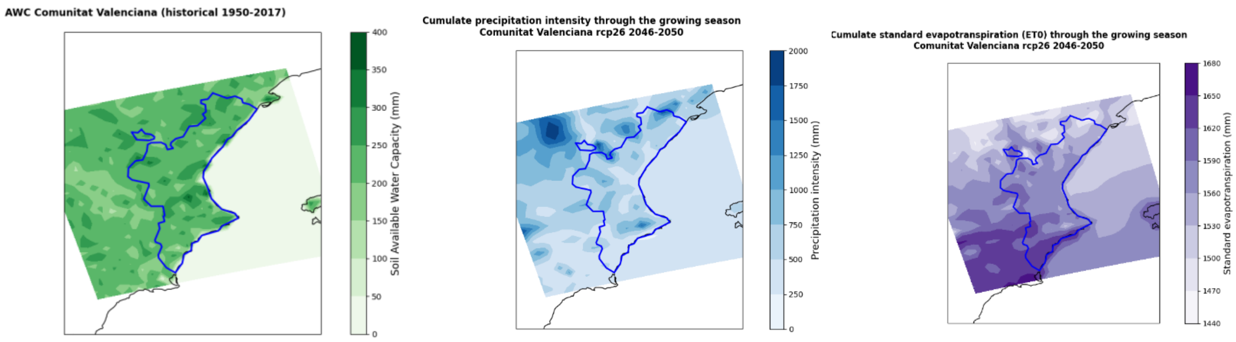

Figure 2-13 AWC, Cumulate precipitation intensity and cumulate standard evapotranspiration of the Comunitat Valenciana (historical and RCP 2.6 2046-2050).

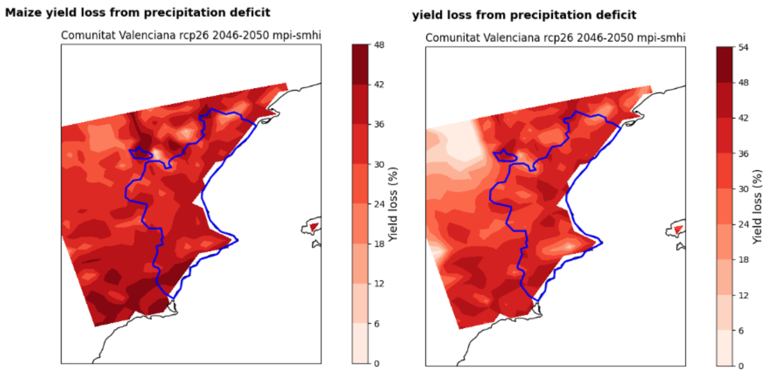

Figure 2-14 Maize yield loss and yield loss from precipitation deficit at de Comunitat Valenciana for RCP 2.6.

The analysis of various maps of the Valencian Community concerning the Castalla basin region and the RCP 2.6 scenario for the period 2046-2050 reveals important considerations regarding the impact of climate change on agriculture and water management in the area. The soil water retention capacity (AWC) ranges from 150 to 200 mm, indicating that the region has a moderate retention capacity, which can be beneficial for certain crops, provided that precipitation is adequate and well-distributed over time. Precipitation is expected to vary between 200 and 750 mm, which can be favorable but may also lead to extreme events if concentrated in short periods, thereby increasing the risk of flooding and erosion and emphasizing the need for proper water and soil management.

With accumulated evapotranspiration levels between 1560 and 1650 mm, the water demand for crops in the region will be high, suggesting that, despite precipitation, there may be a water deficit due to significant water loss through evaporation and transpiration. In this context, yield losses in corn have been observed to be between 24% and 36%, and in other crops, between 18% and 36%, attributed to the precipitation deficit. These significant figures suggest that a considerable portion of production will be lost, potentially compromising food security in the region.

The magnitude of these losses, combined with future climatic conditions, necessitates the adoption of adaptation strategies that include improving water management through more efficient irrigation systems, selecting more resilient crops, and implementing soil conservation practices. Additionally, the results underscore the need to review water and agricultural management policies; authorities must promote sustainable practices and develop technologies that help farmers adapt to changing climatic conditions.

2.3.2.1.2 Risk assessment for relative drought

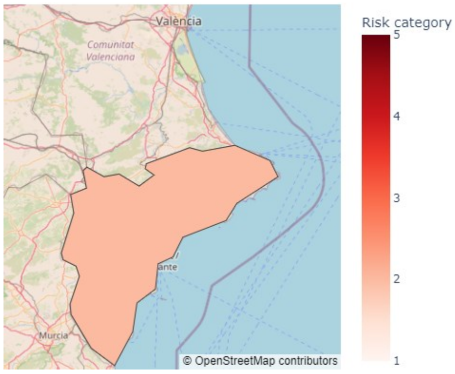

Figure 2-15 Drought risk.

The drought risk analysis map for the province of Alicante shows a risk level classified around 2, indicating a moderate risk of drought in the region. This level suggests that while the province is vulnerable to periods of drought, it is not in an immediate critical situation. However, it is essential to remain vigilant and implement preventive measures, especially since agriculture, which is heavily dependent on water availability, could be affected in years with unfavorable precipitation conditions.

Furthermore, this risk classification serves as a call to action for authorities to adequately manage water resources, developing policies that include conservation and distribution strategies to mitigate the effects of drought. Although the risk is not extremely high, climate change could worsen the intensity and frequency of drought episodes in the future, making the adoption of proactive measures urgent, such as implementing efficient irrigation technologies and training farmers in water management.

It is also recommended to establish a continuous monitoring system to assess climatic conditions and the status of water resources, allowing adjustments in agricultural management strategies. Promoting research in agricultural technologies and sustainable water management can offer solutions that not only mitigate drought risk but also increase community resilience to adverse climatic conditions. In summary, the drought risk analysis in the Valencian Community highlights the need for sustainable actions and adaptation to ensure the resilience of agriculture and water management in the region.

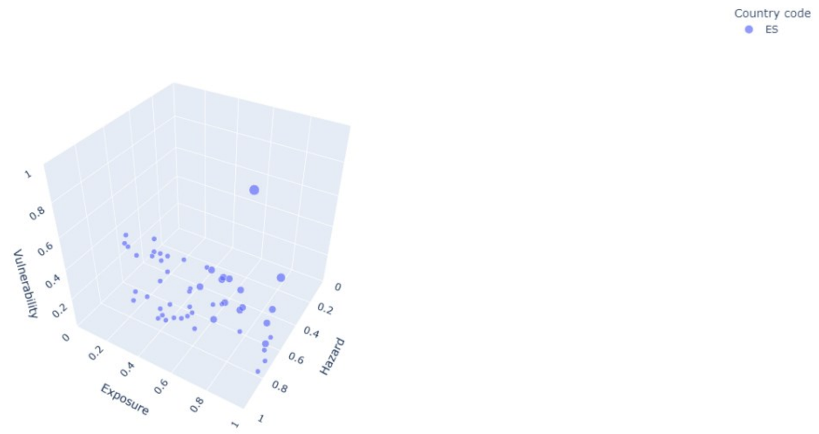

Figure 2-16 Drought risk dimensions.

2.3.2.1.3 Relative Drought hazard and risk visualization

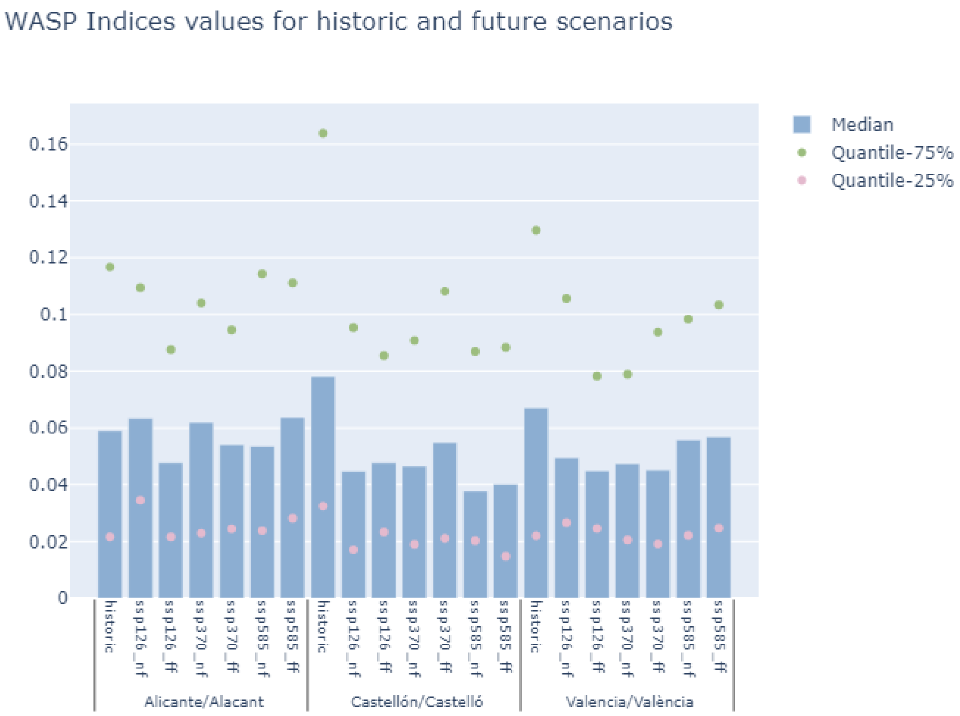

Figure 2-17 WASP Indices values for historic and future scenarios.

In the province of Alicante, the indicators for the mean, 25th percentile, and 75th percentile show values slightly below historical levels, although this decrease is considered not significant. This trend suggests a general shift towards lower water availability or crop productivity, which could be attributed to environmental or management factors. Although the reduction is not alarming, it is crucial to continuously monitor these indices to determine whether it is a temporary trend or a sustained variation, especially in the context of climate change. Additionally, it is vital to contextualize this decrease against indicators of water stress and potential changes in resource management policies.

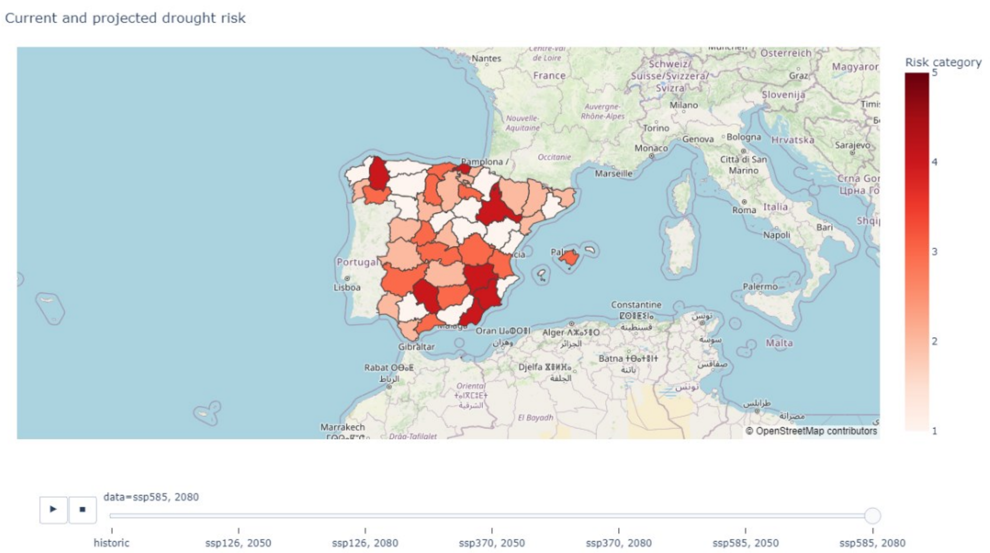

Figure 2-18 Drought risk in Spain for ssp585, 2080.

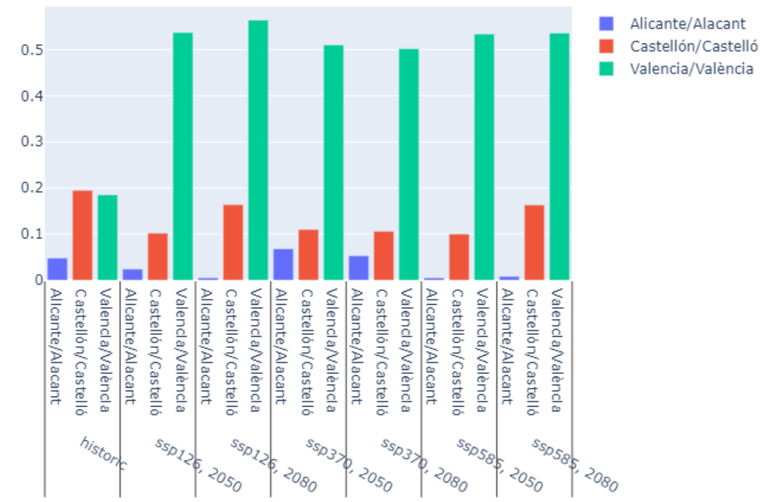

Figure 2-19 Historic and future relative drought risk in Comunitat Valenciana.

The graph represents the relative drought risk in the provinces of Alicante, Valencia, and Castellón under different climate change scenarios, showing clear variability between the three regions. Historically, Alicante has a low drought risk with a value of 0.05, while Valencia and Castellón are closer to 0.2, indicating greater vulnerability in these two provinces. In future scenarios, it is observed that the drought risk in Valencia increases significantly, exceeding 0.5 in all analyzed scenarios, suggesting that this province will face a notable rise in its vulnerability to droughts. On the other hand, Castellón shows a trend toward a decrease in drought risk in most scenarios, although some values remain around 0.175 in projections for 2080, which requires attention. In the case of Alicante, where the study region is located, although the risk tends to decrease, slight increases are recorded in specific situations, indicating fluctuations that could affect water management. In summary, the graph highlights the need for regional approaches to water management, considering the growing vulnerability in Valencia and the variability in Alicante and Castellón to prepare effective strategies to address future droughts.

2.3.2.1.4 Agricultural risk assessment

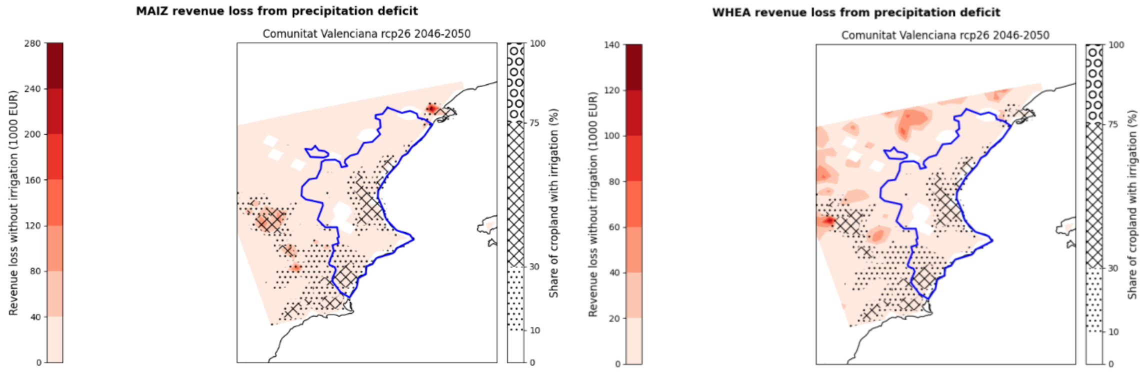

Figure 2-20 Maiz revenue and WHEA revenue loss from precipitation deficit in the Comunitat Valenciana.

2.4 Preliminary Key Risk Assessment Findings

The climate change risk assessment for the Castalla basin region reveals a concerning trend regarding heatwaves. Since 2020, there is an anticipated sustained increase in both the frequency and duration of these heatwaves, particularly under the more adverse RCP 8.5 scenario, which is expected to exceed historical values and show higher peaks compared to the RCP 4.5 scenario. Although data on the total number of days during heatwave events exhibit some variations, projections indicate that, starting from 2020, heatwaves will intensify, particularly distinguishing itself between the two emission scenarios. In the risk assessment based on satellite data, average land surface temperature values indicate that during the summer of 2024, a significant majority of days will exceed 40 degrees, with many days reaching 45 degrees. This rise in temperature coincides with areas of high population vulnerability, demonstrating that the most overheated regions host populations with a high vulnerability index. Projections for the 2016-2045 period indicate a medium risk of heatwaves in both emission pathways, while for 2046-2075, the risk is expected to increase to high in the RCP 4.5 scenario and very high in the RCP 8.5 scenario, suggesting that even with moderate mitigation strategies, additional adaptation measures will be necessary to protect more exposed populations. In conclusion, the rise in the frequency and intensity of heatwaves, along with the vulnerability of certain population sectors, underscores the urgency of adopting robust actions to address this emerging climate challenge.

Regarding the droughts, the analyzed maps indicate the loss of income from corn and WHEA in the Valencian Community under the Greenhouse Gas Concentration (RCP 2.6 scenario) for the period 2046-2050. Although both crops will face significant risks due to precipitation deficits, this optimistic scenario suggests that climate changes will not be as severe as in other higher emission contexts. The dependence on irrigation is crucial, as areas with less irrigation may experience greater difficulties in production. The projected economic losses emphasize the need to adapt agricultural practices, diversify crops, and manage variability in yields and income. It is essential to implement water management strategies, adopt advanced irrigation techniques, and improve agricultural planning to ensure the sustainability and profitability of these crops in an uncertain future. Additionally, research and training in water management are recommended to strengthen resilience to climate change.

2.4.1 Severity

The risk analysis reveals that corn and wheat crops in the Valencian Community will face significant income losses due to precipitation deficits. Although the RCP 2.6 scenario suggests that climatic conditions will not be as severe as in other higher emission scenarios, the projections still show a significant threat to agriculture in the region. The precipitation deficit is identified as the most critical risk, directly affecting the production of these crops, along with changes in temperature patterns, which may also influence their growth. Additionally, reliance on irrigation is a crucial factor, as areas with a lower proportion of irrigated land will experience greater difficulties in maintaining sustainable production levels.
Considering the severity of these risks, the risk associated with precipitation deficits is deemed high, impacting the economic viability of the crops. Projections indicate concerning economic losses, which justify the urgent need to adapt agricultural practices. While the risk is not extreme, the variability in yields and income resulting from changing climatic conditions underscores the importance for farmers to prepare for proactive management in the face of these challenges. In summary, the analysis emphasizes the relevance of water management and adaptation to changing climatic conditions to ensure the sustainability and profitability of agriculture in the region.

2.4.2 Urgency

The identified risks, such as precipitation deficits and changes in temperature patterns, will have a significant impact on agricultural production in the Valencian Community in the medium to long term, particularly in the projected period between 2046 and 2050. Due to the anticipated climatic changes, it is crucial to begin taking immediate action today to minimize future damages. This includes implementing more resilient agricultural practices and investing in irrigation infrastructure that allows farmers to adapt to changing conditions.

The modeled risk is based on a slow onset hazard, as precipitation deficits and climate change in general are phenomena that develop gradually over time. This slow onset nature allows for a window of opportunity for intervention, but it also means that inaction could lead to severe cumulative consequences, intensifying the negative impacts on crops as the year 2050 approaches. Therefore, the urgency of the risk assessment lies in the need to take proactive action, as delaying action could aggravate conditions and significantly increase economic losses. In summary, it is imperative that mitigation and adaptation actions are initiated immediately to ensure the sustainability of agricultural production in the region.

2.4.3 Capacity

In the Castalla basin region, various measures are already being implemented to manage climate risks related to precipitation deficits and changes in temperature patterns. Financially, more efficient irrigation technologies and sustainable agricultural practices are being adopted, which not only reduce economic losses but also attract investments in innovation and development. Socially, a close collaboration between farmers, researchers, and local governments is encouraged, promoting a community-based approach to water resource management and strengthening community networks.

In the human aspect, training for farmers in water management techniques and sustainable agricultural practices is being enhanced, thus increasing human capital and environmental awareness.

In the physical realm, the use of water resources is being optimized, and irrigation infrastructure is being improved, contributing to ecosystem restoration and reducing pressure on water sources. Naturally, the development of sustainable agricultural techniques reinforces local ecosystems and promotes healthier coexistence between agriculture and nature.

These actions not only address current risks but also open up a range of opportunities. Financially, there is the potential to attract more public and private funding. Socially, cooperation and knowledge transfer strengthen community resilience. In human terms, education and training elevate the human capital of the region. Physically, infrastructure is improved, and water pressure is reduced. Naturally, local ecosystems are reinforced, enabling more sustainable and resilient agricultural development in the Castalla basin.

2.5 Preliminary Monitoring and Evaluation

During the first phase of the climate risk assessment in the Castalla Basin, it was observed that the most significant risks are droughts, heat waves, and a potential increase in wildfires, along with the resulting soil loss and desertification. These risks significantly affect agriculture and public health. Information on the change in heatwave frequency is valuable for planning adaptation measures. Local authorities could use this information to develop mitigation strategies, improve public health infrastructure, and strengthen community resilience to the projected increase in extreme temperatures and the risk of wildfires.

However, difficulties were encountered in collecting and analyzing data on the exact magnitude of these risks and their impact on vulnerable communities. The variability of the available data, as well as the lack of historical information on certain climate phenomena, complicated the assessment process. For certain indicators, the risk level is only established for the entire province, which presents a wide variety of climates within its interior due to different altitudes, precipitation, and average annual temperatures. This directly influences the local risk level. A better definition of risk levels is needed in more specific geographic areas at the local level.

Regarding the availability of new data, it was identified that there is recent information on climate patterns and future projections, but more research is still needed on the specific vulnerability of local ecosystems to these risks and the resilience of infrastructure. Furthermore, more resources and expertise would be needed to conduct more comprehensive assessments, and it is suggested that collaborations with academic and research institutions be established to improve understanding of risks and facilitate the development of effective mitigation and adaptation strategies.

Some of the data that could be explored in greater depth is that, for example, water footprint data or studies are currently unavailable, nor are they present in much of the industry or economic activities at the local level, as these actions should be included in companies' environmental policies. It would be advisable to promote and take action to guide companies to prepare water footprint reports.

Although data on municipal water consumption is currently available, it is important to understand the demand by sector in detail, delving into individual businesses and even the activities within this process, in order to determine how vulnerable an economic activity is, and therefore the local economy, to water shortages due to droughts.

Intense heat is also beginning to have economic repercussions, such as a decrease in leisure consumption during heat waves or the suspension or postponement of activities due to the risks involved. Therefore, it may be interesting to conduct economic studies on how heat waves impact consumption in certain services, such as the hospitality industry. Similarly, with regard to the vulnerable population, a quantification of medical incidents resulting from high temperatures is necessary. On the other hand, one of the largest stakeholders in this area is city councils, as they are the political leaders and the primary responsible for establishing regulations to take action to mitigate the effects of climate change. However, interacting with these organizations is sometimes difficult, as they face a significant amount of bureaucracy that often slows down actions and processes.

Regarding the methodology used, developing workflows requires the use of software that requires specific training, in this case Python; an obstacle that can be counterproductive for public, academic, and private organizations seeking to process this data if the appropriate professionals are not available.

Furthermore, more technical support is needed because many things are not entirely clear, and although the help desk response has always been prompt, questions can be numerous.

Sometimes a piece of code was copied, and errors occurred that had nothing to do with the project, but rather with the coding itself.

We have the feeling that things were modified without further testing. It's important that the code is tested because in some cases the libraries were outdated or no longer existed.

3 Conclusions Phase 1- Climate risk assessment

The first phase of the climate risk assessment in the Castalla basin has provided valuable information about the climate hazards facing the region and the urgent need for action. Below are the main conclusions and key findings, along with the challenges that have been addressed and those that still remain.

1. Need for Adaptation

One of the most notable conclusions is the growing necessity to implement adaptation measures regardless of the projected climate scenario. An increase in climate risk is anticipated in the future, which requires a proactive approach to protect vulnerable populations. Recommended adaptation strategies include improving optimization of water management systems, waste water regeneration and reuse, establishing early warning programs for extreme weather events, launching public health awareness campaigns—especially concerning heatwaves—and adequate urban planning that takes sustainability and resilience to climate change into account.

2. Importance of Mitigation

The analyses conducted indicate a clear distinction between the risks associated with different levels of greenhouse gas concentration (RCP 4.5 versus RCP 8.5). This reinforces the need to strengthen efforts both globally and locally to reduce greenhouse gas emissions. Minimizing climate change will help decrease future risks and protect the ecosystems and communities in the basin.

3. Continuous Monitoring

The projection of increased climate risks emphasizes the importance of establishing continuous monitoring systems. This monitoring is crucial for evaluating vulnerability conditions and the effectiveness of implemented adaptation measures. As conditions change, it will be necessary to adjust response strategies to ensure they effectively protect the community and the environment.

Addressed Challenges

In this phase, the main climate hazards, such as droughts and heatwaves, were successfully identified and defined, and their impacts on the population, agriculture, and infrastructure were evaluated.

Unaddressed Challenges

Challenges that still need to be addressed were encountered. The collection of data on the exact magnitude of climate risks was a complicated aspect, and more precise information on climate projections, as well as a deeper analysis of the specific vulnerability of affected groups, is required. In addition, the need to involve more relevant stakeholders, such as climate change and public health experts and energy infrastructure technicians, was identified for the next phases of the assessment.

Key Findings

- Climate projections indicate an increase in the frequency and intensity of extreme phenomena, which generates greater pressure on water resources and public health.

- It is essential to enhance collaboration among all stakeholders to implement effective adaptation and mitigation strategies that respond to the specific climate challenges of the basin.

- Establishing a clear framework for the continuous monitoring and evaluation of risks will increase the community's resilience to climate change.

4 Progress evaluation and contribution to future phases

The deliverable from the first phase of the climate risk assessment in the Castalla basin is fundamental for the development of the project and establishes a clear framework for future activities. This deliverable includes the initial analysis of identified climate hazards, such as droughts and heatwaves, as well as a series of recommendations and adaptation strategies that will enable the region to effectively face these challenges.

The initial assessment has provided a clear understanding of the main climate risks facing the basin, which will serve as the basis for developing a Detailed Adaptation Plan in the next phases. This plan will include specific measures and practices, such as improving water infrastructure and implementing education and awareness programs.

Key stakeholders, including local governments, NGOs, citizens, and the private sector, have been successfully engaged. In the following phases, efforts will focus on further strengthening this collaboration through additional workshops, consultations, and community meetings. The active participation of stakeholders will be essential to ensure that adaptation strategies are relevant and effective, fostering a sense of responsibility and ownership among those involved.

Moreover, the initial phase has highlighted the importance of establishing a monitoring and evaluation system to closely track climatic and social indicators, as well as the effects of adaptation actions. This will ensure that strategies are proactively adjusted as conditions change. The need to raise awareness about climate hazards and their impacts on public health and infrastructure has also been identified, which is why plans will be made to implement awareness campaigns and early warning programs aligned with the recommendations of the deliverable. These activities will facilitate a coordinated approach to prepare the community for extreme climatic events, prioritizing the protection of identified vulnerable groups.

Finally, the lack of precise and updated data related to climate risks and their impact on the region has been recognized. Therefore, in the following phases, additional efforts will be made to collect relevant data and carry out research that deepens the understanding of the risks. This will include collaboration with universities and research institutions to enrich existing knowledge and guide decision-making. The wildfire workflow should be conducted to assess the risk of fire in the abundant forest mass of the region due to water scarcity.

In summary, the deliverable from the first phase has not only outlined the current and future climate challenges in the Castalla basin but has also established a clear path towards concrete and collaborative actions in the subsequent phases of the project. Through the planning of strategies based on the obtained conclusions, the continuous participation of stakeholders, and the development of monitoring systems, it will be ensured that the basin is better equipped to face the effects of climate change and its associated risks.

Table 4-1 Overview key performance indicators

Key performance indicators	*Progress*
2 workflows successfully applied on Deliverable 1.	2 workflows (Heatwaves and droughts) have been successfully applied
1 Communication action	Publication in the "AIJU informa" newsletter.
1 Dissemination action	Event on October 24th, 2024, "Circular Economy: Innovation and Future in the Plastic Sector and Territory," where the CLIMAAX4CAST project was presented to interested stakeholders.

Table 4-2 Overview milestones

Milestones	*Progress*
Mlst1: Workflow A successfully applied.	Workflow A (Heatwaves) has been applied successfully.
Mlst2: Workflow B successfully applied	Workflow B (Droughts) has been applied successfully.
Mlst3: First dissemination meeting whit stakeholders in our region.	On October 24th, AIJU held the event "Circular Economy: Innovation and Future in the Plastic Sector and Territory," where the CLIMAAX4CAST project was presented to interested stakeholders.