Deliverable Phase 2 – Climate risk assessment

Climate Risk Assessment in the Socially Vulnerable Communities of Aigaleo (Clisthenes)

Greece, Aigaleo

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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Abbreviations and acronyms

Abbreviation / acronym	Description
AGL	Municipality of Aigaleo
SECAP	Sustainable Energy and Climate Action Plan
CRA	Climate Risk Assessment
ELSTAT	Hellenic Statistical Authority
FWI	Fire Weather Index
HW	Heatwave
LST	Land Surface Temperature
NCSRD	National Centre of Scientific Research “Demokritos”
PESPKA	Regional Adaptation Plan of Attica
UHI	Urban Heat Island
FUA	West Athens Functional Urban Area
WRF/ARW Model	Weather Research and Forecasting/ Advanced Research Model
RCP	Representative Concentration Pathways
SSP	Shared Socioeconomic Pathways
EFFIS	European Forest Fire Information System
HNMS	Hellenic National Meteorological Service
CDD	Cooling Degree Days
GIS	Geographic Information System
EREL	Environmental Research Laboratory
SME	Small and Medium-sized Enterprise
NGO	Non-Governmental Organization
FG	Focus Group

Executive summary

This deliverable presents the initial Climate Risk Assessment (CRA) for the Municipality of Aigaleo (AGL), developed within the framework of the CLIMAAX – Clisthenes project. It focuses on identifying key climate hazards, vulnerabilities, and capacities to support the future development of inclusive, locally adapted climate adaptation strategies. The core objective of Phase 2 was to address the limitations of coarse-scale data identified in the first phase by thoroughly integrating detailed local information and involving stakeholders in a structured co-creation process. This involved the systematic integration of municipal GIS data, detailed social vulnerability indices, information from the local environmental monitoring network, and census data from the Hellenic Statistical Authority. This shift from regional to neighbourhood-scale analysis is fundamental for translating climate projections into actionable urban planning.

The assessment confirms and details two priority climate hazards for Aigaleo: intensifying urban heatwaves and growing wildfire risk in the Wildland-Urban Interface, particularly around the Aigaleo Grove. Through a cycle of eight Monthly Focus Groups and two Participatory Workshops, the project team and local stakeholders co-defined six locally specific risk indicators: Summer Energy Poverty, Buildings' Exposure to Heatwaves, Heatwave Risk to Vulnerable Populations, Health Exposure to Heatwaves, Workers' Exposure to Heatwaves, and Wildfire (FWI) Risk. These indicators capture critical social vulnerabilities that the CLIMAAX workflow do not include but are essential for Aigaleo's resilience.

Some notable findings include:

Heatwaves: A clear increase in heat stress is projected. Cooling Degree Days (CDD) and the frequency of heatwave days are set to rise substantially, especially under the high-emission scenario (RCP8.5). By the end of the century, the municipality faces a transition from manageable heat risk to severe, potentially unmanageable conditions, disproportionately affecting vulnerable populations in areas with dense, old building stock.

Wildfires: Fire Weather Index (FWI) analysis indicates a significant increase in wildfire risk over time. The occurrence of "very extreme" fire weather days is expected to rise considerably, heightening the danger for interface areas. This emphasises the importance of improved vegetation management and community readiness.

Social Vulnerability: The assessment spatially identifies hotspots of exposure, linking climate hazards directly to socio-economic fragility. Neighbourhoods with high numbers of elderly residents, low-income households, and energy-inefficient buildings are at the greatest risk, emphasising the need for a just and equitable adaptation response.

Persistent challenges include the technical complexity of risk modelling for municipal staff and gaps in hyper-local data. Phase 3 will build directly on these findings, focusing on translating the assessed risks into tangible adaptation strategies. Planned activities include developing a Scalable Policy Canvas, conducting participatory workshops to co-design interventions, and raising awareness to embed climate resilience into the wider West Athens urban strategy.

This detailed CRA emphasises the climate challenges facing Aigaleo and provides a structured foundation for inclusive, evidence-based planning of climate adaptation solutions with strong social impact. The next phase of the project will be further enriched through community engagement and cross-sectoral cooperation in subsequent stages of the Clisthenes project. Building directly on this

assessment, Phase 3 will focus on translating the identified risks into concrete adaptation strategies by developing a Scalable Policy Canvas, organising participatory design workshops, and executing strategic outreach to scale resilience actions across the West Athens area.

In conclusion, the work carried out in Phase 2 provides Aigaleo with a strong, evidence-based foundation for proactive and inclusive climate adaptation planning. It shifts the municipality from a reactive approach to a proactive stance, enabling focused allocation of resources and the design of measures that are both technically robust and socially just, paving the way for effective adaptation strategies in the final phase of the project.

1. Introduction

1.1. Background

The Municipality of Aigaleo is located in the western sector of the Athens metropolitan area. It is a densely populated urban zone covering approximately 6.5 km² with around 70,000 residents. Historically, Aigaleo was established after the 1922 population exchange to accommodate refugees from Asia Minor, Pontus, and Assyrian communities. This foundational moment shaped its strong working-class identity, collective memory, and tradition of solidarity, which continue to define the municipality's social and cultural fabric.

Over the years, Aigaleo has developed into a strategic commercial and residential centre because of its central location and proximity to major roads such as Iera Odos, Thivon Avenue, and Kifissos Avenue. Part of the Eleonas area—an industrial zone, not yet urbanised, currently undergoing transformation—falls within its boundaries with Athens, boosting its economic importance but also creating urban and environmental challenges. Despite being highly urbanised and compact, Aigaleo retains an important green asset, most notably the Aigaleo Grove "Baroutadiko", the largest green space in Western Athens and a vital environmental and recreational resource. Mount Aigaleo further defines the western edge of the city, offering ecological and symbolic significance.

Aigaleo's population today reflects multiple layers of vulnerability. In addition to its ageing population and long-standing low-income households, the municipality is home to migrants and refugees from more recent migration waves, contributing to its multicultural character but also increasing social demands. The cumulative impact of the economic crisis, the COVID-19 pandemic, and intensifying climate-related risks has weakened previously strong community ties and placed pressure on local social services.

Aigaleo has a typical Mediterranean urban environment (Csa classification according to Köppen climate zones). However, the effects of the climate crisis are becoming more apparent. Extreme temperatures—both winter and summer—prolonged and frequent heatwaves, and the intensification of the urban heat island effect caused by densely built structures and limited vegetation have changed living conditions and public health dynamics. The area also faces declining air quality and increasing exposure to extreme weather events, including wildfires in nearby regions. These environmental pressures disproportionately impact vulnerable populations and require urgent adaptation strategies.

This context makes Aigaleo a crucial example for a localised Climate Risk Assessment (CRA). The combination of high social vulnerability, dense urban layout, and increasing climate threats requires a detailed, neighbourhood-level understanding of risk to support effective and fair resilience planning.

1.2. Main objectives of the project

Building on the foundational climate risk screening of Phase 1, Phase 2 of the CLISTHENES project was dedicated to the critical tasks of localisation and refinement. While Phase 1 identified that heatwaves and wildfires are major hazards for the wider Attica region, Phase 2 focused on answering the essential municipal questions: where exactly within Aigaleo are the impacts most severe, who is most affected, and why?

Objectives and Significance for Aigaleo:

The main goal of Phase 2 was to turn general risk awareness into a spatially clear, socially accepted, and practically useful risk profile for the Municipality of Aigaleo. This was done through two related, simultaneous tracks.

The Deep Integration of Local Data: To overcome the limitations of coarse-resolution datasets used in Phase 1, Phase 2 systematically incorporated high-resolution municipal data—including building registries, detailed social vulnerability indices, and local environmental readings from the TransformAr monitoring network. This shift from regional (NUTS3) to neighbourhood-scale analysis is fundamental for translating climate projections into detailed and comprehensive heatwave risk assessments and, consequently, into localised action plans and updates for the municipal SECAP.

The Co-Creation of Knowledge with Stakeholders: To ensure the assessment reflected on-the-ground realities, Phase 2 used a structured participatory cycle (Focus Groups and Workshops). This process helped validate initial model outputs, identify locally-specific vulnerability pathways (e.g., the link between heatwaves, old housing stock, and energy poverty), and clarify institutional ownership of risks.

The significance of this phase for the Aigaleo community is considerable. It shifts the municipality from a reactive approach based on generic hazard data to a proactive, evidence-based planning stance. It provides detailed evidence necessary to prioritise limited resources, target interventions where they are most needed, and develop adaptation measures that are both technically robust and socially equitable.

Benefits of the CLIMAAX Handbook and Local Data Integration:

The CLIMAAX handbook provided an essential standardised, scientific framework (e.g., EuroHEAT, FWI workflows) that guaranteed methodological rigour and comparability across European regions. In Phase 2, its value was optimised precisely through its strategic integration with local data and the development of targeted heatwave workflows tailored to the local context.

Enhanced Relevance & Accuracy: Feeding local socio-economic and building data into the CLIMAAX workflows enabled us to "downscale" the risk maps. For instance, overlaying the locations of pre-1980s apartment blocks with heatwave projections produced a detailed map of building exposure, a metric that was absent from the Phase 1 analysis.

Identification of Local Indicators: The structure of the handbook combined with stakeholder input led to the co-definition of six locally-specific risk indicators (e.g., Summer Energy Poverty, Workers' Exposure to Heatwaves). These indicators highlight vulnerabilities that pan-European models overlook but are crucial for Aigaleo's social resilience.

Creation of a Policy-Ready Evidence Base: The final, refined assessment is no longer just a scientific report; it is a targeted evidence package specifically designed to guide the revision of key municipal policies, particularly the Sustainable Energy and Climate Action Plan (SECAP) and the Civil Protection Plans, ensuring that climate resilience is integrated into the city's main governance tools.

Essentially, Phase 2 used the CLIMAAX framework not as an end goal but as a strong foundation for creating a highly local, collaboratively owned, and practical understanding of climate risk, a crucial base for developing effective adaptation strategies in Phase 3.

1.3. Project team

The project team consists of experienced professionals from the Department of Development and Planning of AGL and the research team of NCSRD.

The Department of Development and Planning oversees the application and execution of all national and European projects in AGL. The team includes Dr. Dimitris Tzempelikos, the Head of the Department, and Evangelia Bakogianni, a project manager and social scientist specialising in European projects.

Dr Dimitris Tzempelikos is a mechanical engineer with expertise in energy, renewable energy technologies, modern financing methods, and the development of sustainable energy and climate action plans. He participates in and leads the AGL team in various European projects.

Evangelia Bakogianni is an architect engineer (MArch) and social scientist working in the fields of urban planning, community engagement, and participatory action research. She is involved in technical, social, and environmental EU projects.

NCSRD is Greece's largest multidisciplinary research centre and acts as a subcontractor for Aigaleo in the project. The scientific group EREL1, involved in the project, adopts a comprehensive R&D approach to sustainable development and climate resilience, encompassing a range of topics and modelling methodologies. The team comprises:

Dr. Athanasios Sfetsos, received a B.Sc. in Physics from the University of Patras in 1995 and a Ph.D. in Electrical Engineering from Imperial College, University of London, in 1999. He has been Research Director at the Institute of Nuclear and Radiological Sciences, Technology, Energy and Safety at NCSR Demokritos since 2021, specialising in “Climate Change and Critical Infrastructure Protection”. His research interests include (i) Critical Infrastructure Protection, focusing on risk analysis of interconnected heterogeneous systems; (ii) Resilience and Crisis Management, with an emphasis on natural hazards; and (iii) Climate Change analysis and the provision of climate services. He is responsible for establishing and maintaining the EREL High Performance Cluster, the largest computational facility of its kind.

Dr Konstantina Politi is a post-doctoral researcher at the Environmental Research Laboratory of NCSR “Demokritos”. She holds a B.Sc. in Physics from the University of Athens (2007), an M.Sc. in “Prevention and Management of Natural Disasters” (2010), and a Ph.D. in climate research from the Department of Geology and Geo-environment (University of Athens, 2023). Her expertise focuses on climate modelling and climate simulations, statistical and extreme value analysis, post-processing of climate data, and the calculation of climate indices in the context of climate change. She has participated in several EU-funded projects on the topic of climate change, and she is currently involved in European research projects related to climate hazards, risk assessment, and adaptation measures.

Dr Iason Markantonis is a post-doctoral researcher at the Environmental Research Laboratory of NCSR “Demokritos”. He holds a B.Sc. in Physics from the University of Patras (2016), an M.Sc. in

“Applied Meteorology and Environmental Physics” (2018), and a Ph.D. in climate research from the Department of Physics (University of Patras, 2025). His expertise focuses on climate change research, analysis of extreme and compound events, post-processing of climate data, and calculating climate indices within the context of climate change. He has participated in several EU-funded projects on climate change and is presently involved in European research projects related to climate hazards, risk assessment, and adaptation measures.

Matrona Panou is a PhD candidate at the School of Chemical Engineering at the National Technical University of Athens (NTUA), holding an Integrated Master’s degree (a combined Bachelor’s and Master’s) from NTUA with a specialisation in materials simulations. Her research interests focus on the modelling and computational simulation of materials, with the aim of better understanding and predicting their behaviour through advanced computational methods and analytical techniques. She is also a Research Assistant working on CLIMAAX models, enhancing existing Python-based models.

1.4. Outline of the document’s structure

This document is organised as follows:

Part 1. Introduction

- Provides background on the local context of AGL and the characteristics of the area, along with the rationale for conducting a climate risk assessment for the CLIMAAX – Clisthenes project.
- The significance of the refined climate risk maps by integrating high resolution information from geospatial data of the study area

Part 2. Climate Risk Assessment (CRA)
The core of the deliverable, following the CLIMAAX Framework presented in the following steps

2.1 Scoping: Defines objectives, context, participation, principles, and stakeholder engagement.

2.2 Risk Exploration: Screens for main hazards (heatwaves, wildfires) and selects scenarios.

2.3 Regionalised Risk Analysis: Details the refinement of risk workflows using local data and provides hazard and risk assessments for:

Heatwaves Risk Assessment:

- ✓ Summer Energy Poverty
- ✓ Building’s Exposure to Heatwaves
- ✓ Heatwave Risk Assessment
- ✓ Health Exposure to Heatwaves
- ✓ Workers’ Exposure to Heatwaves
- ✓ Wildfire (FWI) Risk Assessment

2.4 Key Risk Assessment Findings: Covers the assessment of risk severity, urgency, resilience capacity, and prioritisation.

2.5 Monitoring and Evaluation: Reflects on lessons learned, challenges, and stakeholder feedback from Phase 2.

2.6 Work Plan Phase 3: Outlines the key activities for the final stage of the project.

Part 3: Conclusions Phase 2:

Summarises the key findings of the first CRA phase and details how the results will inform the development of the climate adaptation strategy.

Annexes include data tables, references to external documents, and supporting visual material.

2. Climate risk assessment – phase 2

This chapter details the refined Climate Risk Assessment (CRA) conducted for the Municipality of Aigaleo during Phase 2 of the CLISTHENES project. Building directly on the outcomes and limitations identified in Phase 1 (Deliverable 1), this phase focused on **enhancing the resolution, relevance, and ownership** of the assessment through the systematic integration of high-resolution local data and structured stakeholder co-production. The following sections follow the CLIMAAX Framework, explicitly highlighting the **evolution and changes** from the initial scoping and analysis.

2.1. Scoping

2.1.1. Objectives

The objective of the Phase 2 Climate Risk Assessment (CRA) was to refine and localise the preliminary regional assessment from Phase 1. While Phase 1 established a first-order screening of risks using standardised CLIMAAX workflows, Phase 2 focused on grounding these scientific results in the local context of Aigaleo. The purpose shifted from risk identification to actionable risk interpretation.

The expected outcome is a stakeholder-validated, operational knowledge base consisting of: (1) six locally-defined climate risk indicators, (2) high-resolution, neighbourhood-scale risk maps for heatwaves and wildfires, and (3) validated impact chains that illustrate how climate drivers result in local consequences. These outputs are created for direct policy uptake.

This refined CRA will directly contribute to the upcoming revision of Aigaleo's Sustainable Energy and Climate Action Plan (SECAP), offering evidence to prioritise and geographically focus adaptation actions. It will also support the Municipal Strategic Plan 2024–2028 and relevant departmental operational plans (Social Services, Civil Protection), as well as the broader West Athens 2030 Sustainable Urban Development Strategy.

Limitations, Challenges, and Mitigation in Phase 2
The assessment was scoped to directly address the key limitations encountered in Phase 1. The main challenges and how they were mitigated are summarised in the table below.

Table 2.1 Key limitations in Phase 1 and how they were addressed in Phase 2

Challenge / Limitation from Phase 1	How it was addressed in Phase 2
Coarse spatial resolution of input data (e.g., EuroHEAT, WorldPop)	Integration of high-resolution local data: municipal GIS, ELSTAT census data, and the local monitoring network.
Lack of local socio-economic context in vulnerability assessment.	Co-definition and quantification of six specific local indicators (e.g., Summer Energy Poverty) with stakeholders, using municipal data.
Verification of social impacts on CLIMAAX workflows by municipal personnel	Implementation of a structured participatory cycle (2 Participatory Workshops, 8 Monthly Focus Groups) for continuous feedback and co-creation.

Technical complexity of CLIMAAX workflows for non-expert municipal staff	NCSRD ran the workflows and presented simplified visual outputs (maps and graphs) for discussion during stakeholder sessions.

The assessment concentrates on the two priority hazards (heatwaves, wildfires) and their immediate impacts as defined locally. Detailed adaptation solutions and comprehensive economic evaluation are beyond its scope and are scheduled for Phase 3.

2.1.2. Context

Climate hazards in Aigaleo have traditionally been managed through sectoral emergency responses and fragmented planning. The existing Sustainable Energy and Climate Action Plan (SECAP) offers a mitigation-focused baseline but lacks a detailed, spatially explicit risk assessment to guide targeted adaptation. Previous EU projects (e.g., C2IMPRESS, TransformAr) provided valuable but isolated data points and stakeholder networks. The main issue Phase 2 aims to address is this fragmentation: the absence of a unified, locally validated evidence base that links climate projections with specific urban and social vulnerabilities to inform planning and policy.

This issue is vital within the broader scope of national and regional strategies. Greece's National Adaptation Strategy and the Regional Adaptation Plan of Attica (PESPKA) require local action, yet municipalities like Aigaleo often lack detailed data and methodological support to implement effectively. The project helps Aigaleo shift from generic compliance to evidence-based, locally-tailored execution, directly supporting the aims of the European Green Deal and the EU Mission on Adaptation.

The governance context for this assessment has strengthened since Phase 1. The main frameworks continue to be the municipal SECAP and the Municipality of Aigaleo Strategic Plan 2024–2028, which now explicitly mention the need for climate risk data. The primary change is the formalised operational link between the project team (Planning & Development Dept.) and the departments responsible for risk ownership (Civil Protection, Social Services, Technical Services), established through the Monthly Focus Groups. This internal governance structure guarantees that the assessment results have designated institutional recipients.

The sectors most affected, confirmed and elaborated in Phase 2, are:

- **Public Health & Social Services:** Impacts of heat stress on vulnerable groups (elderly, low-income households) and health risks from wildfire smoke are now quantified by the "Health Exposure" indicators.
- **Built Environment & Infrastructure:** The building stock, particularly older apartments and public spaces, is highly vulnerable to heatwaves, as shown by the new "Building's Exposure" indicator.
- **Local Economy & Labour:** Outdoor workers and small businesses encounter productivity declines and health risks during extreme heat ("Workers' Exposure" indicator).

External factors influencing the issue include the socio-economic legacy of past crises, the limited fiscal autonomy of Greek municipalities, and the strategic direction of ongoing EU projects. Phase

2 actively transformed this last influence from a challenge into an opportunity by directly integrating the CRA with existing projects. Data from TransformAr's monitoring stations was incorporated, and discussions at the final Participatory Workshop examined how the findings could guide actions in projects like Med-IREN (nature-based solutions) and Rock the Block (affordable housing and community engagement).

Possible adaptation interventions identified as relevant through this refined assessment include: targeted building retrofit programmes prioritised by the "Building's Exposure" maps; establishment of a cooling centre network and energy poverty support schemes informed by the "Summer Energy Poverty" indicator; and enhanced vegetation management and community alert systems for the Wildland-Urban Interface, guided by the refined wildfire risk maps. These potential interventions will be described in detail and further developed in Phase 3.

2.1.3. Participation and risk ownership

The stakeholder involvement process in Phase 2 was fundamentally redesigned compared to Phase 1, shifting from a one-time training event to an ongoing, iterative cycle of co-creation and validation. This was implemented through a two-tiered model that distinguished between a technical-operational core and a wider validation and community network.

1. The Two-Tiered Participatory Model:

- **Technical-Operational Core (Monthly Focus Groups):** This was the project's analytical engine, comprising eight monthly meetings. Participation remained consistent and included internal municipal expertise and scientific partners. **Social Services, Civil Protection, Planning & Development Department, Municipal Police, Technical Services**, and researchers from **NCSRD**. This group was responsible for detailed technical work, including data integration, workflow analysis, and the development of the six local risk indicators.
- **Broader Community & Validation Network (Participatory Workshops):** Two workshops involved a diverse range of local actors to ensure community engagement and validation. Participants beyond the core team included: **school teachers, representatives from the Parents and Guardians Association, volunteers from the rescue organisation EPOMEA, local Scouts, the psychosocial support NGO IASIS, a freelance engineer based in the area, a representative from the Egaleo Chamber of Commerce, and workers from the local catering sector**.

2. Stakeholder Mapping and Responsibilities:

The figure below illustrates this two-tiered structure, showing how the core team's technical work was consistently guided by and validated against the knowledge of the wider community network, ensuring both scientific rigour and social relevance.

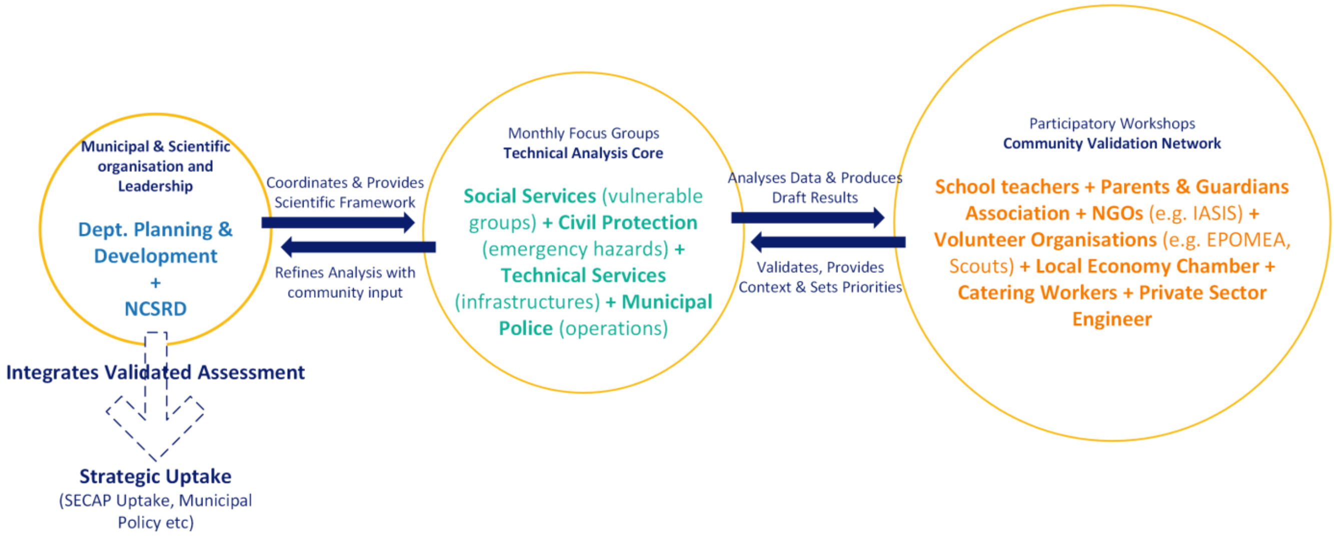


Figure 2.1 Presentation of the two-tiered structure between the core team and the community network

3. Organisation of Risk Ownership:
The iterative process of Phase 2 resulted in a clear attribution and reinforcement of risk ownership across the municipal administration departments.

- **The Civil Protection Department** is responsible for identifying and assessing physical hazards such as heatwaves and wildfires, as well as for emergency response planning.
- **The Social Services Department** now takes clear responsibility for assessing and mitigating risks related to vulnerable groups (elderly, low-income households), **specifically for the "Health Exposure to HWs" and "Summer Energy Poverty" indicators.**
- **The Technical Services Department** owns the risk associated with exposed infrastructure and the built environment ("Building's Exposure to HWs" indicator).
- **The Planning & Development Department** maintains overall coordination and ensures that the integrated risk assessment informs strategic plans.

4. Representatives of Vulnerable Groups & Exposed Areas:

Priority groups were represented both institutionally (Social Services Dept.) and through community stakeholders in the Participatory Workshops (e.g., Parents Association, NGO IASIS). Spatially, **exposed areas** were identified using municipal and ELSTAT data, pinpointing neighbourhoods with dense, old building stock and zones adjacent to the Aigaleo Grove.

5. Acceptable/Tolerable Risk Level:

A formal "acceptable risk" threshold does not exist at the municipal level. Workshop discussions showed that local tolerance is low and closely linked to perceived preparedness. Risks are considered less acceptable if they affect groups with high socio-economic vulnerability or if public services are perceived as lacking capacity to respond. The refined assessment provides the first solid evidence base to inform a future policy debate on defining risk tolerance in Aigaleo.

2.1.4. Application of principles

Social Justice, Equity, Inclusivity

These principles were central to Phase 2, moving beyond the generic stakeholder mapping of Phase 1. Inclusivity was ensured through a two-tiered participatory model. The core Focus Groups included departments responsible for vulnerable populations, such as Social Services. Crucially, the Participatory Workshops specifically invited representatives from groups facing disproportionate risks: the Parents Association (families, children), NGO IASIS (psychosocial support for marginalised individuals), and EPOMEA volunteers (often first responders in vulnerable neighbourhoods). To overcome barriers related to technical literacy, the NCSRD team translated complex workflow outputs into accessible maps and graphs for discussion. Equity was addressed by jointly defining indicators that measure distributive injustice, specifically "Summer Energy Poverty" and "Health Exposure to HWs," which directly link climate hazards to socio-economic vulnerability. The process aimed to ensure procedural justice by confirming that these groups' lived experiences validated and refined the scientific assessment.

Quality, Rigour, Transparency

Rigour was maintained by following the standardised CLIMAAX workflows (EuroHEAT, FWI) as the scientific foundation. Quality was greatly improved compared to Phase 1 by incorporating high-resolution local data (municipal GIS, ELSTAT, TransformAr network) to validate the models, directly tackling the previously identified coarse-resolution limitation. Transparency was achieved through an iterative validation process: the technical team (NCSRD and municipal experts) generated draft results in the Focus Groups, which were then presented, explained, and openly critiqued in the Participatory Workshops. This open-book approach, where assumptions and data limitations were discussed (e.g., the overestimation of population on major avenues in WorldPop data), fostered trust and ensured collective ownership of the final risk assessment.

Precautionary Approach

Given the uncertainties inherent in climate projections and the high social vulnerability identified, a precautionary approach guided the analysis. This was evident in two key choices:

- **Scenario Selection:** The analysis considered the high-emission scenario (RCP8.5) alongside RCP4.5 for heatwaves, prioritising planning for a more severe, though less probable, future to avoid underestimating risk.
- **Risk Prioritisation:** In the absence of a formal municipal "acceptable risk" threshold, the assessment focused on risks that combine a high projected hazard increase with socio-economic vulnerability (e.g., elderly in non-refurbished buildings). This cautious approach recommends proactive adaptation in areas where delayed action could cause severe and disproportionate human impacts, despite uncertainties in modelling.

2.1.5. Stakeholder engagement

Stakeholder engagement in Phase 2 was executed through a structured series of **eight Monthly Focus Groups** and **two Participatory Workshops**, as detailed in Section 2.1.3. This section reflects on the process, communication, and outcomes of these interactions.

Participants: The focus groups involved the core technical team from municipal departments of Social Services, Civil Protection, Planning & Development, Municipal Police, Technical Services, and NCSR Demokritos. The participatory workshops broadened involvement to include school teachers, the Parents and Guardians Association, EPOMEA volunteers, local Scouts, NGO IASIS, a freelance engineer, the Chamber of Commerce, and workers from the catering sector.

Communication of Goals & Results: Communication was conducted through slide presentations, maps, and diagrams generated from the workflow analyses, followed by open discussions. The language was simplified and accessible, with parallel explanations of basic terminology, as many participants were unfamiliar with reading such maps or specific technical terms.

Reception & Feedback from Participants: The reception was very encouraging, with most participants expressing strong interest in the methodology and its possibilities. Key feedback included:

- **Recognition of Technical Need:** Participants consistently noted the process was highly technical and required expert support (such as NCSRD) to be usable, emphasising the vital role of academia in assisting with designing strategies, policies, and prevention measures.
- **Data Gaps & Local Reality:** A recurring point was the lack of localised data, with calls for municipalities and regions to access more detailed data. Furthermore, participants frequently perceived on-the-ground conditions (e.g., heat discomfort, wildfire smoke effects) as more severe than shown in the initial maps and diagrams. They attributed this discrepancy to factors such as older, poorly maintained buildings and infrastructure, and a shortage of cooling areas, highlighting that physical and social contexts amplify modelled risks..
- **Validation & Divergence:** Some outputs were validated through lived experience, while others were questioned, encouraging a critical dialogue that enhanced the assessment.

Future Use by Participants: Participants outlined concrete plans for using the outcomes:

Municipal Departments are committed to revising the SECAP and parts of the municipal strategic planning by incorporating climate risk. They emphasised the need for urban planning measures to enhance green spaces, actions in housing and protection of vulnerable populations through green and sustainable development funding, and the implementation of nature-based solutions. A holistic approach to these issues was considered essential.

Importantly, it was stated that the results "will of course be included in civil protection plans." While no formal continuation of the CLIMAAX collaboration was discussed, the importance of such projects was emphasised for providing a clear situational analysis and acting as a unique opportunity for data collection and analysis otherwise unavailable to local authorities.

Difficulties Encountered: Beyond previously noted technical and data challenges, the main engagement difficulties included:

- **Communication & Comprehension:** Translating complex results into clear, understandable language required extra effort and clarification.
- **Logistical Coordination:** Finding a suitable time for all invited participants was challenging, leading to attendance from those who could ultimately commit, though a broad spectrum was still represented.

Table 2.2 Description of focus groups

Focus Groups					
N.	**Date**	**Time/Duration**	**Main Topic**	**Participants**	**Description/ Outcomes**
1.	Month 7_ 10 April 2025 (Thursday)	11:00 - 12:30	Project Kick-off & Methodology Presentation	11 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	Alignment on project structure, CLIMAAX methodology, and a common understanding of objectives among the core team.
2.	Month 8_ 19 May 2025 (Monday)	11:00 - 12:30	Identification of New Indicators & Data Collection	9 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	Definition and agreement on the 5 new local climate risk indicators to be developed. Established data collection protocols and validation approach
3.	Month 9_16 June 2025 (Monday)	11:00 - 12:30	Heatwave Risk Assessment (General)	10 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	Discussion of general heatwave hazard and exposure data (EuroHEAT). Identification of municipal priorities for heat mapping.
4.	Month 10_ 8 July 2025 (Tuesday)	11:00 - 12:30	Health & Occupational Exposure to Heatwaves	8 persons: representatives of Municipal bodies (engineers of Technical Services, Social	Focus on vulnerable population exposure (elderly, children) and outdoor worker exposure.

				Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	Linked health data with spatial analysis.
5.	Month 12_ 16 September 2025 (Tuesday)	11:00 - 12:30	Building Exposure to Heatwaves	8 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	Analysis of building stock vulnerability (age, materials, insulation). Identified neighbourhoods with a high concentration of thermally vulnerable buildings.
6.	Month 13_ 14 October 2025 (Tuesday)	11:00 - 12:30	Summer Energy Poverty	9 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	In-depth exploration of energy poverty as a climate-induced vulnerability. Linked high temperatures, building inefficiency, and socio-economic data.
7.	Month 14_ 11 November 2025 (Tuesday)	11:00 - 12:30	Wildfire Risk Assessment	10 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	Application and discussion of FWI workflow results. Local refinement of wildfire risk zones, especially for the Aigaleo Grove and Elaionas interface
8.	Month 15_ 5 December 2025 (Friday)	11:00 - 12:30	Consolidated Results & Validation	10 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	Final presentation and joint validation of all refined risk assessments (heatwaves, wildfires, socio-economic indicators) based on the integrated local data

N.	Date	Time/Duration	Main Topic	Participants	Description/ Outcomes
1.	Month 8_ 7 May 2025 (Wednesday)	10:00 - 12:00	Co-identifying Local Risk Categories: To discuss the project's scope and collectively define the key climate risk challenges for Aigaleo, focusing on social, spatial, and infrastructural impacts of heatwaves and wildfires.	14 persons: representatives of: Municipal bodies (engineer of Technical Services, Social Services, Municipal Police, Municipal Civil Protection), educators, association of guardians and parents, association of volunteer rescuers, local scouts, NGO for psychosocial support and health, association of trade and market, catering SMEs, free-lancer engineer	1. Co-created list of key risk categories. 2. Identification of most-affected social groups and geographic areas (neighbourhoods, infrastructures). 3. Established a common language and priorities for the technical work. This workshop's outputs are directly fed into Focus Group 2 for formalising the new indicators
2.	Month 15_ 16 December 2025 (Tuesday)	10:00 - 12:00	Validation & Bridging to Action: 1. To present and validate the final, refined results from all workflows and Focus Groups. 2. To link findings with existing municipal projects and initiate the discussion on concrete protection strategies.	12 persons: representatives of: Municipal bodies (engineer of Technical Services, Social Services, Municipal Police, Municipal Civil Protection), educators, association of guardians and parents, association of volunteer rescuers, local scouts, NGO for psychosocial support and health, association of trade and market, catering SMEs, free-lancer engineer	1. Community validation of scientific results, the refined risk maps and impact chains. 2. Community validation of the results based on local experience/perception. 3. Strategic linking of identified risks to ongoing/future European projects for potential action. 4. Generation of preliminary ideas for adaptation, creating a bridge to Phase 3.

2.2. Risk Exploration

2.2.1. Screen risks (selection of main hazards)

AGL is exposed to a range of environmental hazards that are intensifying due to climate change and urban density. Based on preliminary assessments, CRA phase 1 and stakeholder consultations, the two main climate-related hazards selected for in-depth analysis under the CLIMAAX risk assessment are:

- Urban Heatwaves, and
- Wildfires.

Aigaleo, in Western Athens, is already facing severe heat stress. Summer temperatures during heatwaves often reach 45°C, and extreme heat events now last over two weeks, surpassing 40°c. These conditions are worsened by climate change, dense urbanisation, and a strong urban heat island (UHI) effect, which traps heat within the city, particularly at night. (Katavoutas and Founda 2019). The hazard of heatwaves is most severe in the southeastern parts of the municipality, particularly along major transport routes like Kifissos Avenue. These areas are characterised by high building density, extensive paved and asphalted surfaces, and limited vegetation, which intensifies the urban heat island effect. (Giannaros et al. 2023). The impacts are felt throughout the community, but vulnerable populations remain at the highest risk, including:

- Elderly residents and kids
- Low-income households
- Migrant populations
- People living in poorly insulated or overcrowded housing
- Outdoor workers

These groups often have limited access to cooling, healthcare, and public cooling shelters, making them particularly vulnerable to prolonged heat. Heatwaves already pose serious health risks, including heat exhaustion, cardiovascular stress, and increased mortality, as well as economic losses due to reduced productivity and higher energy costs.

According to *Copernicus Atlas*[1]*, for the study area, projected changes in daily maximum temperature under the high-emissions scenario SSP5-8.5 during summer, compared to the pre-industrial period (1850–1900), are expected to increase from 2.1°C in the near future (2021–2040) to 6.8* °C by the end of the century. Under RCP8.5, similarly positive changes are also estimated with values ranging from 1.5 to 4.7 °C. A significant increase in very extreme hot days (maximum temperature above 40 °C), reaching up to 38 days (p95), is also projected for the far future (2081–2100). Moreover, projected changes in cooling degree days (CDD) indicate a strong increase in cooling needs (from around 251 °C·day to 565 °C·day by the end of the century), consistent with intensifying heat stress under continued high greenhouse gas emissions.

For the risk assessments, a very high-resolution climatic data approach at the local level was adopted, aiming to evaluate impacts on the city of Aigaleo and individual buildings. This allows for capturing fine-scale spatial variability of heat-related hazards and supports a more precise understanding of how climate extremes translate into risks for urban areas, buildings, and exposed populations. Therefore, the following data were used.

- High-resolution climate simulations produced from the NCSRD EREL laboratory
- Building blocks – building density of the study area, provided from the Municipality of Aigaleo
- Population distribution data (ELSTAT, local AGL, WorldPop)
- Social Data (municipality of AGL, ELSTAT)
- Satellite data
- Socioeconomic information from the Municipality and Hellenic Statistical Authority

[1] https://atlas.climate.copernicus.eu/atlas

2.2.2. Choose Scenario

In this phase, the scenario development considered high-resolution climate datasets under the most widely used future climate change scenarios, RCP 4.5 (the intermediate scenario) and RCP 8.5 (the worst-case scenario), based on greenhouse gas emissions. The local climate simulations for RCP 4.5 and RCP 8.5 included one medium-term time horizon representing the near future (2025–2049) and one long-term horizon for the far future (2070–2099), alongside a reference historical period (1980–2004).

According to recent socioeconomic trends provided by ELSTAT based on Census 2021 data (see also ANNEX, table A1.1), future socioeconomic development was characterised by a high share of vulnerable population groups (elderly, children, low-income, low-education households), persistent unemployment, and a very inefficient housing stock. More specifically, 21.8% of the population is already under 12 or over 65. Furthermore, 42% of residents have not completed lower secondary education. This restricts future income growth and job mobility, heightening long-term energy poverty risk. Over 1,000 citizens (~400 families) already receive social support, and 21.7% are below the poverty threshold (Social Profile of the Municipality of Egaleo, 2021). These households will be least able to adapt to rising energy prices or invest in cooling and building upgrades. Most buildings will remain energy inefficient, increasing future cooling demand and energy bills. These conditions indicate limited future adaptive capacity to rising energy costs, cooling demand, and food-energy trade-offs.

2.3. Regionalised Risk Analysis

Collected local social data

Some baseline information is available from municipal services and local GIS tools, along with the collection of local socio-economic data (summarised in Table A1.1 in the ANNEX) at a municipal level provided by the Hellenic Statistical Authority (ELSTAT) and the municipality. However, access to detailed socio-economic data was not feasible due to delays and internal administrative procedures.

Buildings from open sources and AGL GIS

The static geospatial data of buildings was supplied by the GIS-integrated digital open-source platform of the Municipality of Aigaleo (https://gis.egaleo.gr), which offers structured, spatially referenced data for urban planning, infrastructure management, environmental monitoring, and citizen services, featuring interactive tools for visualization, search, and analysis. The GIS platform also provides other geospatial datasets such as Administrative Boundaries, points of Interest, road network, etc.

NCSRD generated climate simulations

The second phase of CLIMAAX involved the integration of 5km-resolution climate datasets provided by NCSRD into the fine-tuned selected workflows of Aigaleo. Thus, high-resolution climate simulations of maximum, minimum temperatures, and relative humidity datasets of 5 km horizontal resolution for the area of Greece were derived from the application of dynamical downscaling EC-

EARTH (Hazeleger et al. 2013) climate fields with the use of the non-hydrostatic Weather Research and Forecasting model (WRF/ARW, v3.6.1) (Skamarock et al. 2008) in a one-way nesting setup composed of two domains. The climate simulations were divided into three time periods: the historical/reference (1980–2004), near future (2025–2049), and distant future (2070–2099). It should also be noted that climate simulation data and the model setup are based on extensive validation studies. (Politi et al. 2018, 2020, 2021, 2022; Katopodis et al. 2020), comparing the downscaled historical simulations with available meteorological data from the Hellenic National Meteorological Service (HNMS). The entire area of Aigaleo is partially or fully covered by four grid cells. Therefore, the time series of the climate datasets for these grid cells were extracted to calculate the necessary indicators related to the risk assessment workflows described in the following sections.

The following workflows were implemented for the risk assessments of Aigaleo (see Table 3 below) in the second phase of CLIMAAX.

Table 2.3 Risk assessments overview for Urban heatwaves and Wildfire

HAZARDS	**Risks to public health, infrastructure, and food security**
Heatwaves (HWs)	
	1. Summer Energy Poverty
	2. Building's exposure to HWs
Urban heatwaves workflow	3. Heatwave Risk Assessment
	4. Health exposure to HWs
	5. Workers' exposure to HWs
Wildfire	
Wildfire (FWI) workflow	FWI Risk assessment

The summer energy poverty risk assessment primarily used hazard data for both historical and future periods described in subsection (2.2.4). It relied on cooling degree days (CDD) to estimate the energy needed for cooling during the warm months (from May to October). The climate hazard information, combined with vulnerability data represented by building density, will evaluate the risk level of cooling energy demand for buildings caused by heatwaves.

The ***building's exposure to heatwaves*** was measured using the annual probability of exceeding the maximum temperature over a 50-year period, which acted as the hazard metric for evaluating the building's vulnerability to thermal stress.

The ***heatwave risk assessment*** evaluates the impact of climate change caused by extreme heatwave events, along with the vulnerable population groups within the Municipality of Aigaleo that are most at risk.

The ***health exposure to HWs*** involves historical and projected hazard climate data of the Humidex indicator exceeding a critical threshold, serving as a measure of heat discomfort. Combined with the vulnerable population, this assesses the health risk level associated with exposure to extreme heat.

The ***outdoor workers' exposure to HWs*** used the same historical and projected indicator as in the previous risk assessment, by combining the geospatial layer of open spaces within the Municipality of Aigaleo. The open space area is considered the zone where outdoor workers are active, taking into account the Municipality's Environmental / Green Spaces services and street cleaners. Additionally, food delivery services and a significant number of inter-country transport services located in the Elaionas area are included.

The overall risk workflows process for the heatwave assessments is included in the ANNEX (section 1). For each risk assessment (from subsections 2.2.4. to 2.2.8), the selected hazard, vulnerability, and exposure data are summarised in the relevant table. Additionally, in the last column of the table, the type of risk output produced is indicated.

Depending on the category of the heatwave risk assessment the following hazard data/indicators were used:

- Cooling Degree Days (CDDs)
- Return level of TX for 50-year return period
- Number Heatwave days (similarly to the 1nd phase)
- Number of days with Humidex>40

Moreover, the definitions of each hazard indicator and their calculation formulas can be found in the ANNEX.

High-resolution EO datasets

Land Surface Temperature (LST) from Landsat 8 was also utilised to evaluate exposure within the satellite-derived data approach at a 30 x 30 m resolution (ANNEX). A regridding methodology was employed to refine the risk output, ensuring it better suited the local context by downscaling the risk results to a higher resolution. This approach was applied in the five risk assessments of the Urban Heatwaves Workflows because it enables the depiction of extreme heat at a scale pertinent to urban analysis, capturing both regional climate signals and local thermal heterogeneity. A detailed description of the methodology can be found in the Annex.

Social data sets – high resolution

In the context of vulnerable data, two types of datasets were implemented based on the category of risk assessment:

1. Population density: Fused data from ELSTAT, AGL Municipality and WorldPop were used to provide the population distribution data, focusing only on vulnerable groups to the heatwaves, **children under 5 years old and males and females over 65 years old**.
2. Building density: The geospatial data of building blocks, calculated as building density (based on the covered area of buildings per building block) from the GIS platform constructed and adapted at LSTs' grid resolution of 30 x 30 m.

Finally, the Wildfire Workflow was implemented in a similar way to the first phase of the project, with some additional analysis using the 5km hazard datasets derived from the WRF model, by estimating the projected values of the following indicators:

- Seasonal FWI
- The 95th percentile of FWI
- Very extreme days (FWI > 70)

It should be noted that the presentation of the results is shown at the municipal level (for the entire area of Aigaleo) in table format and at a high-resolution urban scale, spatially. All additional datasets and intermediate results are included in the ANNEX for both resolution scales (Section 2). The output results for the wildfire hazard are included in this deliverable, and only the description of the fire-indicators can be found in the ANNEX.

2.3.1. Hazard #1.1 – Summer Energy Poverty

The following two tables provide an overview of the types of data used for the hazard and risk assessment (Table 2.4) and the classification of these data types on a 5-point scale (Table 2.5), respectively.

Table 2.4 Data overview for workflow #1.1

Hazard data	***Vulnerability data***	***Exposure data***	***Impact metrics/Risk output***
Cooling Degree days	Buildings	Building Density	Possible energy cooling demand risk level to buildings

Table 2.5 Table with categories limiters (as min, max)

Category	**1**	**2**	**3**	**4**	**5**
Hazard	< 63.48	63.48, 94.98	94.98, 126.48	126.48, 157.98	157.98>
Vulnerability	0.04, 0.09	0.09, 0.15	0.15, 0.20	0.20, 0.25	>0.25
Risk	Very low	Low	Medium	High	Very High

2.3.1.1. Hazard assessment

In the following figure (Figure 2.2), the evolution of the annual Cooling Degree Days (CDD) is illustrated under the two climate scenarios (RCP4.5 and RCP8.5), from the historical period to the end of the century. It shows a clear upward trend in heat exposure, with moderate increases under RCP4.5 and much stronger increases under RCP8.5, particularly after 2050. By the late 21st century, extreme cooling demand is expected to become significantly more frequent and intense (CDD values above 200 per year under RCP8.5), emphasising a growing climate pressure on health, buildings, and energy systems. systems.

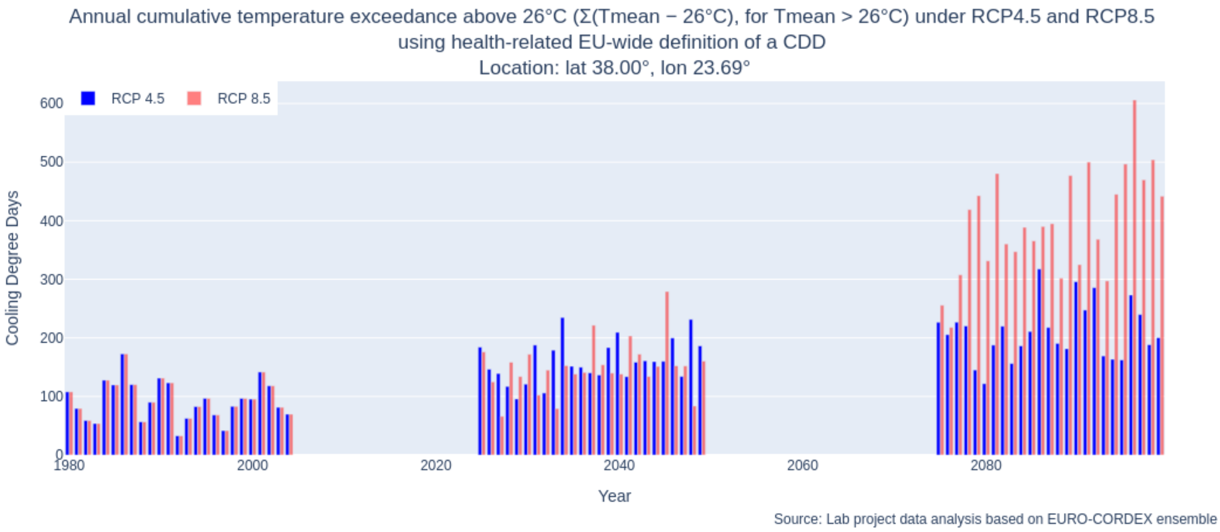


Figure 2.2 Cooling degree days per year under RCP4.5 (blue lines) and RCP8.5 (red lines) for Aigaleo (37.99°N, 23.68°E).

2.3.1.2. Risk assessment

Municipal level

For the risk assessment, both vulnerability data and historical as well as projected hazard data workflows were conducted. This analysis combined the historical and projected results of the hazard assessment (of the CDD) related to climate change (RCPs 4.5 and 8.5) with the layer of the buildings' density (mean value of the total area) for the Municipality of Aigaleo. The risk was also calculated using the 10 + 10 risk matrix and then converted into a 5-grade classification ranging from very low to very high risk.

Table 2.6 Risk assessment analysis at Municipal level.

	Hazard data		***Vulnerability data***		***Risk output***
	Cooling Degree Days (CDD)	**Class**	**Building density**	**Class**	**Possible energy cooling demand risk level to buildings**
Historical period	90.13	2	0.29	High	High
RCP4.5 – Near Future	160.69	5	0.29	High	Very High
RCP8.5 – Near Future	150.92	4	0.29	High	Very High
RCP4.5 – Far Future	211.17	5	0.29	High	Very High

RCP8.5 – Far Future	398.13	5	0.29	High	Very High

High-resolution risk assessment

For the urban risk assessment, the vulnerability data and both historical and projected hazard data workflows were executed by downscaling the hazard and vulnerability data to the LST resolution for a detailed representation of the risk at the building block level. The final output was produced by combining the layer of historical and projected hazard assessment results (from the CDD) with the layer of building density for the Municipality of Aigaleo. The risk was also calculated using the 10 + 10 risk matrix and then translated into a 5-point classification scale from very low to very high risk (see Figure 2.3).

Figure 2.3 Energy cooling demand risk level to building's exposure (30m) for the historical period 1980–2004 (a) and in the near future (2025–2049) and far future (2070–2099) periods (b), under RCP 4.5 and RCP 8.5, for the Municipality of Aigaleo

2.3.2. Hazard #1.2 – Buildings Exposure to heatwaves

The following two tables provide an overview of the types of data that were used for the hazard and risk assessment (Table 2.4 Data overview for workflow #1.1 and the classification of the data types on a 5th scale (Table 2.8), respectively.

Table 2.7 Data overview workflow #1.2

Hazard data	***Vulnerability data***	***Exposure data***	***Impact metrics/Risk output***
Return level of TX for the 50-year return period	Buildings	Building Density	Possible thermal risk level to buildings' infrastructure

Table 2.8 Table with categories limiters (as min,max.)

Category	**1**	**2**	**3**	**4**	**5**
Hazard	40.66, 40.71	40.71, 40.74	40.74, 40.77	40.77, 40.81	40.81>

2.3.2.1. Hazard assessment

The Figure 2.4 illustrates the spatial evolution of extreme temperature, used here as an indicator of building thermal stress, within the outlined study area (Aigaleo) under historical and future climate conditions. The comparison across periods and scenarios highlights both the temporal progression of thermal stress and its sensitivity to different climate change pathways.

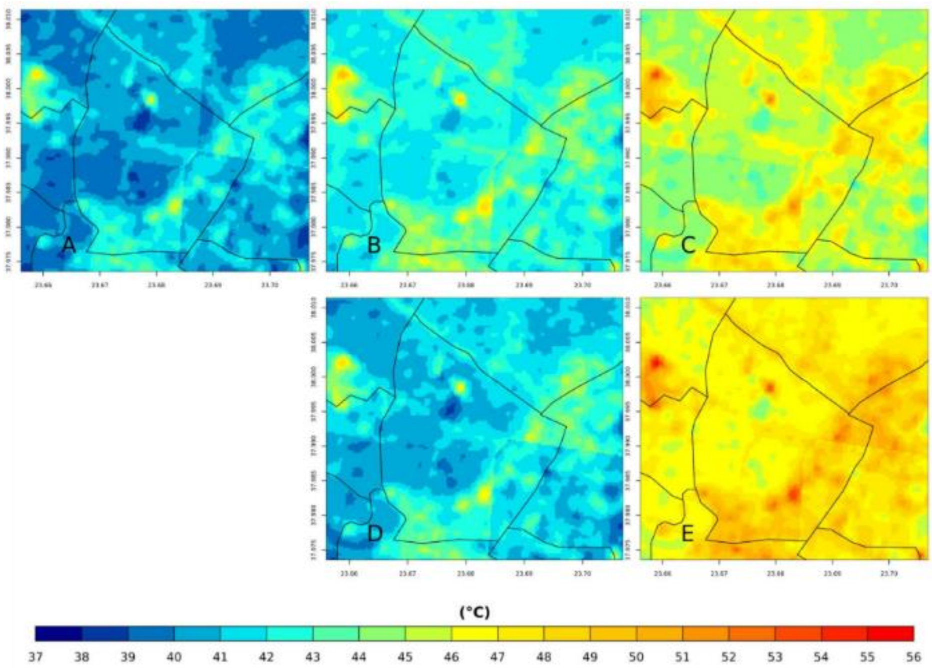


Figure 2.4 Return levels of TX values for 50-year return period, in the near future period (2025-2049), RCP4.5 (B) and RCP8.5 (D) and the far future period (2070-2099), RCP4.5 (C) and RCP8.5 (E) compared to the historical period (1980-2004, A) at high-resolution.

Overall, the figure shows a significant rise in building thermal stress under climate change in targeted areas, caused by increasing extreme temperatures over time and intensified under higher-emissions scenario RCP8.5. The clear contrast between RCP4.5 and RCP8.5 highlights the importance of emission reduction in limiting future thermal stress on buildings, while the consistent increase across all future periods emphasises the need for targeted adaptation and resilience strategies.

2.3.3. Hazard #1.3 – Heatwave risk assessment

The following two tables provide an overview of the types of data that were used for the hazard and risk assessment (Table 2.4 Data overview for workflow #1.1 and the classification of these data types on a scale of 1 to 5 (Table 2.10), respectively.

Table 2.9 Data overview workflow #1.3

Hazard data	*Vulnerability data*	*Exposure data*	*Impact metrics/Risk output*
Heatwave days	Vulnerable Population	Population density	Possible heat risk level to vulnerable population

Table 2.10 Table with categories limiters (as min,max.)

Category	1	2	3	4	5
Hazard	0, 2.44	2.44, 4.89	4.89, 7.33	7.33, 9.78	>9.78
Vulnerability	3.31, 7.1	7.1, 10.9	10.9, 14.	14.7, 18.6	18.6, 22.4
Risk	Very low	Low	Medium	High	Very High

2.3.3.1. Hazard assessment

The following figure (Figure 2.1Figure 2.5) shows the projected annual number of heatwave days at a location near Athens (37.99° N, 23.68° E) from the late 20th century to the end of the 21st century under two climate scenarios, RCP4.5 (blue) and RCP8.5 (red), based on a health-related EU-wide heatwave definition. During the historical period (1980-2004), heatwave days are relatively few and vary, usually fewer than 10 days per year. From 2025 onwards, both scenarios indicate a clear increase in heatwave frequency, with RCP8.5 displaying a faster and more intense rise than RCP4.5. By the mid-century, annual heatwave days often surpass 10–15 days, particularly under RCP8.5. In the late 21st century, the difference between the scenarios becomes more distinct: RCP4.5 stabilises at moderate yet still elevated levels, typically between 10 and 30 days per year, while RCP8.5 shows a significant surge, with numerous years experiencing 40–60 or more heatwave days and notable interannual variability. Overall, the figure demonstrates a marked increase in heatwave exposure over time, especially under the high-emissions scenario.

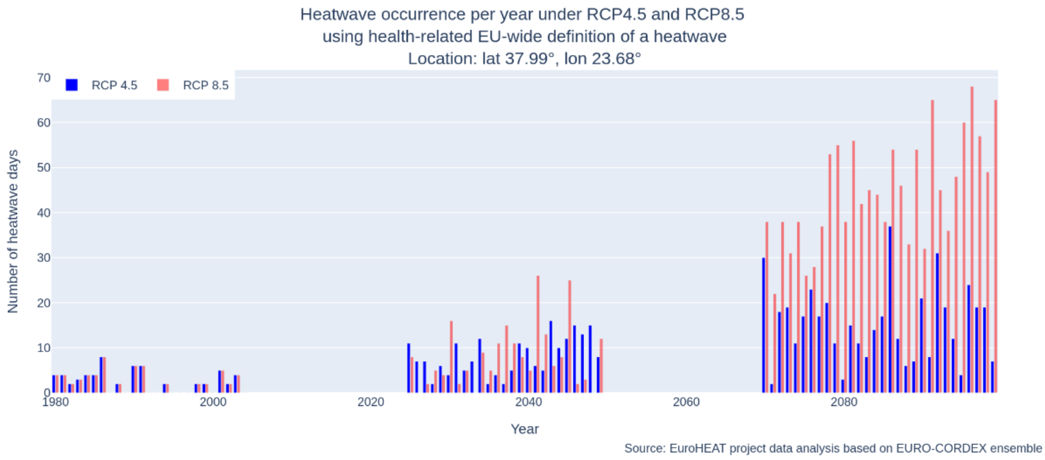


Figure 2.5 Heatwave occurrence per year under RCP4.5 (blue lines) and RCP8.5 (red lines) using health-related EU-wide definition of a heatwave for Aigaleo (37.99°N, 23.68°E).

2.3.3.2. Risk assessment

The following table presents the heat-risk assessment for vulnerable populations by combining climate hazard, vulnerability, and future climate scenarios.

Municipal level

Table 2.11 Risk assessment analysis at Municipal level.

	Hazard data		***Vulnerability data***		***Risk output***
	Number of Heatwave days	**Class**	**Population density**	**Class**	**Possible heat risk level to vulnerable population**
Historical period	**2.80**	2	15.41	High	Low
RCP4.5 – Near Future	**7.68**	4	15.41	High	Medium
RCP8.5 – Near Future	**7.92**	4	15.41	High	Medium
RCP4.5 – Far Future	**15.55**	5	15.41	High	High
RCP8.5 – Far Future	**43.87**	5	15.41	High	High

Even under current climate conditions, the municipality already shows high vulnerability because many residents live in dense, socially fragile environments. However, since the climate hazard remains relatively low, the overall risk is also low. In the near future and under both scenarios, the number of heatwave days is expected to rise compared to the historical period. Although population density stays the same, the significant increase in climate hazard has elevated the overall heat risk to the "Medium" category. This indicates that climate change alone, without any demographic shifts, can substantially raise risk. In the distant future, hazard levels reach the maximum class (5), leading to a high risk, particularly under RCP8.5.

Even if the population remains stable, climate warming alone is enough to elevate the municipality from manageable heat risk today to severe and potentially unmanageable risk by the end of the century, especially under RCP8.5.

High-resolution risk assessment

Regarding the geographical distribution of the future heatwave risk, Figure 2.6 provides spatial information on the expected heatwave risk to vulnerable populations during the historical period and two future periods under RCP4.5 and RCP8.5.

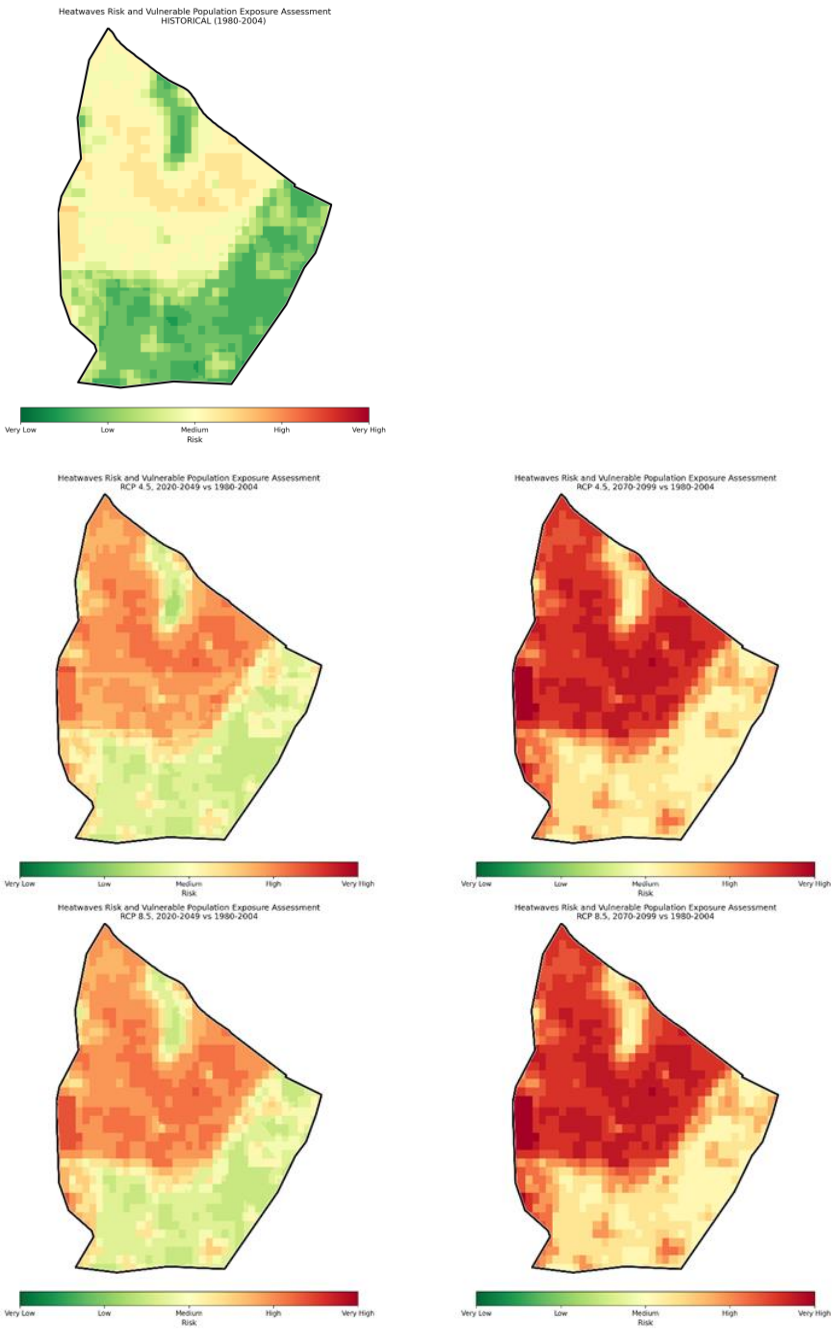


Figure 2.6 Heawave risk and vulnerable population exposure (30m) for the historical period 1980–2004 (a) and in the near future (2025–2049) and far future (2070–2099) periods (b), under RCP 4.5 and RCP 8.5, for the Municipality of Aigaleo.

2.3.4. Hazard #1.4 – Vulnerable Groups Health Exposure to HW

The following two tables provide an overview of the data types that were used for the hazard and risk assessment (Table 2.4 Data overview for workflow #1.1 and the classification of the data types on a scale of 1 to 5 (Table 2.13), respectively.

Table 2.12 Data overview workflow #1.4

Hazard data	***Vulnerability data***	***Exposure data***	***Impact metrics/Risk output***
Number of days with Humidex >40	Vulnerable Population	Population Density	Possible heat stress risk level to vulnerable population's health exposed to HWs

Table 2.13 Table with categories limiters (as min,max).

Category	**1**	**2**	**3**	**4**	**5**
Hazard	0, 2.44	2.44, 4.89	4.89, 7.33	7.33, 9.78	>9.78
Vulnerability	3.31, 7.1	7.1, 10.9	10.9, 14.	14.7, 18.6	18.6, 22.4
Risk	Very low	Low	Medium	High	Very High

2.3.4.1. Hazard assessment

Figure 2.7 shows a significant rise in the number of days with discomfort conditions (Humidex > 40) for the Municipality of Aigaleo under both climate scenarios, with much greater increases under RCP8.5. While such extreme humid heat is below 10 days per year in the historical period, it becomes more common in the near future and rises sharply in the distant future, especially after 2070. Under RCP8.5, several decades experience more than 30 days per year of high-Humidex, indicating a shift from occasional extreme discomfort to sustained, high-risk heat stress conditions that can substantially impact the health of vulnerable groups.

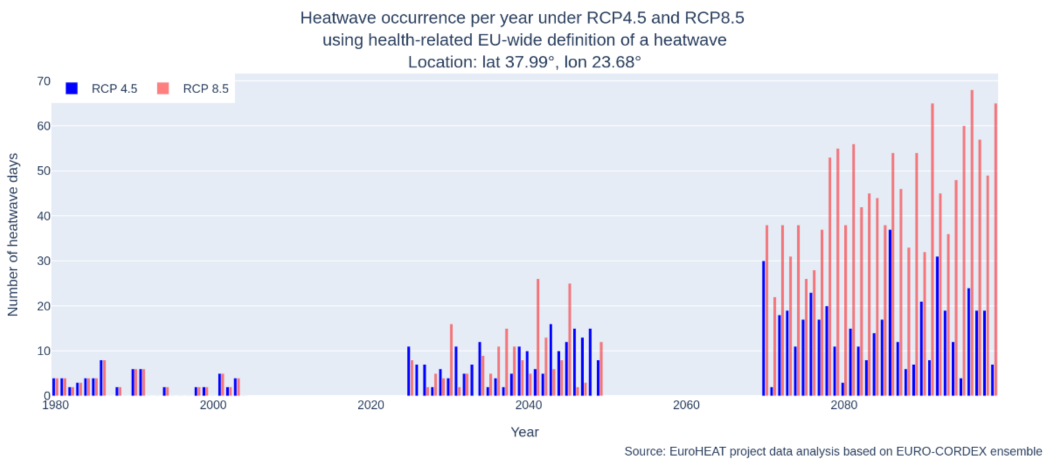


Figure 2.7 Number of days with Humidex>40 per year under RCP4.5 (blue lines) and RCP8.5 (red lines) for Aigaleo (37.99°N, 23.68°E).

2.3.4.2. Risk assessment

Municipal level

The following table illustrates how the health risk from extreme heat and humidity (Humidex > 40) for vulnerable populations increases over time as climate conditions worsen. In the past, very few high-Humidex days (about 2.5 per year) result in a low health risk, despite population density and vulnerability already being high. In the near future, both RCP4.5 and RCP8.5 scenarios show a clear increase in hazardous days (around 6 per year), elevating the risk to medium. In the distant future, the number of dangerous discomfort days rises further, especially under RCP8.5, where it surpasses 30 days annually, pushing the overall health risk to the High category. This demonstrates that, because vulnerability and exposure remain elevated, climate-driven increases in heat (high maximum temperatures) and humidity are the primary factors driving the rise in health risks within the municipality.

Table 2.14 Risk assessment analysis at Municipal level.

	Hazard data		Vulnerability data		Risk output
	Number of days with Humidex>40	**Class**	**Population density**	**Class**	**Possible health risk level to vulnerable population exposed to HWs**
Historical period	2.48	1	15.41	High	Low
RCP4.5 – Near Future	6.616	3	15.41	High	Medium
RCP8.5 – Near Future	5.716	3	15.41	High	Medium
RCP4.5 – Far Future	10.1952	5	15.41	High	High
RCP8.5 – Far Future	33.7192	5	15.41	High	High

High-resolution risk assessment

Regarding the geographical distribution of the potential health risk level, Figure 2.6 provides spatial information on expected heatwave risk for vulnerable populations during historical periods and two future scenarios under RCP4.5 and RCP8.5.

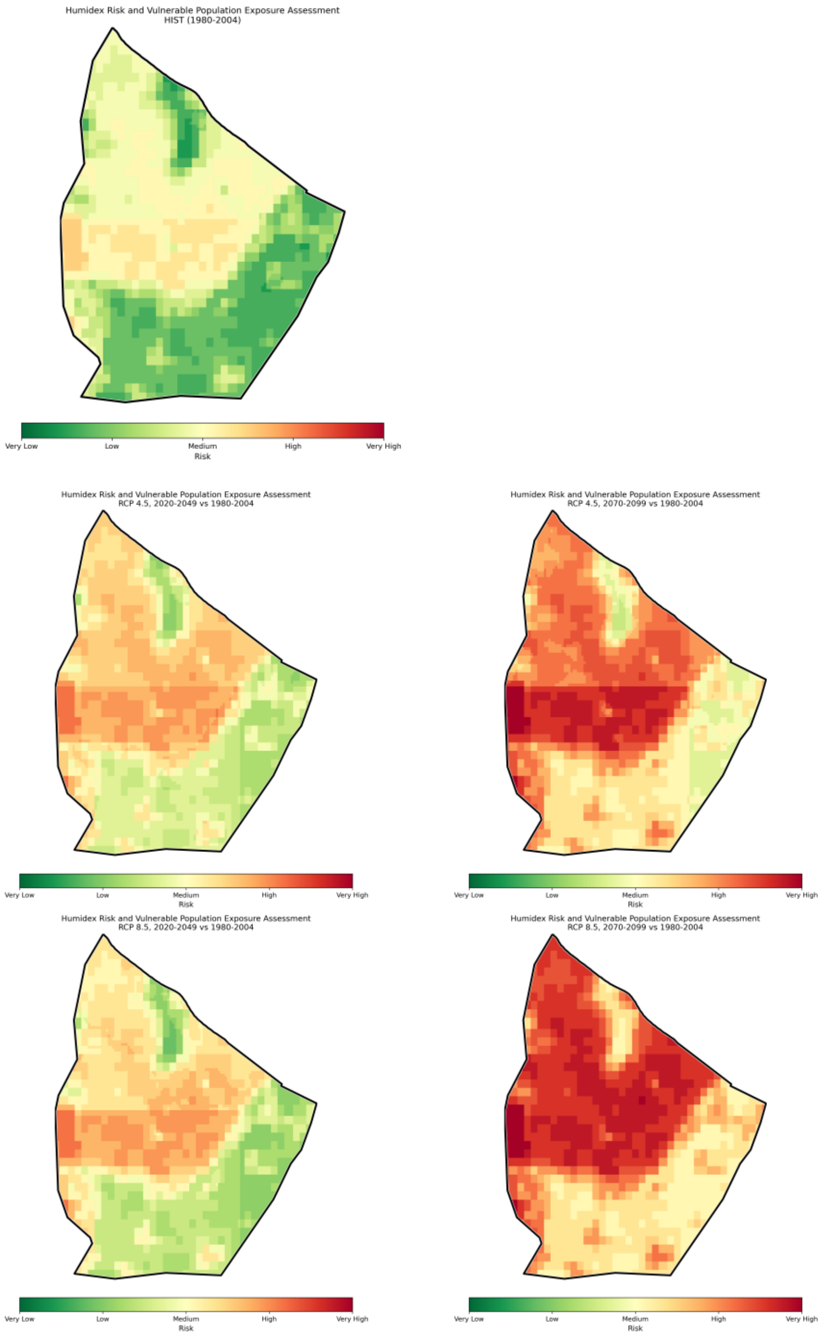


Figure 2.8 Possible health risk level to vulnerable population exposure (30m) for the historical period 1980–2004 (a) and in the near future (2025–2049) and far future (2070–2099) periods (b), under RCP 4.5 and RCP 8.5, for the Municipality of Aigaleo.

2.3.5. Hazard #1.5 - Workers' exposure to HWs

The following table provides an overview of the types of data that were used for the hazard and risk assessment (Table 2.4 Data overview for workflow #1.1.

Table 2.15 Data overview workflow #1.5.

Hazard data	***Vulnerability data***	***Exposure data***	***Impact metrics/Risk output***
Number of Days with HUMIDEX > 40	Location of outdoor workers	Outdoor workers density	Overlay

2.3.5.1. Hazard assessment

The high-resolution figure was discussed in subsection 2.2.7. The rationale for employing this index in the hazard and risk assessment analysis is thoroughly explained in the relevant section ANNEX.

2.3.5.2. Risk assessment

Figure 2.6 provides the spatial information for the expected heat stress risk level to the outdoor workers during the historical and the two future periods under RCP4.5 and RCP8.5.

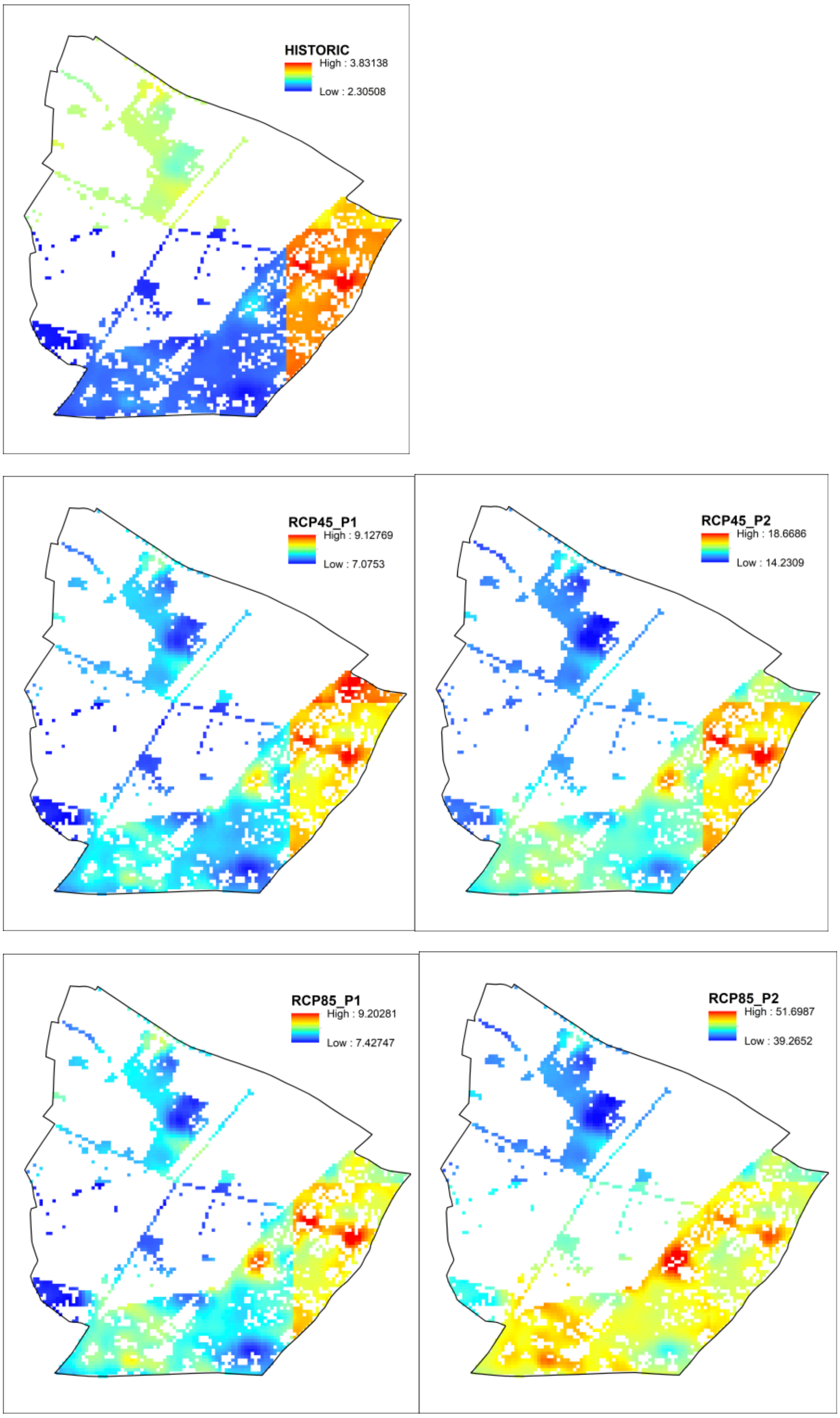


Figure 2.9 Possible heat stress risk level to outdoor workers exposure (30m) for the historical period 1980–2004 (a) and in the near future (2025–2049) and far future (2070–2099) periods (b), under RCP 4.5 and RCP 8.5, for the Municipality of Aigaleo

2.3.6. Hazard #2 – Wildfires – FWI risk assessment

For the assessment of wildfire risk, the FWI workflow already applied in project phase 1, has also run for the present phase, pointing out which areas should be prioritized by adaptation measures. All data used are summarised in Table 2.16.

Table 2.16 Data overview workflow #2

Hazard data	***Vulnerability data***	***Exposure data***	***Impact metrics/Risk output***
FWI (WRF)	Population living in the Wildland Urban Interface, Protected Areas, Ecosystem Irreplaceability Index, Population Density, Ecosystem Restoration Cost Index	Burnable Vegetation	Points with highest wildfire risk

2.3.6.1. Hazard assessment

Apart from the Wildfire workflow analysis applied on the 1st phase of CLIMAAX, hazard data of:

- The annual timeseries of seasonal (May to October) FWI
- The annual timeseries of the FWI 95th percentile
- The timeseries of the number of days exceeding the very extreme class of FWI (FWI >70) according to EFFIS classification,

were produced with the use of WRF model climate datasets of 5-km high resolution, illustrated in the figures below and the mean values of these indicators are presented in a table format for the whole area of Aigaleo. A brief description of the calculation of the indices can be found in the Annex.

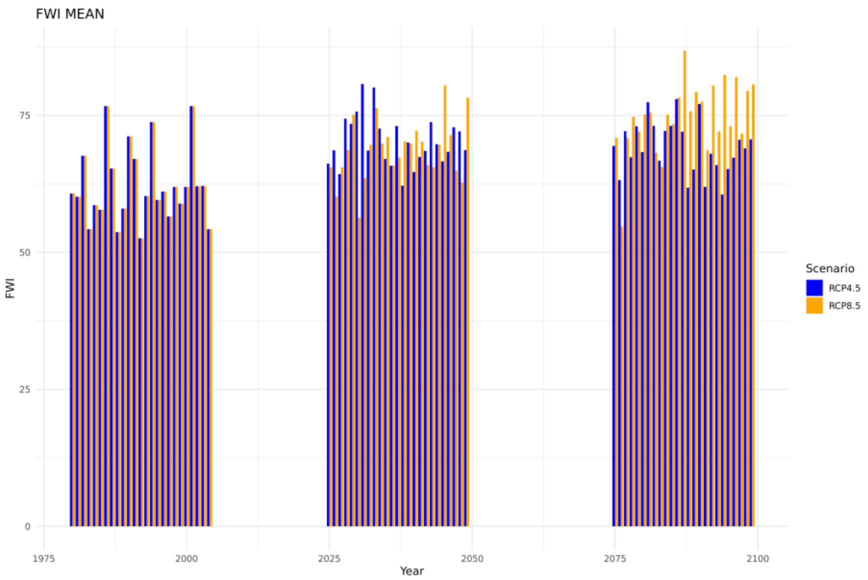


Figure 2.10 The annual value of seasonal FWI during fireseason, for the historical period 1980–2004 under RCP4.5 (blue lines) and RCP8.5 (orange lines) for the near and far future periods integrated in the municipality level.

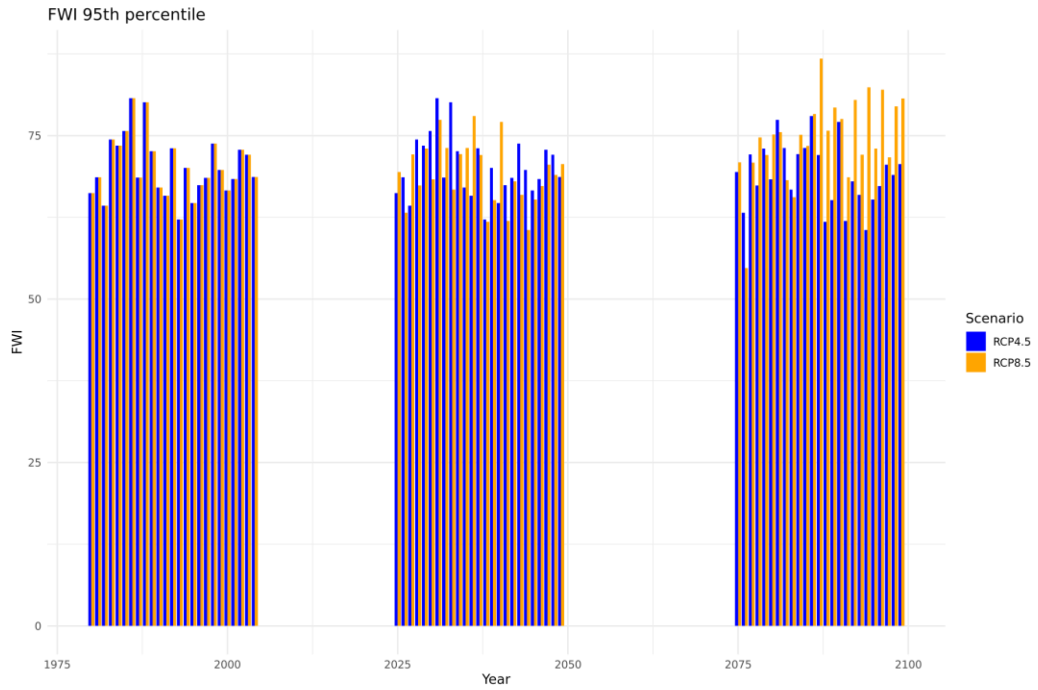


Figure 2.11 The annual value of 95th percentile of FWI during fireseason, for the historical period 1980–2004 under RCP4.5 (blue lines) and RCP8.5 (orange lines) for the near and far future periods integrated in the municipality level.

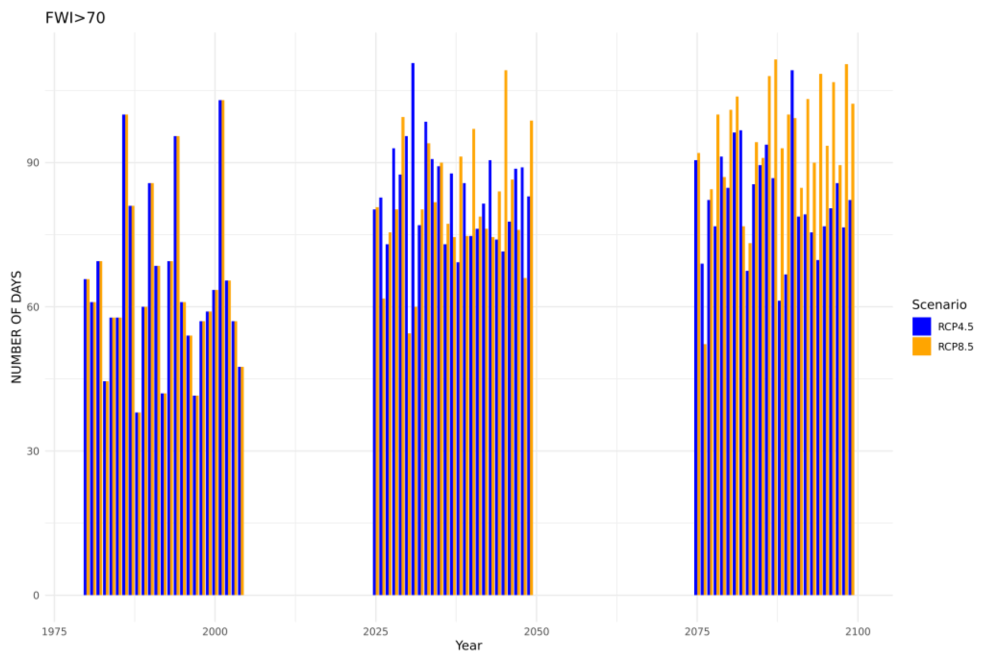


Figure 2.12 The number of days with FWI>70 (as very extreme class) during fireseason, for the historical period 1980–2004 under RCP4.5 (blue lines) and RCP8.5 (orange lines) for the near and far future periods, integrated in the municipality level.

The table below (Table 2.17) shows a clear intensification of wildfire risk over time under both climate scenarios, using three Fire Weather Index (FWI) indicators. In the historical period, the seasonal mean FWI is 62, with 61 days classified as very extreme (FWI > 70), already indicating significant fire risk. In the near future, both RCP4.5 and RCP8.5 project an increase in mean FWI to around 69–70 and a sharp rise in very extreme fire days to more than 80 per season, implying that dangerous fire conditions will become much more frequent. In the far future, the trend continues to rise, particularly under RCP8.5, where the 95th percentile of FWI reaches 148 and very extreme days increase to 94, compared to 61 historically.

Municipal Level

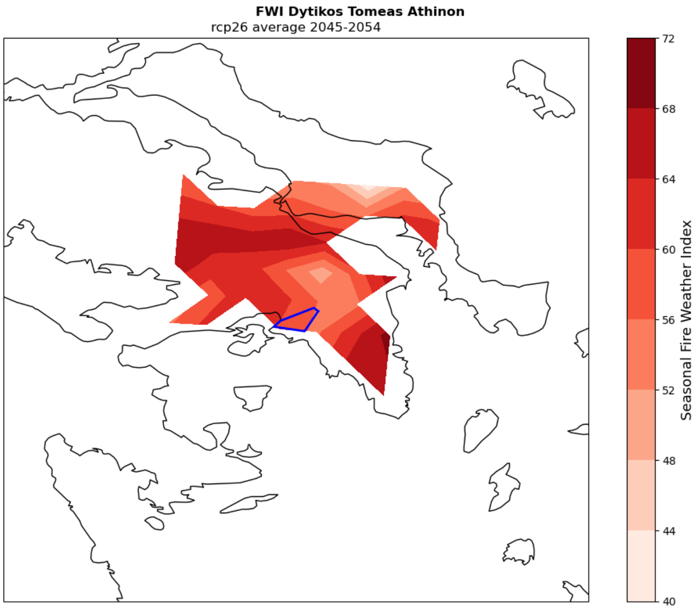
Table 2.17 Hazard indicators analysis for Aigaleo.

	Historical period	RCP4.5 – Near Future	RCP8.5 – Near Future	RCP4.5 – Far Future	RCP8.5 – Far Future
Seasonal mean FWI	62	70	69	69	70
FWI 95 the percentile	108	137	135	134	148
Very Extreme (FWI>70) in days	61	84	81	82	94

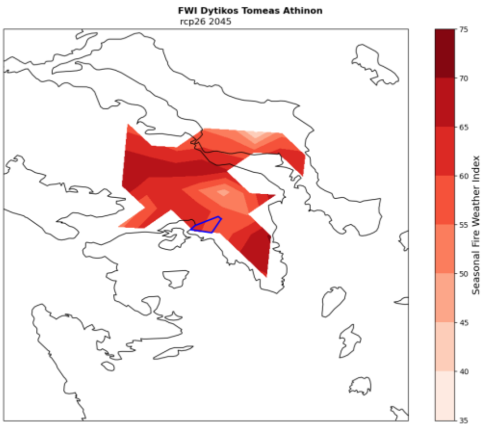
Overall, the table shows that wildfire risk in the region will increase in both frequency and severity, with the most significant worsening under the high-emission scenario, turning extreme fire weather from a seasonal threat into a persistent and escalating problem hazard.

Generally, high values are observed for both historical and future periods. These values are significantly higher than those reported in literature (<50 days for most of Attica), which could be due to the low threshold (>70) applied to the FWI for identifying the very extreme class in Greece, as proposed by EFFIS, when the mean FWI value in the historical period is 62. This finding is also addressed by (Varela et al. 2018), who proposed the approach of Percentile indices (Varela et al. 2020; Casallas et al. 2022; Politi et al. 2023), which provides suitably varying FWI boundaries of classes based on the specific physical characteristics of the study area.

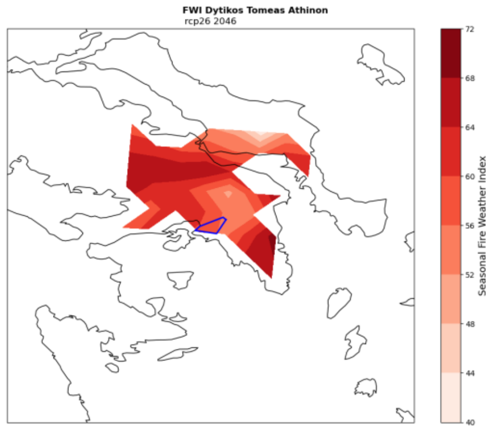
Following the Wildfire workflow, the wildfire hazard assessment for Aigaleo was conducted based on the spatial and temporal trends in seasonal FWI intensity and to changes in the fire weather season duration and onset based on FWI. In addition, the spatial distribution of seasonal FWI is shown as a climatological mean and for each year of the period 2045-2054, based on RCP2.6.


FWI Dytikos Tomeas Athinon
rcp26 average 2045-2054
Seasonal Fire Weather Index
72
68
64
60
56
52
48
44
40

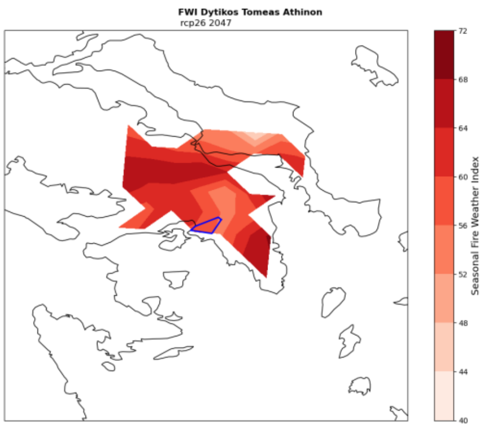
(a)


FWI Dytikos Tomeas Athinon
rcp26 2045
Seasonal Fire Weather Index

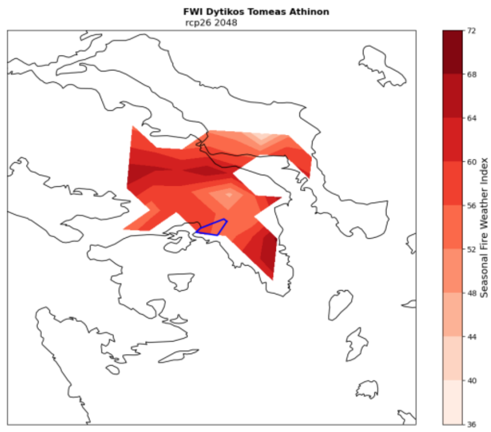
(b)


FWI Dytikos Tomeas Athinon
rcp26 2046
Seasonal Fire Weather Index

(c)


FWI Dytikos Tomeas Athinon
rcp26 2047
Seasonal Fire Weather Index

(d)


FWI Dytikos Tomeas Athinon
rcp26 2048
Seasonal Fire Weather Index

(e)

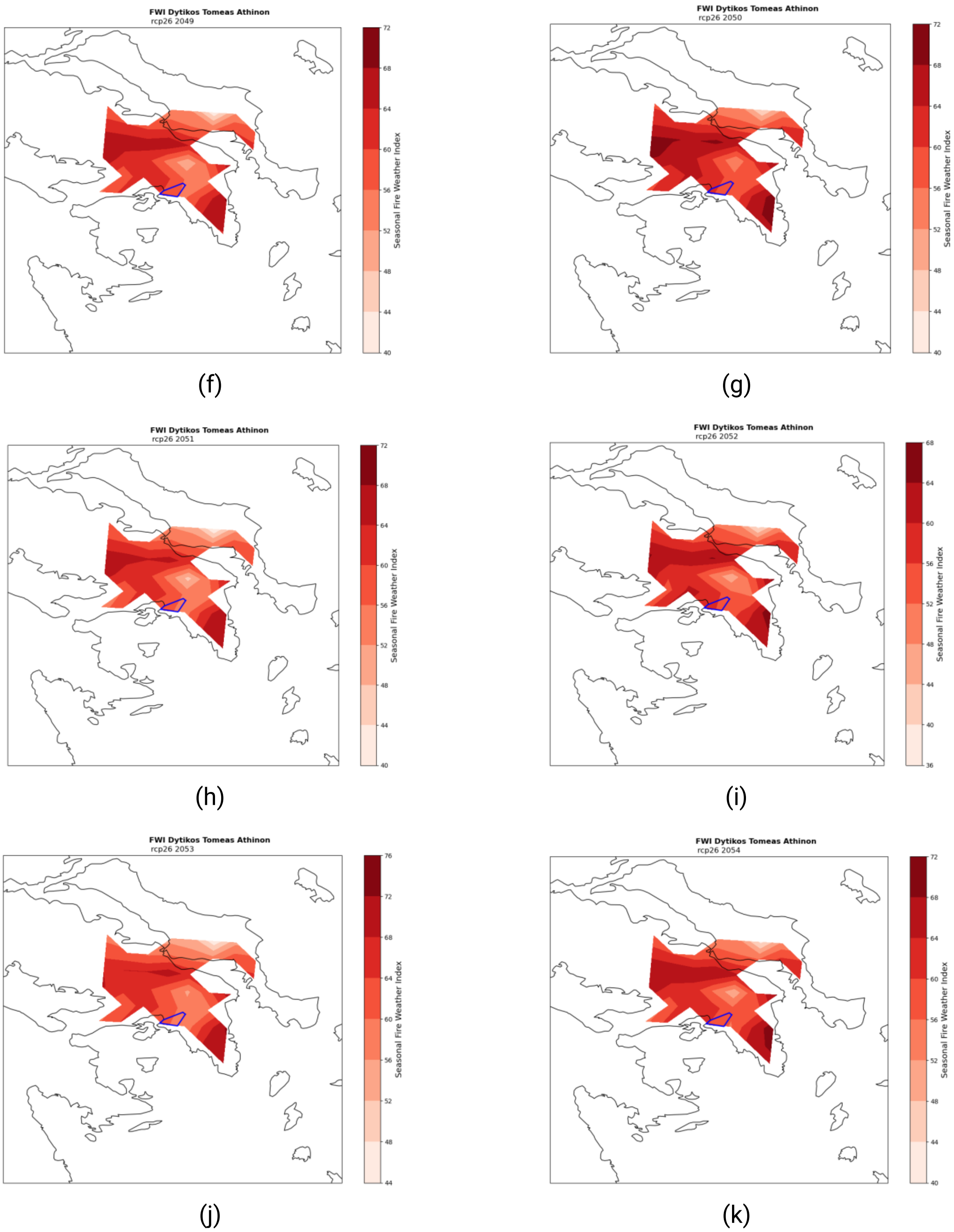


Figure 2.13 Geographical distributions of (a) the mean FWI of the period 2045-2054 and (b-k) the seasonal FWI of each year of the period 2045-2054, based on RCP2.6. The blue frame includes Dytikos Tomeas Athinon, where Aigaleo is located

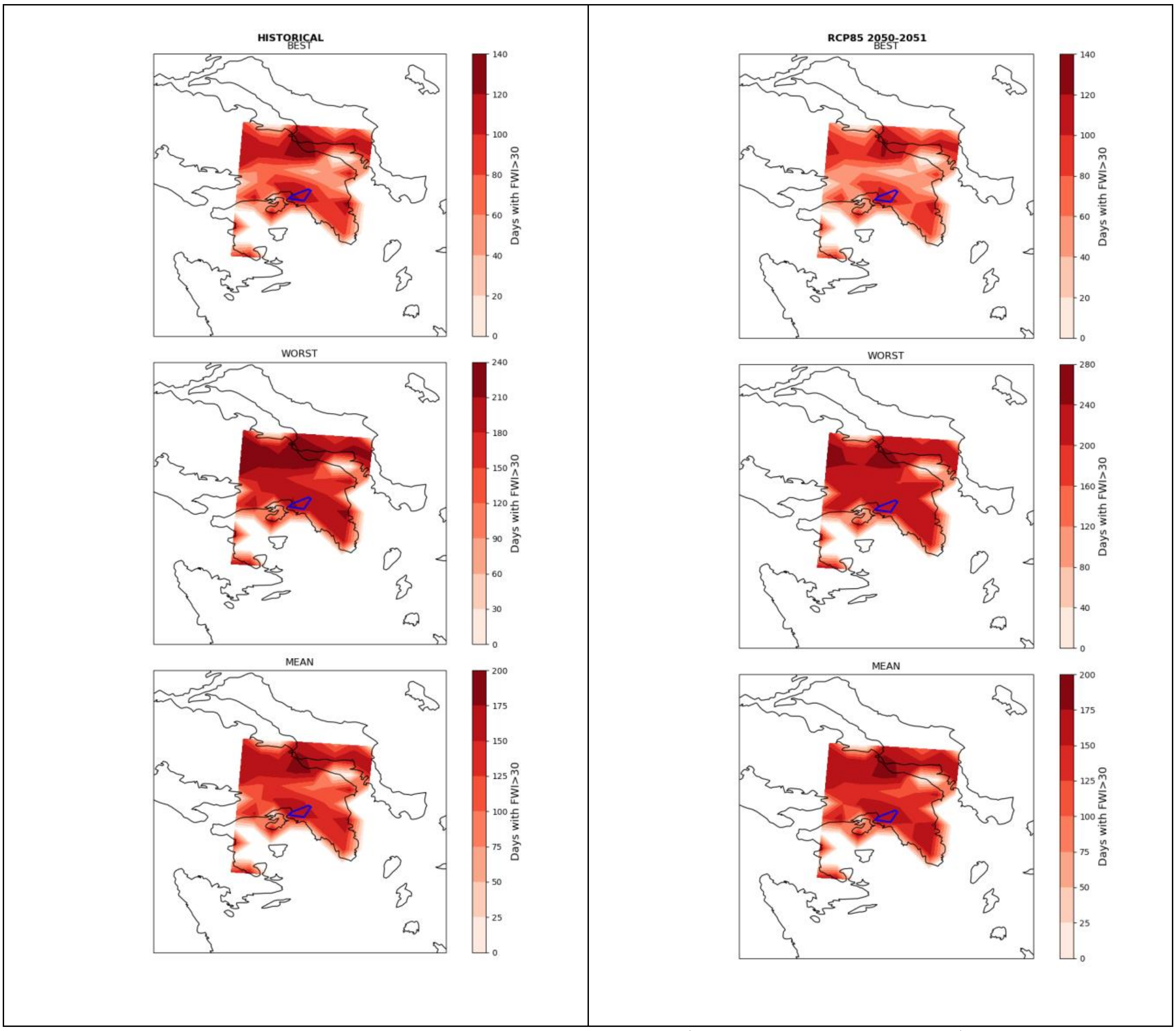


Figure 2.14 Geographical distributions of the fire weather season length (number of days with FWI>30) for the historical period 1985-2005 (left column) and the future period 2045-2054 (right column) for the greater area of Attica. The best (first row), worst (second row) and mean (third row) case conditions are presented. The blue frame includes the west part of Attica, where Aigaleo is located.

In Figure 2.14, the geographical distributions of fire weather season length in the historical (1985-2005) and future (2045-2054) periods for Attica are shown. For both periods, “best”, “worst” and “mean” case conditions are presented. The worst- and best-case scenarios are obtained respectively summing and subtracting the inter-model and inter-annual standard deviation of the fire weather season from the mean. This range of possible conditions covers 95% of the possible distribution. In general, very high values are observed for both historical (up to 200 days in the mean case scenario) and future (up to 180 days in the mean case scenario) periods. These values are much higher than those observed in literature (<50 days for the greatest part of Attica) and this due to the low threshold (>30) applied to the FWI, which is not indicative of Greek conditions.

2.3.6.2. Risk assessment

Figure 2.15 Illustrates the projected spatial distribution of the Fire Danger Index (FDI) for Dytikos Tomeas Athinon under the RCP4.5 climate scenario for 2045–2054, when FWI exceeds 30. The FDI is derived from combining the seasonal FWI and the fuel availability, represented by the burnable vegetation. (Figure 2.16a). These danger indicators are normalized and averaged to produce a fire danger index, which is later combined with a set of wildfire vulnerability indicators (Figure 2.16b-f) to produce the risk index.

As depicted in Table 2.16, the following vulnerability indicators were used for the risk assessment. The geographical distributions of each of these indicators are given in Figure 2.16b-f. The main key findings are summarised as follows:

- The highest proportions of population in WUI areas (up to 41%) occur in the coastal zones of Piraeus, Sounion, and Laurium, while Dytikos Tomeas Athinon shows values between 20% and 41%.
- Protected areas reach their maximum extent in Mount Parnitha (up to 85%), whereas most of Attica ranges from 30% to 60% and Aigaleo from 40% to 50%.
- The irreplaceability index across Attica, including its western sector, is generally moderate (0.4 and 0.6).
- Population density is highest (>500 people/km²) in Dytikos Tomeas Athinon.
- The restoration cost index varies widely across Attica (near zero to 0.7), with intermediate values of 0.4-0.5 for Dytikos Tomeas Athinon.

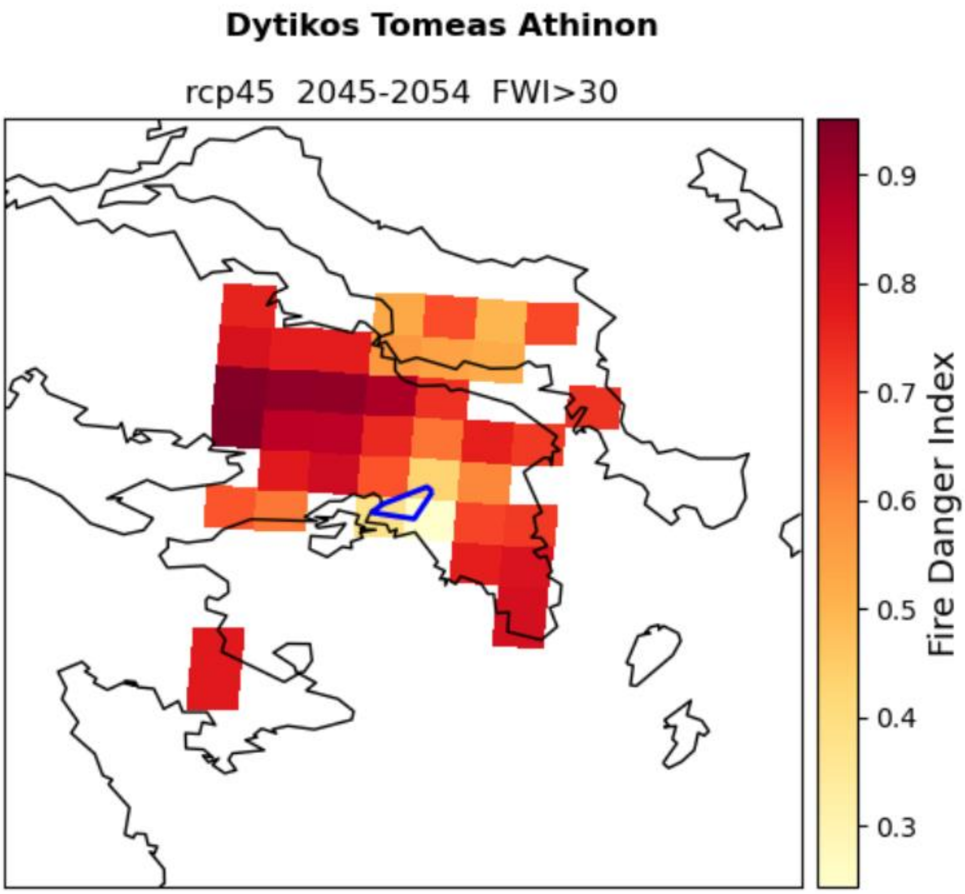


Figure 2.15 Geographical distribution of Fire Danger Index for the period 2045-2054, based on RCP4.5 over the greater area of Attica. Darker red areas represent the highest projected fire risk, while lighter colors indicate moderate risk. *The blue frame includes Dytikos Tomeas Athinon, where Aigaleo is located.*

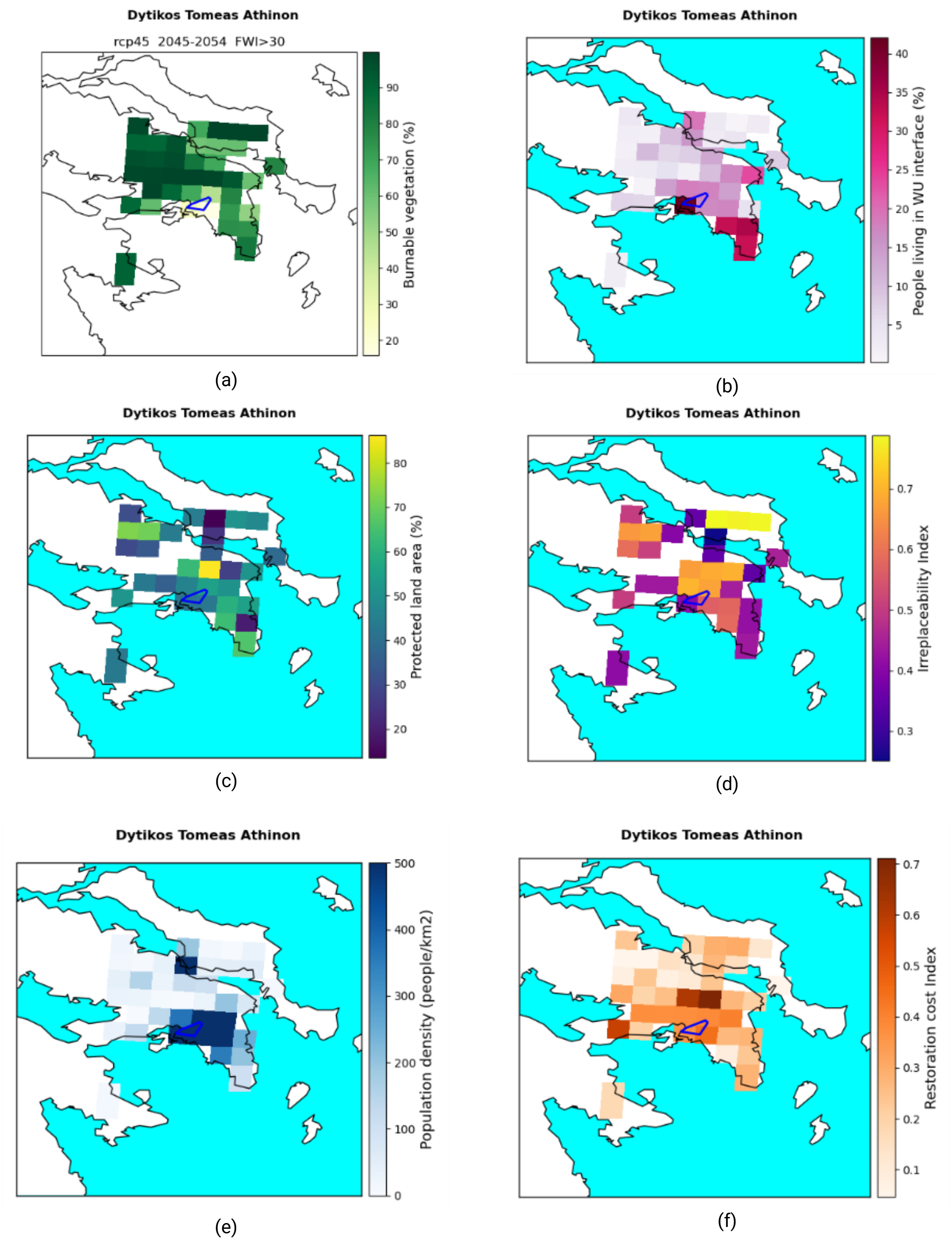


Figure 2.16 Geographical distribution of (a) burnable vegetation (%), (b) people living in Wildland Urban Interface (%), (c) protected areas fraction (%), (d) irreplaceability index, (e) population density (people/km^2) and (e) restoration cost index for the period 2045-2054, based on RCP4.5 over the greater area of Attica. The blue frame includes Dytikos Tomeas Athinon, where Aigaleo is located.

The final output of the risk analysis is illustrated in Figure 2.16. This figure illustrates the geographical distribution of seasonal FWI, highlighting the areas of highest and lowest fire risk with red and green dots, respectively. It is based on the Wildfire (FWI) risk assessment workflow, which considers hazard, vulnerability, and exposure data and uses the Pareto analysis described in Section 2.3.1.1 of the first deliverable. According to the results, the blue outlined areas, where Aigaleo is located, are characterised as high fire risk.

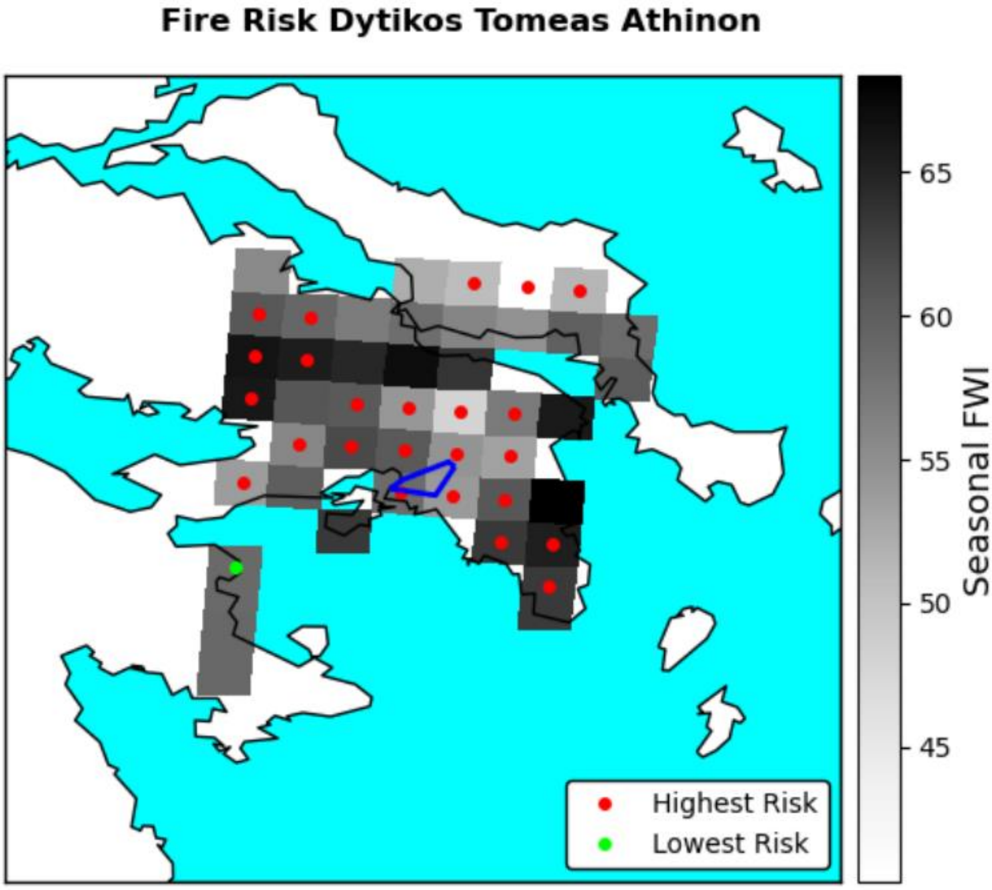


Figure 14. Geographical distribution of seasonal FWI (colors) and Fire Risk (red and green dots) for the period 2045-2054, based on RCP4.5 over the greater area of Attica. The blue frame includes Dytikos Tomeas Athinon,, where Aigaleo is located.

2.4. Key Risk Assessment Findings

2.4.1. Mode of engagement for participation

The engagement process for risk evaluation in Phase 2 was designed as an iterative, two-tiered model aimed at progressing from co-creation to validation.

- Tier 1 - Technical Deep-Dive (Monthly Focus Groups): This core group of municipal department experts (Social Services, Civil Protection, Technical Services, Planning & Development, Municipal Police) and NCSR Demokritos researchers served as the technical evaluators. Their role was to scrutinise the CLIMAAX workflow outputs, integrate local data, and formulate the preliminary risk indicators and maps. Engagement here was continuous and analytical.
- Tier 2 - Community Validation (Participatory Workshops): A broader group of stakeholders (including school teachers, the Parents' Association, NGOs like IASIS, EPOMEA volunteers, local businesses, and engineers) was engaged to ground-truth and validate the technical evaluations. Their role was to provide reality checks, prioritise concerns, and ensure the risks reflected lived experience.

Reflection on Feedback Regarding the Risk Assessment

The feedback collected during this process was essential in turning the risk assessment from a purely technical task into a tool that is relevant to the local context. Key reflections include:

- **Validation of Core Hazards, Challenge of Scale:** Stakeholders unanimously identified heatwaves and wildfires as the top hazards. However, they consistently reported that the local severity and personal impact of these hazards (e.g., indoor heat discomfort, wildfire smoke effects) appeared more intense than some initial model predictions indicated. This emphasised the vital need to incorporate local socio-economic and infrastructural vulnerability data (e.g., building quality, population density) into climate hazard models, which became a key focus of the refinement.
- **Identification of Systemic Vulnerabilities:** Discussions extended beyond physical hazards to explore systemic risk pathways. For instance, the connection between heatwaves, poor housing, energy poverty, and health effects on the elderly was prominently highlighted. This direct feedback resulted in the co-definition of specific risk indicators (such as Summer Energy Poverty) and influenced the development of impact chains that illustrate how climate factors can initiate localised social crises.
- **Clarification of Risk Ownership and Use:** The process acted as a practical exercise in clarifying institutional responsibility. Feedback from department representatives directly translated into commitments to use the assessment: Social Services for targeting energy-poor households, Civil Protection for updating emergency plans, and Technical Services for informing infrastructure upgrades. This demonstrates how participatory evaluation connects assessment with actionable outcomes governance.

- **Acknowledgment of Technical and Data Gaps:** A common piece of feedback was recognising the assessment's technical complexity and the ongoing lack of hyper-local data. This honest reflection is a key outcome: it establishes a clear agenda for future capacity building (such as the need for sustained academic-municipal partnerships) and data collection priorities, ensuring the assessment serves as a starting point for an ongoing process rather than a final endpoint.

In conclusion, the mode of engagement ensured that the risk evaluation was not conducted for the community but with it. The feedback did not change the core climate projections but fundamentally reshaped how their implications for Aigaleo were understood, prioritised, and prepared for, ensuring the final assessment is both scientifically robust and socially responsible legitimate.

2.4.2. Gather output from Risk Analysis step

The Summer Energy Poverty risk assessment in Aigaleo evaluates projected increases in Cooling Degree Days (CDD) under climate scenarios RCP4.5 and RCP8.5, combined with high-resolution data on building density and socio-economic vulnerability. Using Land Surface Temperature (LST) and municipal GIS data, the analysis produces neighbourhood-scale risk maps that classify cooling energy demand risk from very low to very high. These outputs feed directly into the evaluation of risk severity, urgency, and priority, highlighting hotspots where heat exposure, inefficient housing, and social fragility intersect—guiding targeted adaptation in Phase 3.

2.4.3. Assess Severity

The severity of current and future Summer Energy Poverty risk was assessed by combining projected Cooling Degree Days (CDD) with local building vulnerability and socio-economic data. Current risk was classified as Substantial due to high existing vulnerability in older housing and energy poverty. Under RCP8.5 in the distant future, severity escalates to Critical, as extreme cooling demand intersects with persistent socio-economic fragility, threatening health, well-being, and social stability. This classification reflects both the magnitude of projected hazard increase and the limited adaptive capacity of vulnerable communities populations.

Table 2.18 Summary of severity assessment by hazard workflow.

HAZARDS	Risks to public health, infrastructure, and food security	Assessment	Severity
1. Summer Energy Poverty	Historic	Numeric and expert agreed	2
	4.5 NF	Numeric and expert agreed	3
	8.5 NF	Numeric and expert agreed	3
	4.5 FF	Numeric and expert agreed	3
	8.5 FF	Numeric and expert agreed	3

2. Building's exposure to HWs	Historic	Numeric and expert agreed	1
	4.5 NF	Numeric and expert agreed	2
	8.5 NF	Numeric and expert agreed	2
	4.5 FF	Numeric and expert agreed	2
	8.5 FF	Numeric and expert agreed	2
3. Heatwave Risk Assessment	Historic	Numeric and expert agreed	2
	4.5 NF	Numeric and expert agreed	3
	8.5 NF	Numeric and expert agreed	3
	4.5 FF	Numeric and expert agreed	4
	8.5 FF	Numeric and expert agreed	4
4. Health exposure to HWs	Historic	Numeric and expert agreed	2
	4.5 NF	Numeric and expert agreed	3
	8.5 NF	Numeric and expert agreed	3
	4.5 FF	Numeric and expert agreed	4
	8.5 FF	Numeric and expert agreed	4
5. Workers' exposure to HWs	Historic	Numeric and expert agreed	2
	4.5 NF	Numeric and expert agreed	2
	8.5 NF	Numeric and expert agreed	2
	4.5 FF	Numeric and expert agreed	3
	8.5 FF	Numeric and expert agreed	3
Wildfire (FWI) workflow	Historic	Numeric and expert agreed	2
	4.5 NF	Numeric and expert agreed	3
	8.5 NF	Numeric and expert agreed	3
	4.5 FF	Numeric and expert agreed	3
	8.5 FF	Numeric and expert agreed	3

2.4.4. Assess Urgency

The urgency of Summer Energy Poverty was assessed by examining the rate at which hazard intensity increased and considering the existing social vulnerability timeline. The risk shifts quickly from present to future scenarios, with Cooling Degree Days projected to rise sharply under RCP8.5 by mid-century. Given the slow progress of building retrofit programmes and the immediate health threats faced by vulnerable groups during heatwaves, the urgency assessment for Summer Energy Poverty was based on the projected increase in Cooling Degree Days (CDD) from historical to future levels, combined with expert input from municipal and NCSRD specialists.

The sharp rise in CDD under RCP8.5 by mid-century, coupled with ongoing socio-economic vulnerability identified in stakeholder workshops, suggests that the risk will increase rapidly. Given the slow progress of building retrofits and immediate health threats to vulnerable populations, the situation was classified as Immediate Action Needed. This highlights the urgent need for quick intervention in energy support, housing upgrades, and community cooling strategies. The risk category was designated as Immediate Action Needed, emphasising the pressing requirement for proactive cooling assistance, energy upgrades, and social protection measures to prevent escalating health and equity issues.

Table 2.19 Summary of urgency assessment by hazard workflow.

HAZARDS	Risks to public health, infrastructure, and food security	Assessment	Urgency
Urban heatwaves	1. Summer Energy Poverty historic	Hazard change and FC validated	4
	2. Building's exposure to HWs	Hazard change and FC validated	4
	3. Heatwave Risk Assessment	Hazard change and FC validated	4
	4. Health exposure to HWs	Hazard change and FC validated	4
	5. Workers' exposure to HWs	Hazard change and FC validated	4
Wildfire (FWI) workflow	FWI Risk assessment	Hazard change and FC validated	2

2.4.5. Understand Resilience Capacity

The resilience capacity of Aigaleo to its key climate risks has been assessed across five capital types (Financial, Social, Human, Physical, Natural) and categorised as Low, Medium, Substantial, or High. This assessment reflects the current situation, considering existing measures and the significant constraints highlighted during stakeholder engagement process.

Existing Climate Risk Management Measures:

- **Financial Capacity**: The municipality utilises competitive EU project funding (e.g., TransformAr, Med-IREN, Rock the Block) for pilot initiatives. National programmes like "EKSIKONOMO" (home energy upgrade scheme) offer subsidies for household energy improvements, and the winter heating allowance is available for vulnerable groups. However, there is no equivalent support for summer cooling, highlighting a significant gap in tackling summer energy poverty..
- **Social & Human Capacity**: The established stakeholder network from the CLIMAAX participatory process is a valuable asset. Regular training sessions are held for the Civil Protection Department and municipal staff. The municipality actively engages in public awareness campaigns..

- Physical & Natural Capacity:
  - **Plans & Data:** The city has a Sustainable Energy and Climate Action Plan (SECAP) and benefits from the TransformAr environmental monitoring network.
  - **Cooling Infrastructure:** Official municipal cooling centres are designated and operate during heatwaves.
  - **Building Stock:** A major EU project, Rock the Block, is already in the process of energy and aesthetic renovation of 10 apartment buildings, with some flats allocated for vulnerable households at affordable rents.
  - **Wildfire Prevention:** The Aigaleo Grove undergoes annual maintenance (firebreak clearing) in collaboration with forest services. The Med-IREN project will trial nature-based solutions in a central area, aiding urban cooling and water management.

Identification of Weak Spots & Capacity Gaps:
The assessment identifies systemic weaknesses that limit resilience:

- Fragmented and Non-Guaranteed Funding: The heavy dependence on short-term, competitive external grants prevents long-term, strategic investments in resilience infrastructure (e.g., retrofitting all public buildings, creating a robust green network). There is no consistent, annual public funding stream dedicated to municipal climate adaptation measures.
- Gaps in Critical Infrastructure: Most municipal public buildings (schools, service centres) are not energy-efficient or climate-proofed, resulting in high operational costs and inadequate protection during extreme heat or cold for both users and the municipal budget.
- Limitations in Early Warning & Targeting: There is no integrated, real-time early warning and information system (for example, a dedicated app) to proactively reach and protect highly vulnerable groups, such as the elderly, during heatwaves.
- Governance & Regulatory Hurdles: challenges remain in enforcing vegetation management on private land within the Wildland-Urban Interface (WUI), resulting in ongoing, unaddressed local fire-risk hotspots.

Specific Planned Interventions:

The primary planned intervention is the formal integration of the CLIMAAX risk maps and indicators into the upcoming revision of the city's SECAP and Civil Protection Plan. This will translate identified risks into targeted actions, such as prioritising building upgrades in high-risk zones and designing evidence-based nature-based solutions. The continuation of the participatory working model established by CLIMAAX is also seen as a key intervention to maintain capacity and social cohesion engagement.

In summary, while there is growing institutional awareness and stakeholder engagement, the lack of dedicated municipal budgets, the slow rollout of retrofits, and constrained social service capacity limit overall resilience, necessitating strengthened governance and sustained investment.

Table 2.20 Assessment of resilience capacities by hazard workflow.

HAZARDS	Risks to public health, infrastructure, and food security	Assessment	Resilience Capacities

Urban heatwaves workflow	1. Summer Energy Poverty historic	Focus Groups	2
	2. Building's exposure to HWs	Focus Groups	1
	3. Heatwave Risk Assessment	Focus Groups	2
	4. Health exposure to HWs	Focus Groups	1
	5. Workers' exposure to HWs	Focus Groups	2
Wildfire (FWI) workflow	FWI Risk assessment	Focus Groups	3

2.4.6. Decide on Risk Priority

These scores were then cross-referenced in the evaluation dashboard's risk matrix. Risks with high Severity and Urgency scores, combined with low capacity scores, were escalated to High Priority. This objective scoring was subsequently validated and refined during participatory stakeholder workshops, ensuring that the priorities reflected both scientific analysis and local expertise judgement.

Table 2.21 Risk priority by hazard workflow and risk assessment analysis.

HAZARDS	Risks to public health, infrastructure, and food security	Severity		Urgency	Capacity	Risk Priority
		C	**F**			
Urban heatwaves workflow	1. Summer Energy Poverty	2	3	4	2	Very High
	2. Building's exposure to HWs	1	2	4	1	Medium
	3. Heatwave Risk Assessment	2	4	4	2	High
	4. Health exposure to HWs	2	4	4	1	Very High
	5. Workers' exposure to HWs	2	4	4	2	Medium
Wildfire (FWI) workflow	FWI Risk assessment	2	3	2	3	Low

2.5. Monitoring and Evaluation

During the second phase of climate risk assessment, a more consolidated overview of the existing and/or anticipated heatwave and wildfire risk was made.

The main challenges encountered during this period are related to updating the workflows. Even for experienced programmers, generating the necessary spatial mapping and processing remains quite difficult. Data ingestion from external sources (netcdf files) was not straightforward.

A few technical observations have emerged that are worth highlighting, as they directly impact the flexibility and overall performance of the analysis. First, an important point concerns the format of the input datasets. CLIMAAX is primarily designed to handle data in a Copernicus format; however, in our case, the new datasets we introduced were produced using a different map projection. This caused a minor difficulty in reading and processing the data properly, making it necessary to convert them to ensure compatibility with the existing model framework. This issue became more pronounced when multiple points were used (more than four), where the workflow proved to be more problematic and less stable.

Additionally, a second important observation concerns the spatial scale of the analysis. Currently, CLIMAAX performs the analysis primarily at the municipality level, which can restrict its usefulness for studies requiring finer spatial resolution. Consequently, further transformations and adjustments were necessary to downscale the analysis and better suit the specific needs of our application. Overall, these points indicate that although CLIMAAX is a highly valuable tool, there is potential for improvement in its compatibility with different data projections and in increasing the flexibility of the analysis across multiple spatial levels scales.

The Phase 2 work confirmed that the core technical and data-related challenges identified in Phase 1 are systemic. These include:

1. **Technical Complexity of Workflows:** Updating and running the CLIMAAX workflows, including spatial processing and ingesting data from external sources (e.g., netCDF files), remains highly complex, even for experienced programmers, creating a significant technical barrier for municipalities.
2. **Persistent Data Limitations:** As noted in Phase 1, the coarse spatial resolution of core datasets (e.g., EuroHEAT, FWI, WorldPop) makes them unsuitable for capturing local patterns in a municipality as small as Aigaleo. The Phase 1 finding that "WorldPop data overestimate population density on major avenues" was a critical insight that guided our search for local data.
3. **Lack of Comparability and Transparency:** The Phase 1 conclusion that "CRA results for heatwaves and wildfires are not directly comparable" due to differing scales and methodologies highlights a fundamental limitation for integrated risk prioritisation.

The main challenge in Phase 2 was therefore not identifying new problems, but implementing solutions to these known constraints within the project's resources. This was achieved by shifting focus from generating new model outputs to thoroughly contextualising existing ones with local data knowledge.

Stakeholder Role and Feedback:

Stakeholder feedback in Phase 2 evolved from that in Phase 1. While Phase 1 feedback described the process as "straight-forward," engagement in Phase 2 revealed a more nuanced perspective: stakeholders appreciated the final, interpreted results but reiterated the limitations of the underlying data. They consistently noted that impacts experienced locally felt more severe than some model outputs indicated, directly echoing the Phase 1 concern about coarse data resolution. This feedback was vital; it shifted the discussion from "what do the models say?" to "how do we layer our local reality onto these models to make them actionable?" – leading directly to the co-creation of the six local indicators.

Ensuring Learning, Data Gaps, and Future Needs

Phase 2 represented a strategic learning approach. Instead of attempting to fix the unfixable (e.g., the resolution of pan-European climate models), we concentrated on what the municipality could do control:

- **Learning Applied:** We addressed the "coarse data" issue by systematically integrating high-resolution local datasets (municipal GIS, TransformAr station data, social registries).
- **New Data & Remaining Gaps:** The primary "new data" consisted of this localised vulnerability and exposure information. However, significant gaps remain, as identified in Phase 1: the need for better-documented vulnerability datasets, consistent spatio-temporal frameworks across hazards, and tools for modelling specific impacts like wildfire spread at the local level scale.
- **Future Need:** The fundamental need persists for accessible, high-resolution climate and vulnerability services tailored to local authorities, along with improved municipal technical capacity to manage and analyse complex data.

Communication of Outcomes and Institutionalisation:

The final CRA outcomes will be communicated via the municipal website, NCSRD platforms, and a public presentation. Importantly, the process will continue beyond the project. Ongoing collaboration with NCSRD on environmental projects will provide a direct channel for utilising these results in future initiatives. Additionally, the network of engaged stakeholders and the cross-departmental working model established through the Focus Groups will be actively employed in ongoing and future projects, ensuring the CRA findings inform tangible actions.

Process Efficiency and Perceived Impact:

The resource strategy in Phase 2 responded directly to lessons from Phase 1. We optimised the use of time and staff by utilising NCSRD for complex technical workflow operations, while directing municipal staff towards local data collection, stakeholder engagement, and result interpretation. This division of labour proved effective. The main impact of the CRA is that it transformed a technically difficult process with data limitations into a socially and politically relevant evidence base. It has fostered a shared understanding of risk priorities across departments, provided a solid justification for seeking targeted funding (e.g., for building retrofits in high-risk zones identified with local data), and strengthened institutional capacity by creating a common language around climate risk among technicians, policymakers, and the community.

2.6. Work plan Phase 3

Main Activities, Rationale, and Methodology:

1. **A3.1 Development of a Scalable Policy Canvas (M16):**
    - **What & Why:** This activity will synthesise the key risk assessment findings (including the six local indicators and impact chains) into a strategic policy document. The canvas will explicitly map identified risks to potential policy interventions at municipal, regional, and national levels, while also highlighting institutional and regulatory roadblocks. Its purpose is to create a direct, actionable link between scientific assessment and political decision-making.
    - **How:** The canvas will be developed by the core team, directly incorporating inputs from Aigaleo's Strategic Plan and relevant findings from previous projects (e.g., the resilience plan from C2IMPRESS). It will serve as the foundational document for subsequent participatory workshops.
2. **A3.2 Participatory Adaptation Workshops (M17-M22):**
    - **What & Why:** A series of workshops will reconvene the project's stakeholder network, including municipal departments, community groups, NGOs, and technical experts. The main aim is to co-design specific adaptation measures and policies based on the Policy Canvas and the validated risk maps.
    - **How:** The workshops, scheduled for early 2026, will be structured to present the climate risk profile of Aigaleo and facilitate discussions on specific solutions and interventions. A key focus will be ensuring a just transition, addressing the vulnerabilities identified in Phase 2 (e.g., energy poverty, exposure of outdoor workers). This activity is the core of translating assessment into action.
3. **A3.3 Awareness Raising and Strategic Scaling (M19-M22):**
    - **What & Why:** This activity concentrates on sharing results and encouraging collaboration beyond the immediate project scope to maximise impact.
    - **How:** It involves two parallel tracks:
        - **Local/Regional Uptake:** Engaging the West Athens Functional Urban Area (FUA) and neighbouring municipalities to present the methodology and findings, encouraging replication.
        - **Scientific & European Integration:** Connecting project outcomes with broader European initiatives, particularly by linking data and practices to projects like CA4EOSC (for data FAIRification) and JustSafe, thereby ensuring interoperability and contributing to the European climate adaptation knowledge base.
4. **A3.4 Open Advocacy and Formalisation Meeting (M21):**
    - **What & Why:** The final major stakeholder event aims to obtain formal political endorsement for the main outputs of the project.
    - **How:** A high-level meeting with the municipal administration and council will take place to present the consolidated Policy Paper (derived from the Canvas) and a summary of a heatwave emergency plan. The aim is to promote the official adoption and integration of these documents into the city's operational and strategic planning frameworks.

Focus on Follow-up from Phase 2:

Phase 3 is explicitly designed to build on the outcomes of Phase 2. The validated risk hotspots, local indicators, and impact chains will directly inform the Policy Canvas (A3.1), ensuring that adaptation measures are targeted both geographically and thematically. The Participatory

Workshops (A3.2) will use these earlier findings as the non-negotiable starting point for discussions, asking stakeholders "*Given these specific risks we have agreed upon, what should we do about them?*"

Limitations and Aspects Not Studied:
Phase 3 will concentrate on planning, policy formulation, and governance integration. It will not involve:

- Detailed engineering designs or cost-benefit analyses for specific infrastructure projects (e.g., precise blue-green infrastructure plans). This level of detail requires further, dedicated project development.
- • The physical implementation or construction of adaptation measures. This phase aims to produce robust plans and secure political mandate necessary to secure funding and initiate implementation in a post-project phase.
- • A comprehensive update of all municipal regulatory frameworks. The focus is on developing targeted, evidence-based policy proposals (such as the heatwave plan) that can be incorporated into existing systems.

3. Conclusions Phase 2- Climate risk assessment

During this project phase, the present work confirmed that the core technical and data-related challenges identified in Phase 1 are systemic. The main difficulties were connected to a) the technical complexity of workflows for regenerating high-resolution spatial mapping and processing needed from external sources, the persistent data limitations (especially social datasets), which are unsuitable for capturing local patterns in a municipality as small as Aigaleo, and 3) the lack of comparability and transparency of hazards across different scales and methodologies, posing limitations for integrated risk prioritisation. Therefore, the main difficulty in Phase 2 was not discovering new challenges, but operationalising solutions to these known constraints within the project's resources. This was achieved by shifting focus from generating new model outputs to deeply contextualising existing ones with local data and knowledge.

The evaluation framework across hazards such as summer energy poverty, building exposure to heatwaves, heatwave risk, health exposure, workers' exposure, and wildfire risk for severity combines historical data with future scenarios (4.5 and 8.5, near- and far-future). Severity levels generally rise under future scenarios compared to historical conditions, highlighting a clear escalation of risk due to climate change. For most heat-related hazards (buildings, health, workers, and heatwave risk), severity typically increases from moderate (2) under historical conditions to moderate–high or high (3–4) under future scenarios. Summer energy poverty is already at a moderate level historically (2) and rises to higher severity (3) under all future scenarios, indicating growing pressure on households and infrastructure. Wildfire risk (FWI) remains consistently moderate (2–3), with higher values projected under future climate conditions, regardless of scenario. Overall, the severity assessment indicates a systematic intensification of climate-related risks, especially heat-related impacts, with implications for public health, infrastructure, and food security.

All urban heatwave risks are assessed through hazard change and FC-validated evaluations, emphasising strong confidence in the identified urgency. Urban heatwaves are recognised as the most urgent hazard, with all related risk categories (summer energy poverty, buildings, heatwave risk, health, and workers' exposure) assigned the highest urgency level (4). The consistently high urgency scores indicate that heatwave-related impacts pose immediate and serious risks to public health, infrastructure, and food security. In contrast, the wildfire (FWI) workflow is given a moderate urgency level (2), suggesting that while wildfire risk is important, it is less immediate than heatwave threats in the study area. Urgency assessment highlights a clear prioritisation of adaptation and mitigation actions for urban heatwaves, with wildfire risk a secondary, yet still relevant, concern.

Regarding resilience capacities, it was observed that although there is growing institutional awareness and stakeholder engagement, the absence of dedicated municipal budgets, slow retrofit implementation, and limited social service capacity restrict overall resilience, highlighting the need for strengthened governance and sustained efforts investment.

In conclusion, the risk of heatwaves is classified as a high priority, indicating significant impacts that require strong policy and planning responses. Summer energy poverty and health exposure to heatwaves emerge as the most critical risks, both ranked as Very High priority, due to consistently high urgency and limited resilience capacity. The results clearly show that heatwave-related risks should be the primary focus of adaptation and resilience strategies, while wildfire risk, although relevant, represents a lower immediate priority in the study area.

4. Progress evaluation

The connection between this deliverable, its outputs and the planned activities for the following phases of the project can be summarised in the following:

1. **From Risk Assessment to Policy Development (A3.1)**
   The **Scalable Policy Canvas** in Phase 3 will **directly incorporate** the six local risk indicators and risk maps from Phase 2. For example:
   - The **"Summer Energy Poverty" indicator** will inform policies related to energy subsidies, building retrofits, and cooling assistance.
   - The **"Health Exposure to HWs" maps** will guide the placement of health interventions and cooling centres.
2. **From Data to Co-Design (A3.2)**
   The **Participatory Adaptation Workshops** will use the **risk maps and impact chains** from Phase 2 as **starting points for discussion**. Stakeholders will be asked:
   - *"Given the high risk in these neighbourhoods, what specific actions should we take?"*
   - *"How can we address the vulnerability pathways we identified?"*
3. **From Local Insights to Regional Scaling (A3.3)**
   The **Awareness Raising** activity will **share Phase 2 methodologies and findings** with the **West Athens Functional Urban Area (FUA)** and other municipalities. The localised approach and stakeholder model from Aigaleo can serve as a **blueprint for replication**.
4. **From Evidence to Advocacy (A3.4)**
   The **Open Advocacy Meeting** will present the **Policy Canvas** and a **heatwave emergency plan** derived from Phase 2 risks. The goal is to secure **formal adoption** by the municipal council, turning assessment into **official policy**.

How Phase 2 Sets the Foundation for Phase 3

- **Phase 2 answered:** *"Where are the risks, who is affected, and why?"*
- **Phase 3 will answer:** *"What should we do about it, and how do we make it happen?"*

The **outputs of Phase 2 can be viewed as** they are **decision-support material** that will be actively used in Phase 3 to:

- **Target interventions** geographically with an important social footprint.
- **Justify funding and policy changes**.
- **Engage stakeholders** with clear, localized evidence.

Within the proposal AGL has proposed the following set of indicators (KPI) to monitor the progress of the CLISTHENES project. The progress of the attainment is depicted in the Table below

Table 4-1 Overview key performance indicators

KPI number	Description	Progress at M6
KPI1 (@M3)	20 staff members of EGL and NCSRD trained in the CLIMAAX approach	Done at phase 1
KPI2 (@M7)	5 new climate indicators related to vulnerable communities identified	Achieved – section 2.3.1 to 2.3.5
KPI3 (@M15)	3 impact chains identified and validated	Achieved – Annex Section 1
KPI4 (@M7, M15)	2 on-site meetings	1 performed at M6
KPI5 (@M15)	8 validation events conducted with local representatives	Achieved – section 2.1.5
KPI6 (@M22)	1 scientific publication produced	In progress
KPI7 (@M22)	20 posts made on EGL's and NCSRD's social media	10 posts made
KPI8 (@M16)	1 scalable policy canvas produced	Not started
KPI9 (@M22)	5 meetings conducted with local stakeholders for replication and upscaling	Not started
KPI10 (@M6)	2 workflows successfully applied on D1	Done at phase 1
KPI10 (@M15)	2 workflows successfully applied on D2	Achieved – 5 workslows implemented

Table 4-2 Overview milestones

Milestones	***Progress***
M1 - Successful implementation of the training sessions (M3, P1)	Achieved at phase 1
M2 - Completion of P1.6 (M6, P1)	D1 accepted
M3 - Localized CLIMAAX Methodology (M15, P2)	Validated by local stakeholders CRA for Aigaleo
M4 - Production of A3.1 (M16, P3)	Not started
M5 - Creation of the interventions and policies of PHASE 3 (M22, P3)	Discussion at local workshop – officially due in M17 (workshop planned for Feb 17, 2026)
M6 - Completion of A3.4 (M21, P3)	Not started

Milestones	*Progress*
M7 - Attend the CLIMAAX workshop held in Barcelona. (M8, P2)	Presentation by Dr. Jason Markantonis link here https://climaerel.ipta.demokritos.gr/index.php/2025/06/29/regions-and-municipalities-meet-in-barcelona-at-the-climaax-workshop/
M8 - Attend the CLIMAAX workshop held in Brussels (M15, P2)	Not held yet

5. Supporting

As a complementary document ANNEX_D2_Clisthenes is also attached following the Deliverable 2. Annex contains detailed and supporting information, such as risk workflows, hazard maps, graphs and engagement process documentation.

6. References

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Annex_D2_Clisthenes

TABLE OF CONTENTS

1 DESCRIPTION OF THE DOWNSCALING METHODOLOGY AND RISKS WORKFLOW PROCESS

This section involves primarily the description of the downscaling and re-gridding procedure for the implementation of five risk assessments (applying the urban heatwave workflow). Then, the risk workflow process for each risk assessment is illustrated, along with the description and formulas of the corresponding hazard indicator used for the selected hazards.

1.1 Downscaling from region to urban scale

A spatial downscaling and re-gridding procedure was implemented to translate regional information from 5 × 5 km to the urban scale (30 × 30 m). The study area of Aigaleo is represented by four coarse-resolution grid cells. To capture urban spatial variability, high-resolution data at 30 × 30 m resolution were used as a spatial refinement layer. Each high-resolution cell was assigned to its nearest coarse-resolution grid cell, and mean values were computed for each of the four coarse-resolution grid cells. The high-resolution values were subsequently normalized by dividing them by the corresponding coarse-cell mean, yielding a dimensionless spatial deviation factor that represents local-scale heterogeneity. This deviation factor was then applied to the coarse-resolution for each grid cell, producing downscaled, 30 × 30 m high-resolution estimates suitable for urban risk assessment.

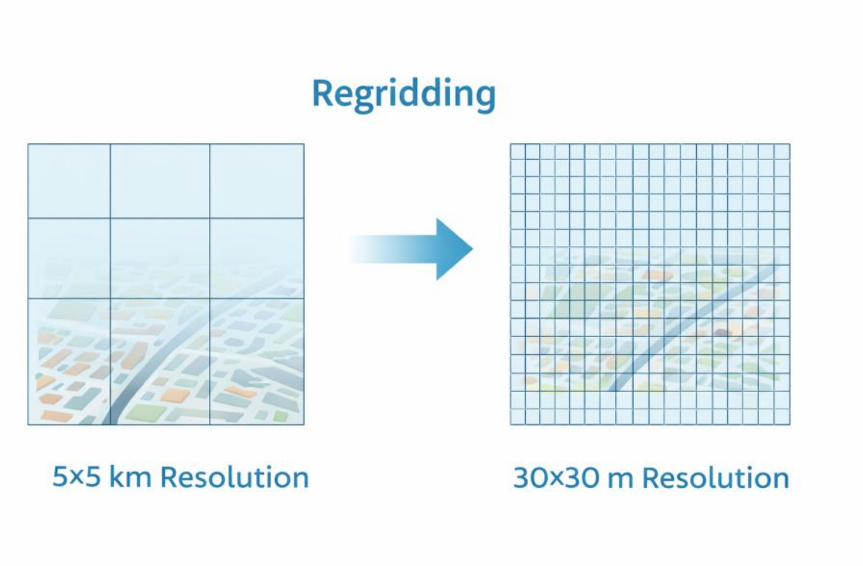

Figure A1.1 Regridding representation from 5x5 km resolution grid to 30x30 m resolution.

1.2 Hazard #1.1 – Summer Energy Poverty

Risk workflow process of hazard #1.1

The primary objective of the energy poverty assessment is to map energy vulnerability across the Municipality of Aigaleo, with a focus on identifying the most at-risk areas. This assessment aims to highlight the need for adequate cooling to ensure thermal comfort and protect the well-being of residents, particularly during the summer months. The overall risk workflow process of summer energy poverty is illustrated in Figure A1.2.

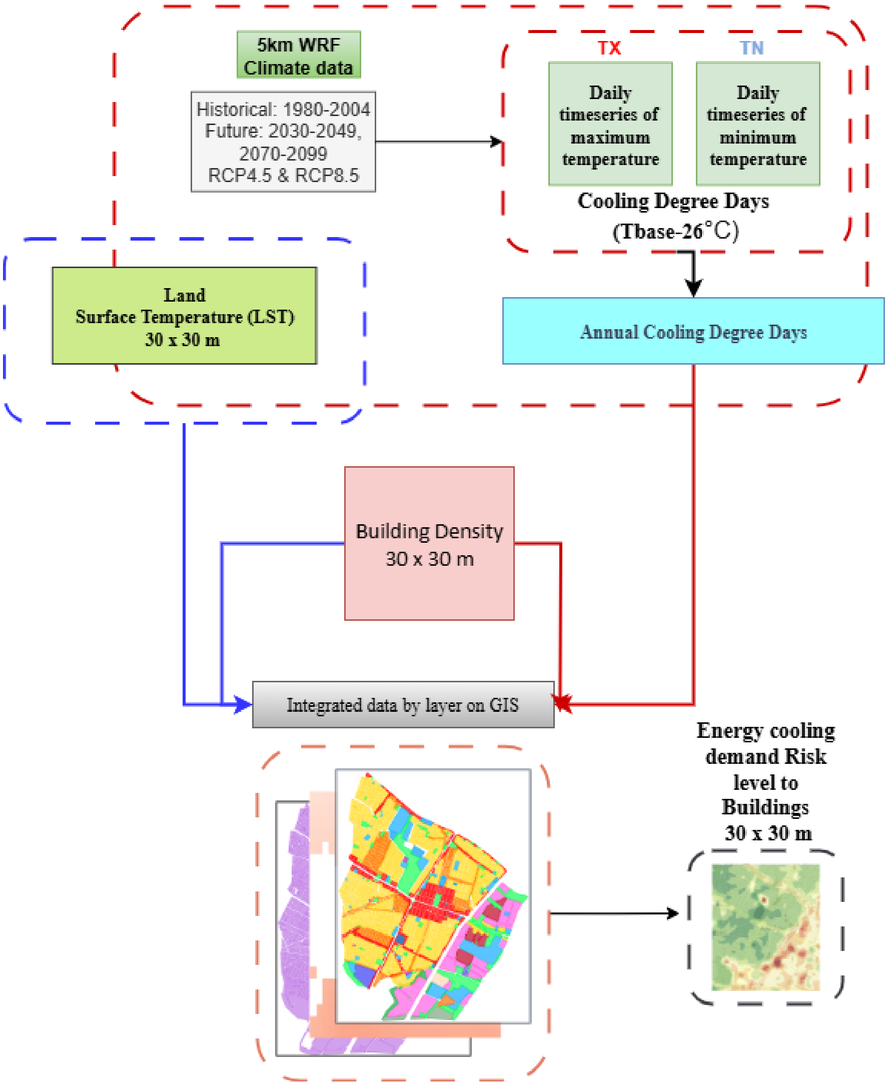

Figure A1.2 Workflow for mapping high-resolution scale cooling energy demand and risk by integrating climate (WRF-derived temperature and cooling degree days), land-surface temperature, and building density in a GIS framework (30 × 30 m resolution) through the CLIMAAX tool.

Description of the hazard: Cooling Degree Days (CDDs)

Cooling Degree Days (CDDs) is a fundamental metric used to measure and predict the energy consumption required for cooling, directly correlating with the prevalence and severity of summer energy poverty. Rising CDD values, driven by climate change and increased heatwaves, highlight a growing public health and social crisis for vulnerable households.

The summer energy poverty assessment applied to Aigaleo is based on the 5km high-resolution historical and future climate datasets to calculate the annual cumulative sum of daily degrees above a daily mean temperature over the summer period, to count the total annual energy consumption required for cooling.

The formulation adopted here is based on daily mean, maximum and minimum temperatures. To calculate Cooling Degree Days (CDD)[1], we calculate the average daily temperature (Max + Min / 2), then subtract the chosen base temperature (Tbase= 26°C, according to Energy Performance of Buildings Regulation - KENAK)[23]; if the result is positive, that's the value of CDD for the day, otherwise it's zero, with totals accumulated over time to estimate cooling energy needs. The time period of calculations is from May to October.

The summer energy poverty risk assessment involved hazard data for the historical and future periods described in subsection (2.2.4), based on the cooling degree days (CDD) as a measure to estimate the energy consumption required for cooling and the vulnerability data represented from the building density. In addition, for the overall assessment, any available and provided information based on several indicators defined by the JRC[4] and other reports[5] from the European Commission (https://energy-poverty.ec.europa.eu/) was considered. The indicators involved low housing quality, affordability and expenditure indicators, energy usage and access indicators, urban environmental factors, and socioeconomic data provided by the Hellenic Statistical Authority and other socioeconomic databases (eg., https://bpes.ypeka.gr/?page_id=21&stat=222). Some information will be visualised spatially for the identification of the affected areas with high cooling energy demand during summer and other information will be summarised in a table (A1.1) to assess the energy state of the whole Municipality.

Table A1.1 Summary of indicators proposed by the European Poverty Advisory Hub for the Municipality of Aigaleo.

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[1] Spinoni, J.; Vogt, J.; Barbosa, P.; Dosio, A.; McCormick, N.; Bigano, A.; Füssel, H.-M. Changes of heating and cooling degree-days in Europe from 1981 to 2100. *Int. J. Climatol.* **2018**, *38*, e191–e208

[2] Spinoni, J.; Vogt, J.; Barbosa, P.; Dosio, A.; McCormick, N.; Bigano, A.; Füssel, H.-M. Changes of heating and cooling degree-days in Europe from 1981 to 2100. *Int. J. Climatol.* **2018**, *38*, e191–e208

[3] Technical Chamber of Greece Technical Chamber of Greece, Technical Guideline 20701-3/2010; Athens (2014)

[4] https://unece.org/statistics/documents/2024/11/presentations/addressing-energy-poverty-local-perspective-analysis

[5] European Commission: Directorate-General for Energy, *Framing summer energy poverty – Insights and recommendations for a resilient future – Final report*, Publications Office of the European Union, 2025, **https://data.europa.eu/doi/10.2833/3135617**

Category	*Indicator*	*Municipality of Aigaleo*
Climate	Cooling Degree Days (CDD)	~200
Low quality housing	Overcrowding	10.206 citizens/km²
	Building Energy Performance Certificate	396 of above *C category* and 22 of *A+, A, B categories*, out of 14259 number of total buildings ([https://bpes.ypeka.gr/?page_id=21&stat=222)](https://bpes.ypeka.gr/?page_id=21&stat=222)
	Total inhabited dwellings Access to Active Cooling	29.734 (Census 2021) 25.511 (85%)
Demographics: elderly, young children, chronic illness, low-income, disability. Vulnerable households or persons / total households or persons	Total population	65.831 (Census 2021)
	Persons aged under 12 and over 65	~14.353 or 21.8% (Census 2021)
	Persons with an education level under lower secondary school	27.606 or ~42% (Census 2021)
	Citizens / households with social support	>1000 citizens (~400 families) (Social Profile of the Municipality of Egaleo, 2021)
	Unemployment rate	4.356 citizens or 13.8% (Census 2021)
Energy expenditure indicators	Citizens / households under poverty threshold / number of citizens / households	2.952 citizens (21,7%) - national threshold (Social Profile of the Municipality of Egaleo, 2021)

1.3 Hazard #1.2 – Buildings Exposure to heatwaves

Risk workflow process of hazard #1.2

The objective of assessing buildings' exposure to heatwave zones is to identify which buildings are most affected by extreme heat, especially during prolonged heatwave events. The findings can support the development of targeted cooling interventions and urban planning strategies aimed at enhancing thermal safety and comfort for occupants, particularly in socio-economically vulnerable neighborhoods. The overall risk workflow process of buildings exposure to heatwaves is illustrated in Figure A1.3.

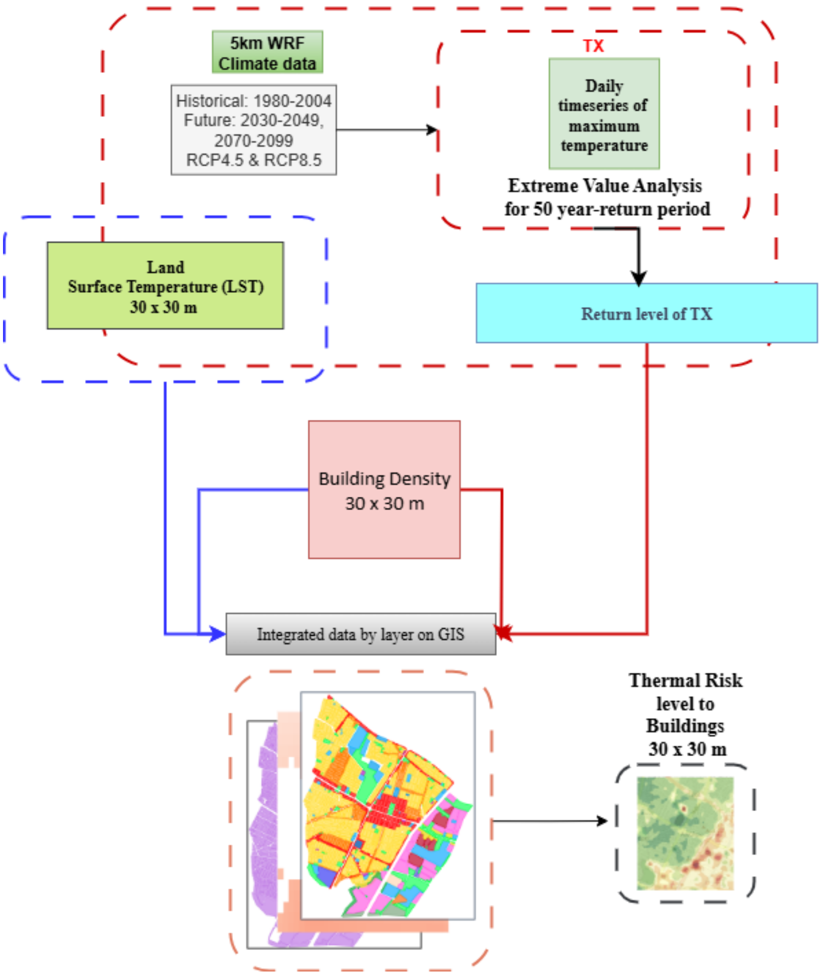


Figure A1.3 Workflow for mapping high-resolution scale thermal risk on buildings by integrating climate (WRF-derived temperature and cooling degree days), land-surface temperature, and building density in a GIS framework (30 × 30 m resolution).

Description of the hazard: Return level of TX

EN 1991-1-5 "Eurocodes 1 – Actions on structures – Part 1-5: General actions – Thermal actions" gives the principles and rules for calculating thermal actions on buildings. The characteristic value of a climatic action (e.g. wind, snow, temperature) is defined so that it is exceeded with an annual probability of 0.02, i.e. corresponding to an average return period of 50 years. Thus, in the case of building exposure to heatwaves, and for the return periods of 50 years, the expected return level of the maximum temperature (TX) was calculated for the historical and future examined periods. The return level was considered as the magnitude of risk. The estimation of the extreme values of TX involved the application of extreme value theory, after applying the 1-year block maxima method to determine the highest values for each year (for extracting the annual maximum series), and fitting to the extreme value distribution, such as the Generalized Extreme Value (GEV) distribution to obtain the return value of the maximum temperature for 50 years.

1.4 Hazard #1.3 – Heatwave risk assessment

Risk workflow process of hazard #1.3

The heatwave risk assessment aims to identify and evaluate areas and population groups within the Municipality of Aigaleo that are most at risk due to extreme heatwave events. It assesses the impact of climate change and social factors that contribute to heat vulnerability and public health risks. The overall risk workflow process of the heatwave risk assessment is illustrated in Figure A1.4.

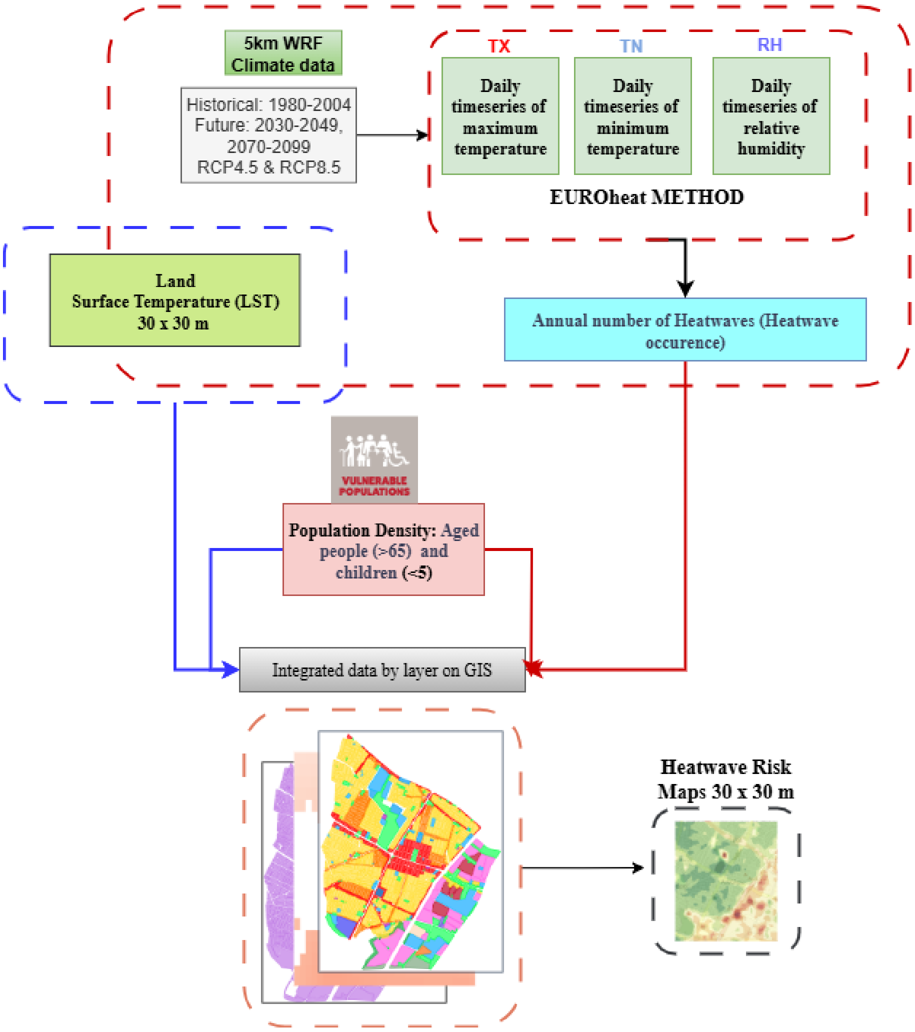


Figure A1.4 Workflow for mapping high-resolution scale heatwave risk by integrating WRF-derived climate variables (TX, TN, RH), land-surface temperature, and vulnerable population data using the EUROHEAT method in a GIS framework (30 × 30 m resolution) through the CLIMAAX tool.

Description of the hazard: Heatwave days

The heatwave hazard assessment involved the integration of regional 5km of spatial resolution climate datasets implemented in the CLIMAAX workflow, for the case of Aigaleo. Similarly to the 1st phase the high-resolution dataset defined the heatwaves based on the Health-related EU-wide definition. Thus, the heatwaves were defined for the summer period of June to August “as days in which the maximum apparent temperature (Tappmax) exceeds the threshold (90th percentile of Tappmax for each month) and the minimum temperature (Tmin) exceeds its threshold (90th percentile of Tmin for each month) for at least two days”. This definition applies thresholds on both minimum and maximum temperatures and thus it accounts for the effect of minimum temperature on the severity of a heatwave.

1.5 Hazard #1.4 – Health Exposure to HW

Risk workflow process of hazard #1.4

The objective of this assessment is to evaluate the health risks associated with exposure to extreme heat and to identify the population groups and geographic areas most vulnerable to heatwave impacts. It aims to examine key determinants of heat-related health outcomes, such as age, pre-existing medical conditions, socio-economic status, housing quality, and access to cooling and healthcare services. By mapping and understanding these health vulnerabilities, the assessment will support the development of targeted heat-health action plans, early warning systems, and public health interventions that reduce heat-related illnesses and mortality, with a particular focus on protecting high-risk populations such as the elderly, infants, chronically ill individuals, and socially isolated residents. The overall risk workflow process of health exposure to heatwaves is illustrated in Figure A1.5.

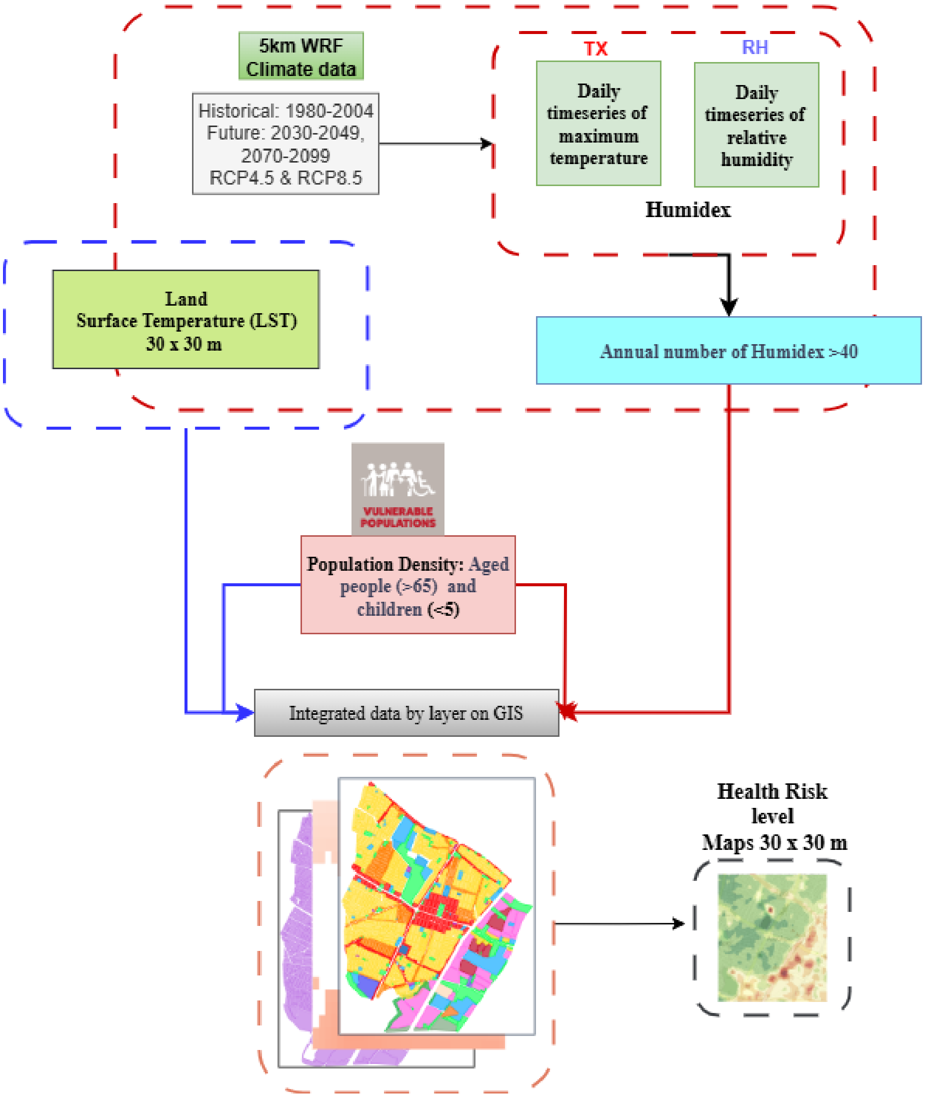


Figure A1.5 Workflow for mapping high-resolution scale health risk due to heatwaves by integrating WRF-derived climate variables (TX, TN, RH) for calculating Humidex days (Humidex>40), land-surface *temperature, and vulnerable population data in a GIS framework (30 × 30 m resolution) through the CLIMAAX tool.*

Description of the hazard: Number of days with Humidex>40

The population's exposure to heatwaves is based on the calculation of the widely used index of thermal discomfort, the humidex and more specifically, the number of days above a certain threshold. The Humidex is a Canadian index used to describe how hot the weather feels to the average person, combining temperature and humidity into a single value in degrees Celsius. The index is categorized into different classes to indicate the level of discomfort and potential health risks. A Humidex above 40 means you will experience great discomfort, and physical exertion should be avoided.

Table A2. Reference legend for Humidex range and degree of comfort

Humidex	***Degree of comfort***
20 - 29	*Little discomfort*
30 - 39	*Some discomfort*
40 - 45	*Great discomfort; avoid exertion*
Above 45	*Dangerous; heat stroke quite possible*

1.6 Hazard #1.5 – Workers' exposure to HWs

Risk workflow process of hazard #1.5

The objective of this assessment is to identify high-risk occupational groups, working conditions within the Municipality of Aigaleo where heat stress poses significant health and productivity risks. The assessment will support the development of targeted action plans and strategies, workplace safety regulations, and adaptation measures to keep outdoor workers safe during extreme heat conditions, such as adjusted working hours, access to shade and hydration, use of protective clothing, and awareness campaigns, to protect the health, safety, and well-being of workers. The overall risk workflow process of outdoor workers' exposure to heatwaves, is illustrated in Figure A1.6.

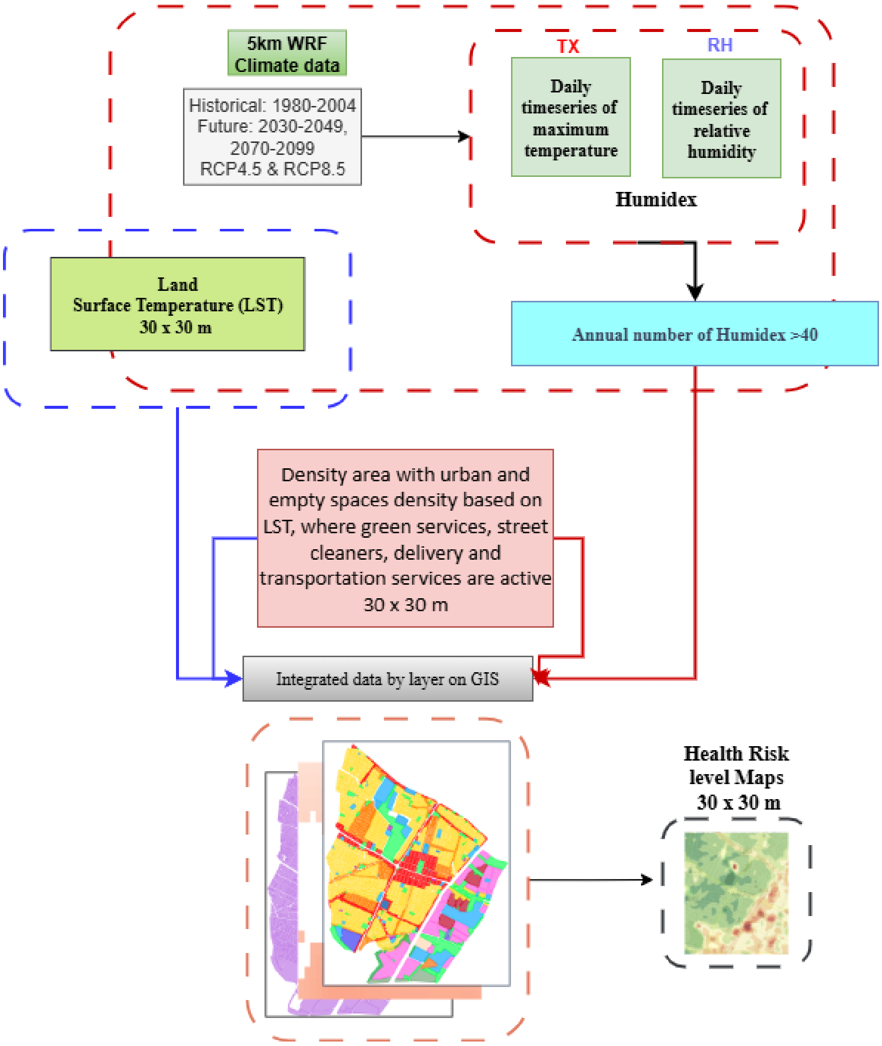


Figure A1.6 Workflow for mapping high-resolution scale heat-stress risk level to outdoor workers by integrating WRF-derived climate variables (TX, TN, RH) for calculating Humidex days (Humidex >40), land-surface temperature, and relevant areas where these people are exposed to heat, in a GIS framework (30 × 30 m resolution).

Description of the Hazard: Number of days with Humidex > 40

In Greek legislation, the WBGT index is referenced in the recent Circular 65581/2023, 56163/2022 of the Ministry of Labour and Social Insurance, which introduced emergency measures to address workers' heat stress, using WBGT as the primary criterion for suspending work or implementing protective measures, when the index exceeds 32.2 °C. The application of these provisions is triggered when the Hellenic National Meteorological Service (HNMS) issues an official announcement declaring the occurrence of heatwave conditions.

However, it should be noted that WBGT ideally requires information on solar radiation and radiant heat (via globe temperature), which were not available; therefore, a simplified temperature–humidity–based WBGT approximation was used despite its known limitations in representing the full heat stress environment.

To approximate the Humidex threshold corresponding to a WBGT value of 32.2, we used a WBGT lookup table (Figure A1.7) based solely on surface air temperature and relative humidity. First, combinations of air temperature and relative humidity producing WBGT values close to 32 were extracted from the table, and linear interpolation was applied where necessary to approximate the target WBGT of 32.2. For each resulting temperature–humidity pair, Humidex was then calculated using the formulation implemented in the "HeatStress" R package. This approach was adopted to establish a practical Humidex threshold consistent with the available WBGT data.

Wet Bulb Globe Temperature (WBGT) from Temperature and Relative Humidity

Temperature (°C)

Relative Humidity (%)	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
0	15	16	16	17	18	18	19	19	20	20	21	22	22	23	23	24	24	25	25	26	27	27	28	28	29	29	30	31	31	32	32
5	16	16	17	18	18	19	19	20	21	21	22	22	23	24	24	25	26	26	27	27	28	29	29	30	31	31	32	33	33	34	35
10	16	17	17	18	19	19	20	21	21	22	23	23	24	25	25	26	27	27	28	29	30	30	31	32	32	33	34	35	36	36	37
15	17	17	18	19	19	20	21	21	22	23	23	24	25	26	26	27	28	29	29	30	31	32	33	33	34	35	36	37	38	39	
20	17	18	18	19	20	21	21	22	23	24	24	25	26	27	27	28	29	30	31	32	32	33	34	35	36	37	38	39			
25	18	18	19	20	20	21	22	23	24	24	25	26	27	28	28	29	30	31	32	33	34	35	36	37	38	39					
30	18	19	20	20	21	22	23	23	24	25	26	27	28	29	29	30	31	32	33	34	35	36	37	39							
35	18	19	20	21	22	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39								
40	19	20	21	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39									
45	19	20	21	22	23	24	25	26	27	27	28	29	30	32	33	34	35	36	37	38											
50	20	21	22	23	23	24	25	26	27	28	29	30	31	33	34	35	36	37	39												
55	20	21	22	23	24	25	26	27	28	29	30	31	32	34	35	36	37	38													
60	21	22	23	24	25	26	27	28	29	30	31	32	33	35	36	37	38														
65	21	22	23	24	25	26	27	28	29	31	32	33	34	36	37	38															
70	22	23	24	25	26	27	28	29	30	31	33	34	35	36	38	39															
75	22	23	24	25	26	27	29	30	31	32	33	35	36	37	39																
80	23	24	25	26	27	28	29	30	32	33	34	36	37	38																	
85	23	24	25	26	28	29	30	31	32	34	35	37	38	39																	
90	24	25	26	27	28	29	31	32	33	35	36	37	39																		
95	24	25	26	27	29	30	31	33	34	35	37	38																			
100	24	26	27	28	29	31	32	33	35	36	38	39																			

WBGT > 40

Note: This table is compiled from an approximate formula which only depends on temperature and humidity. The formula is valid for full sunshine and a light wind

Figure A1.7 Wet bulb globe temperature (in degrees Celcius) relative to relative humidity. Source: https://koreystringer.institute.uconn.edu/wet-bulb-globe-temperature-monitoring/

For relative humidity between 20% and 100%, the above results yield Humidex values ranging approximately from 39.1 to 41.9, with a mean value of about 40.3. Consequently, it was decided to use the number of days with Humidex > 40 for this hazard and risk assessment.

1.7 Hazard #2 -–Wildfires – FWI risk assessment

Risk workflow process of hazard #2

The official Greek fire season runs from May 1st to October 31st; thus, the indicators were calculated and analysed during this period, shifting from the CLIMAAX proposed workflows to the 1st phase of the project that considered FWI values from June to September.

Description of the hazard: FWI indicators

The calculation of the values of the Canadian FWI was performed using the package CFFDRS (https://r-forge.r-project.org/projects/ cffdrs/) of R statistical computing software using as input four weather variables at 12:00 hours: the temperature at 2 m, relative humidity, wind speed at 10 m and daily (total) precipitation.

For each year, the fire season has a duration from May to October for FWI calculations. Moreover, the simulations were initialized one month in advance (in April) in order to equilibrate the model and minimize the effect of errors in the initial conditions used in the FWI calculation. After calculating the daily values of the FWI system for each grid point, emission (RCP) scenario and fire season, the 95th percentile and the number of days with FWI>70 were computed.

2 HAZARD MAPS on AGL scale

This section includes a series of figures illustrating the hazard, vulnerability, exposure and risk data involved in the analysis per risk assessment, that were not included in the Deliverable due to space limitations.

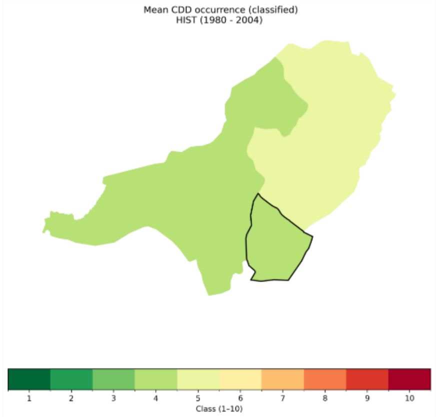
The results are shown for both historical and future periods (RP1: 2020–2049 and RP2: 2070–2099) at multiple spatial scales, including the regional scale (Western Athens, encompassing the Municipality of Aigaleo), the Municipal level, and the urban scale, as High-resolution level.

2.1 Hazard #1.1 – Summer Energy Poverty

2.1.1 Municipality Level

Hazard data

Historical period



Future Projections

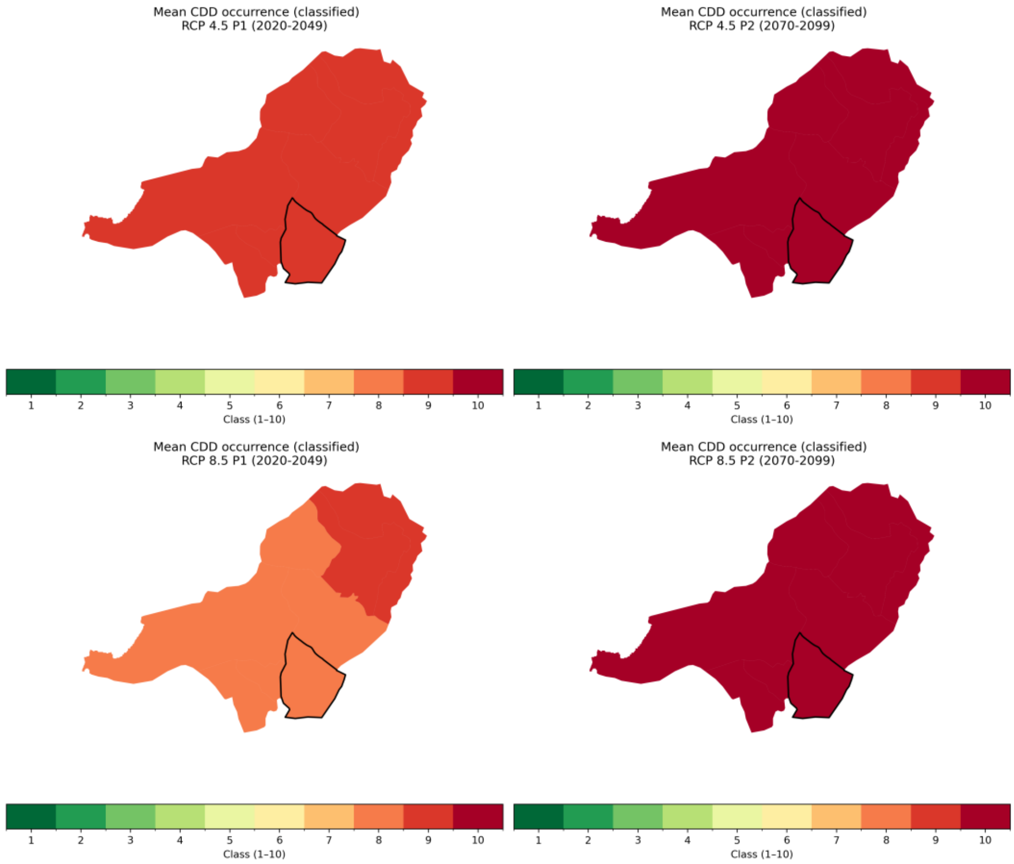


Figure 2.1. Classified (10-classes) mean Cooling Degree Days (CDD) for the historical period 1980–2004 (top) for RCP 4.5 and RCP 8.5 in the near future (RP1:2020–2049) and far future (RP2:2070–2099) periods (bottom).

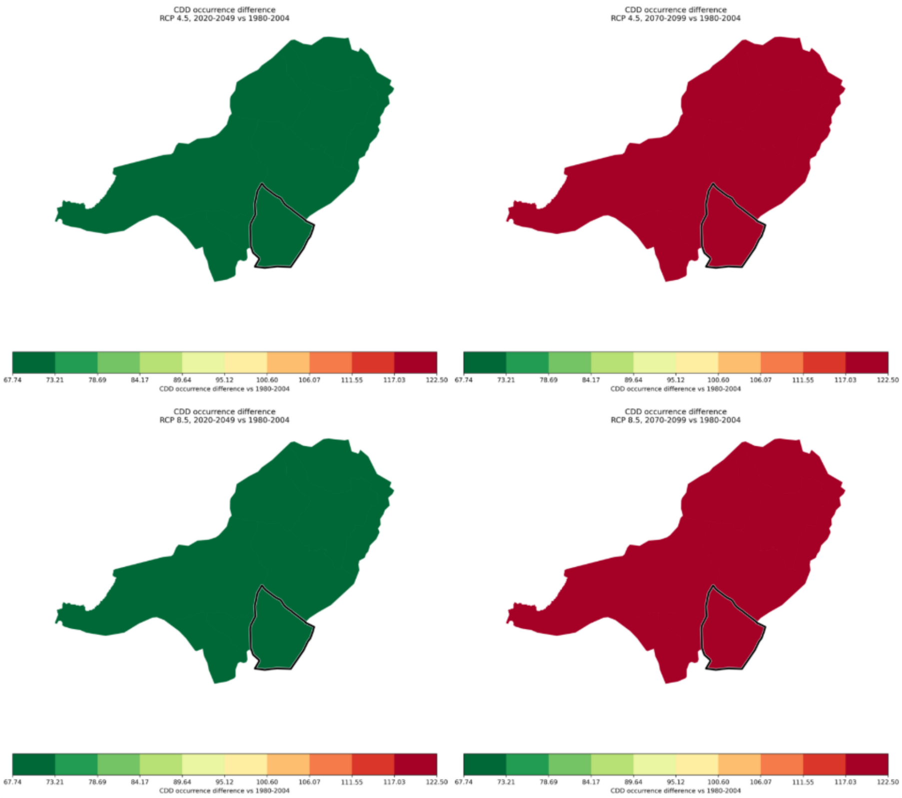
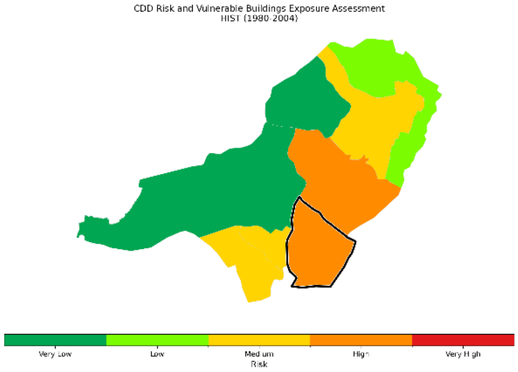


*Figure 2.2. **Absolute changes** in Cooling Degree Days (CDD) relative to 1980–2004 for RCP 4.5 and RCP 8.5 in the near future (RP1) (2020–2049) and far future (RP2) (2070–2099) periods.*

Risk Levels

Historical Period



Future periods

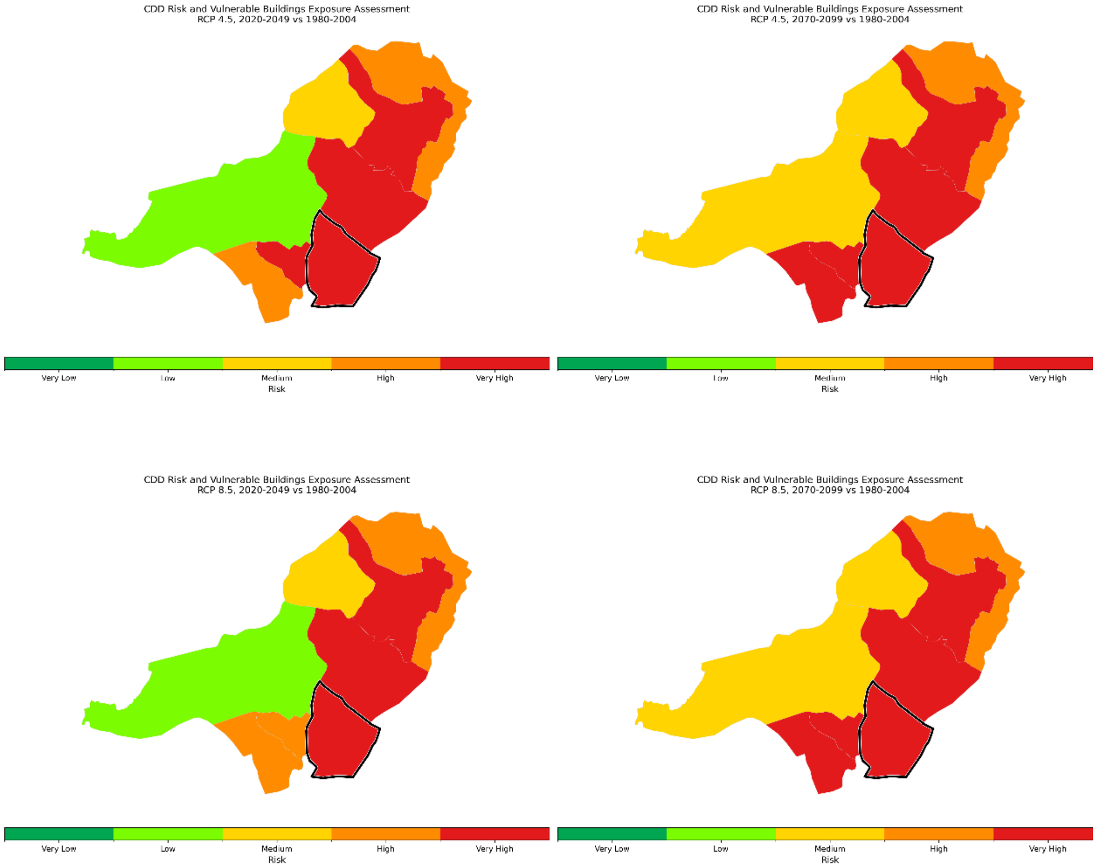


Figure 2.3 5-scale classification of CDD risk to buildings' exposure to HWs in the historical period 1980–2004 and for RCP 4.5 and RCP 8.5 in the near future (RP1:2020–2049) and far future (RP2:2070–2099) periods, for the West Athens and the Municipality of Aigaleo (outlined area).

2.1.2 High-resolution level

Hazard data

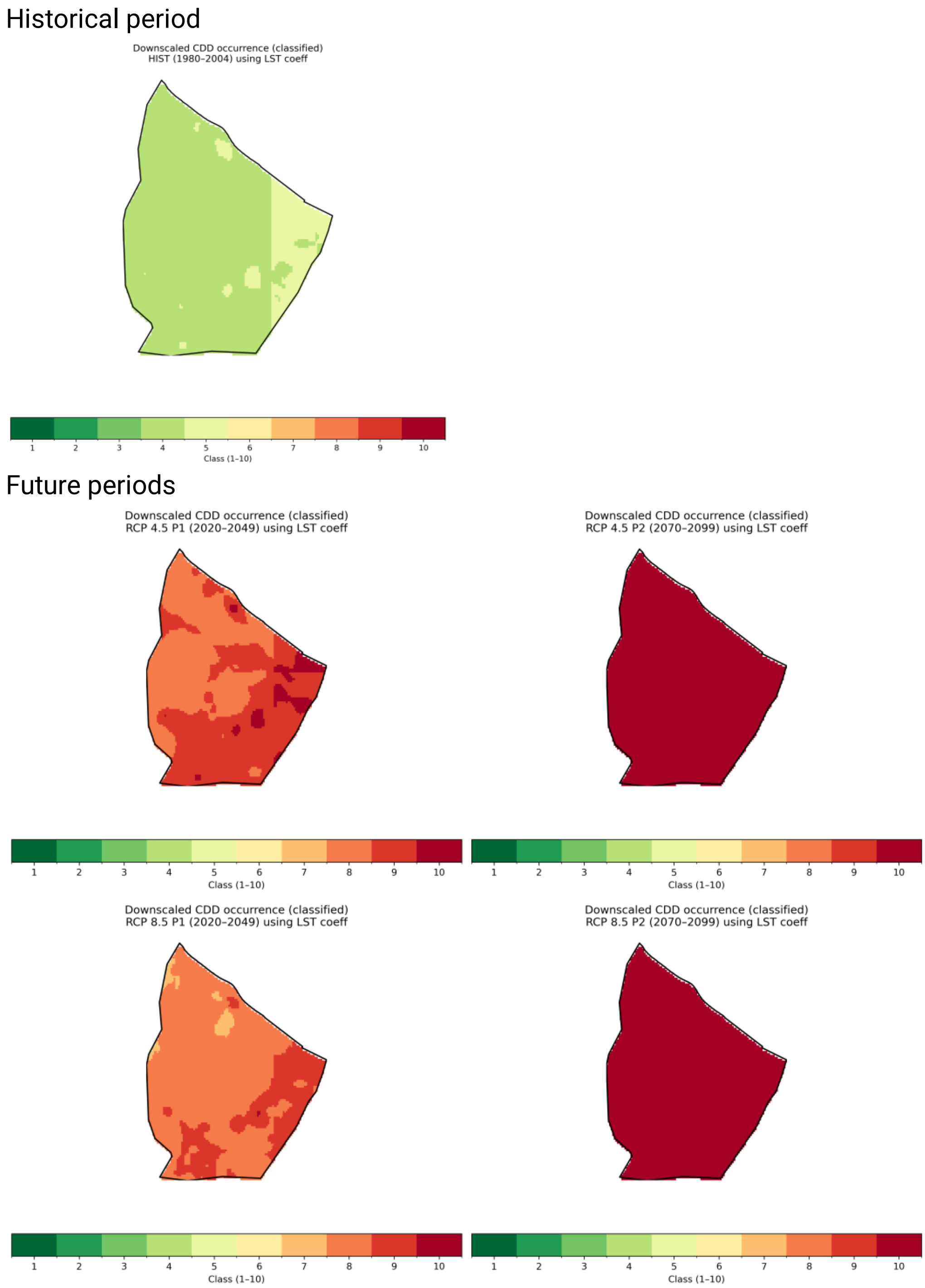


Figure 2.4. High-resolution classified (10-classes) mean Cooling Degree Days (CDD) for the historical period 1980–2004 (top) for RCP 4.5 and RCP 8.5 in the near future (RP1:2020–2049) and far future (RP2:2070–2099) periods (bottom)

Exposure data

Figure 2.5. 5-scale classification heat exposure at high resolution scale

Vulnerability data

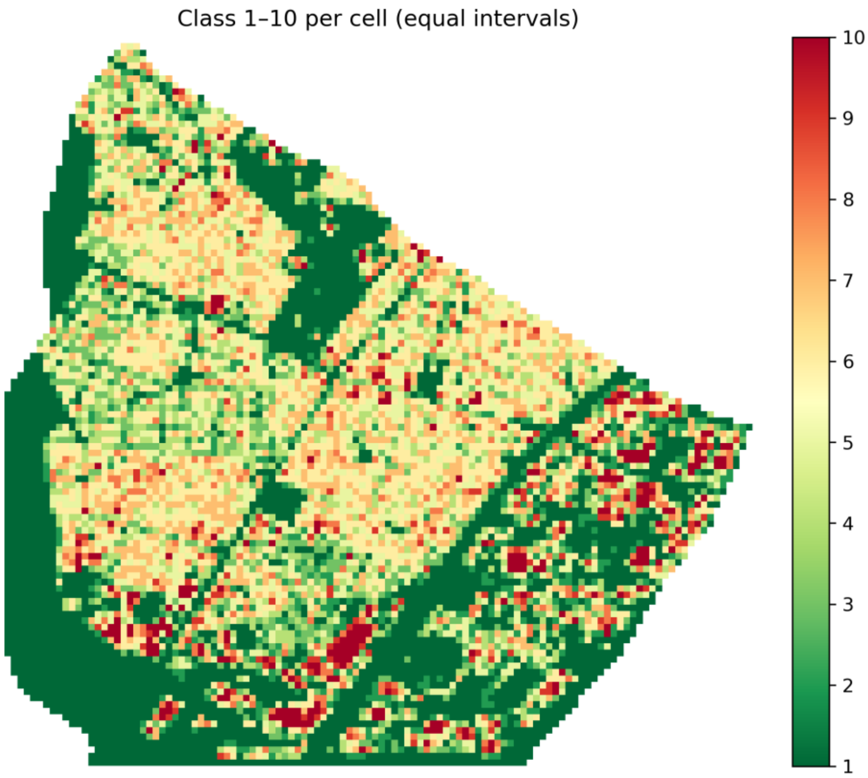


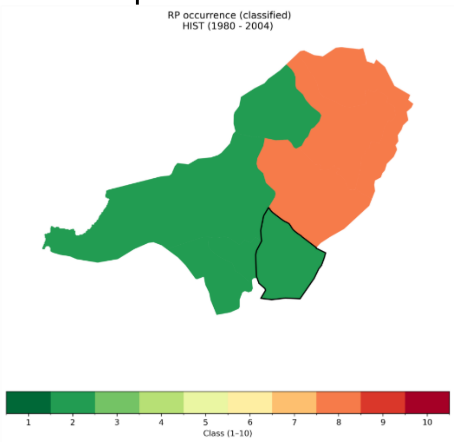
Figure 2.6. High-resolution (30x30 m) Building Density classification in 10 classes.

2.2 Hazard #1.2 – Buildings Exposure to heatwaves

2.2.1 Municipality Level

Hazard data

Historical period



Future Periods

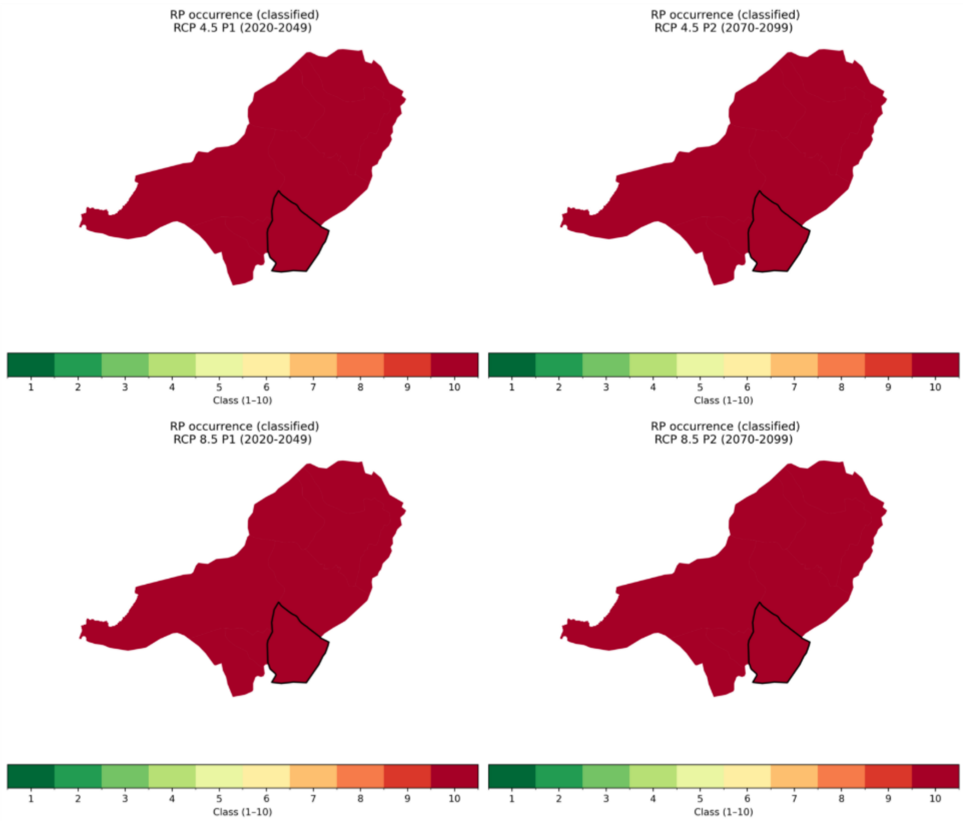


Figure 2.7. Classified (10-classes) mean Return level (RP) of TX for 50-year return period, for the historical period 1980–2004 (top) for RCP 4.5 and RCP 8.5 in near future (RP1:2020–2049) and far future (RP2:2070–2099) periods (bottom).

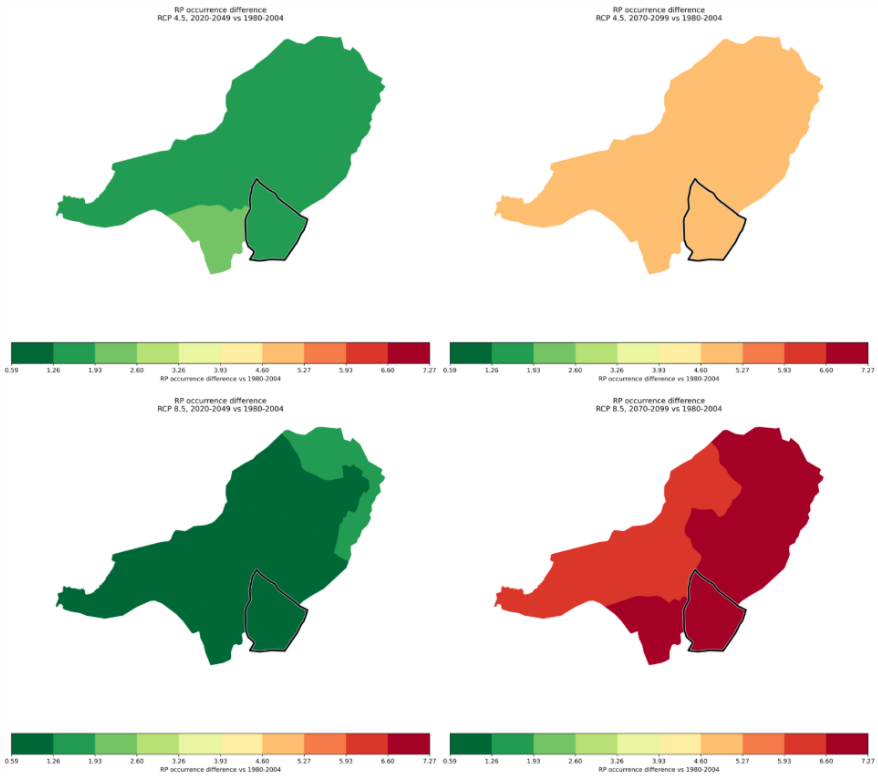


*Figure 2.8. **Absolute changes in return levels of TX** relative to 1980–2004 for RCP 4.5 and RCP 8.5 in the near future (RP1:2020–2049) and far future (RP2:2070–2099) periods.*

2.2.2 High-resolution level

Exposure data

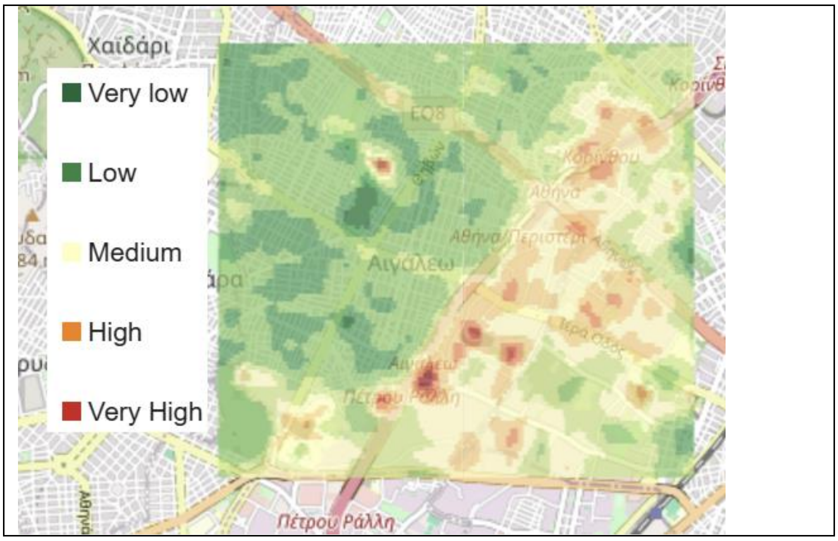


Figure 2.9. 5-scale classification heat exposure derived at high resolution scale

Vulnerability data

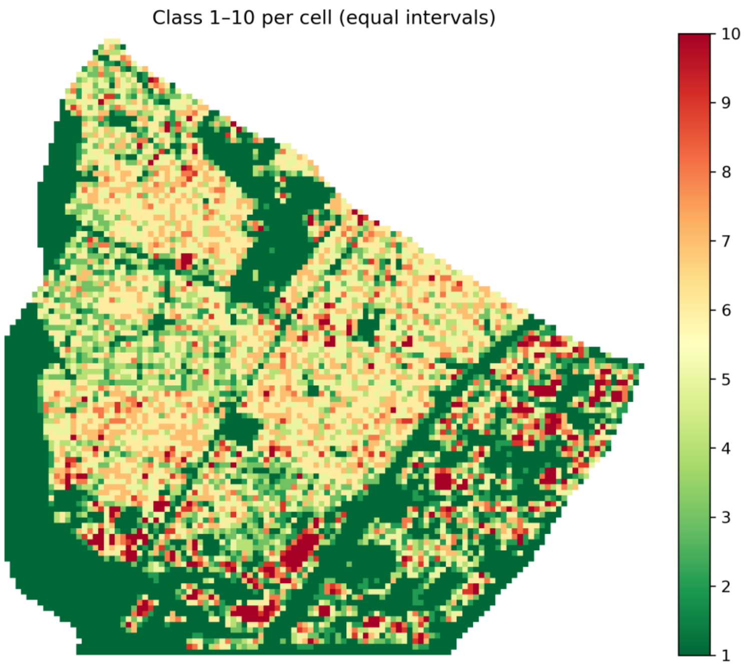


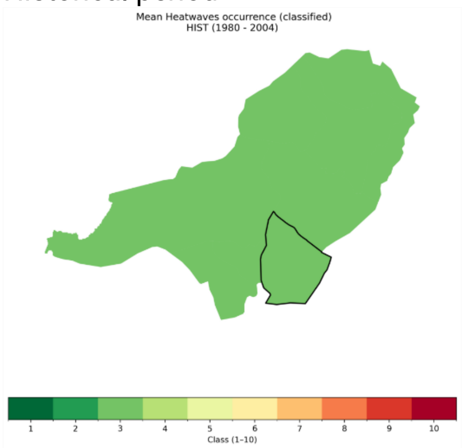
Figure 2.10. High-resolution (30x30 m) Building Density classification in 10 classes.

2.3 Hazard #1.3 – Heatwave risk assessment

2.3.1 Municipality Level

Hazard data

Historical period



Future Periods

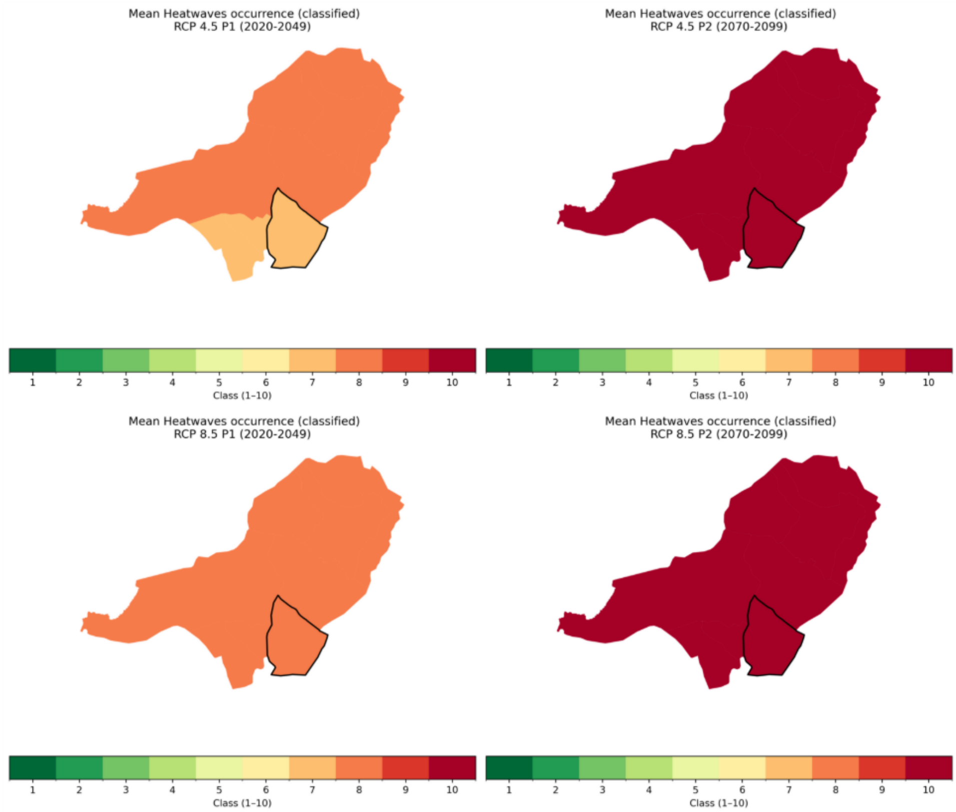


Figure 2.11. Classified (in 10 classes) mean number of heatwaves for the historical period 1980–2004 (top) for RCP 4.5 and RCP 8.5 in near future (RP1:2020–2049) and far future (RP2:2070–2099) periods (bottom).

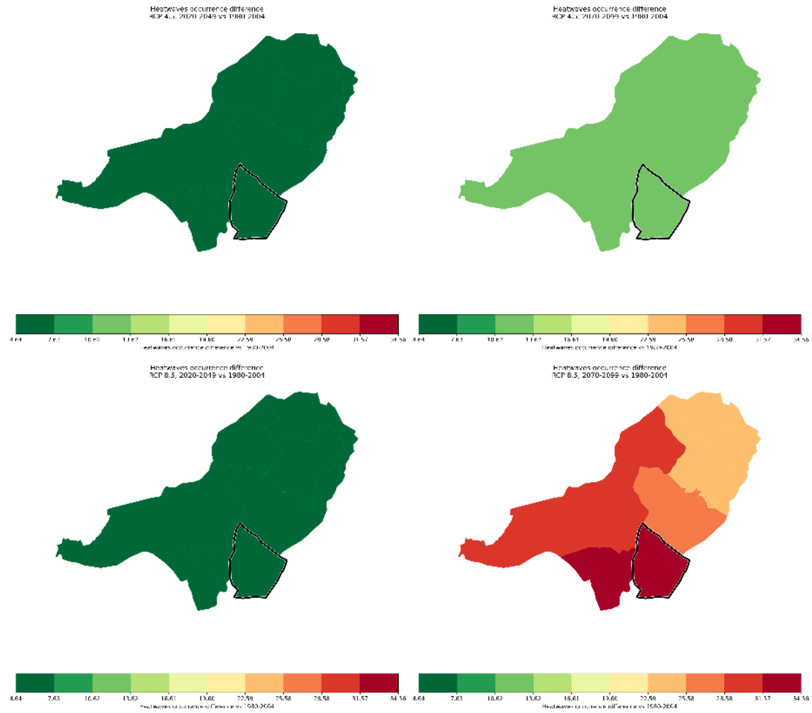


*Figure 2.12. **Absolute changes in the number** of heatwaves relative to 1980–2004 for RCP 4.5 and RCP 8.5 near future (RP1:2020–2049) and far future (RP2:2070–2099) periods.*

Vulnerability data

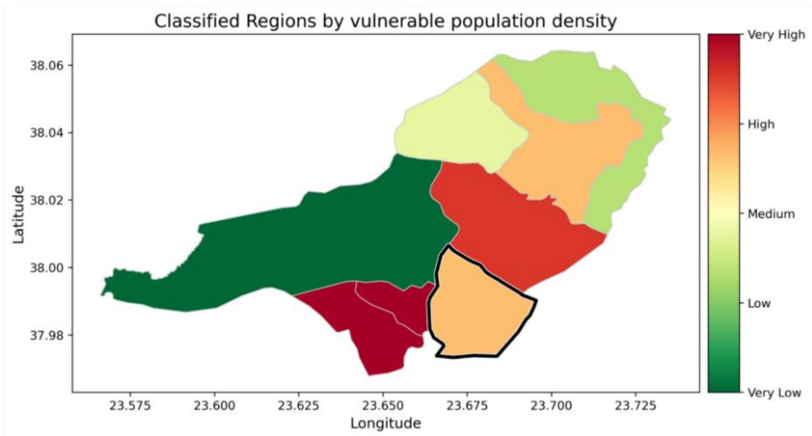
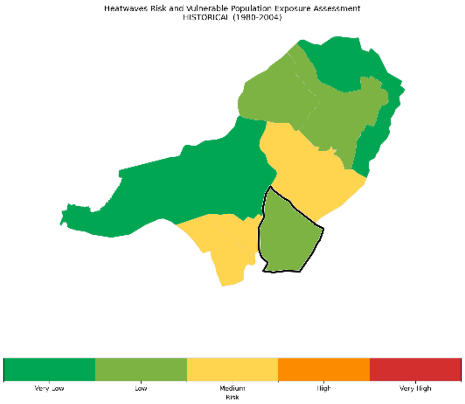


Figure 2.13. Scaled to 5 classes (very low to very high) vulnerable population density in West Athens (the highlighted sub-area defines the Municipality of Aigaleo).

Risk levels

Histrorical Period



Future Period

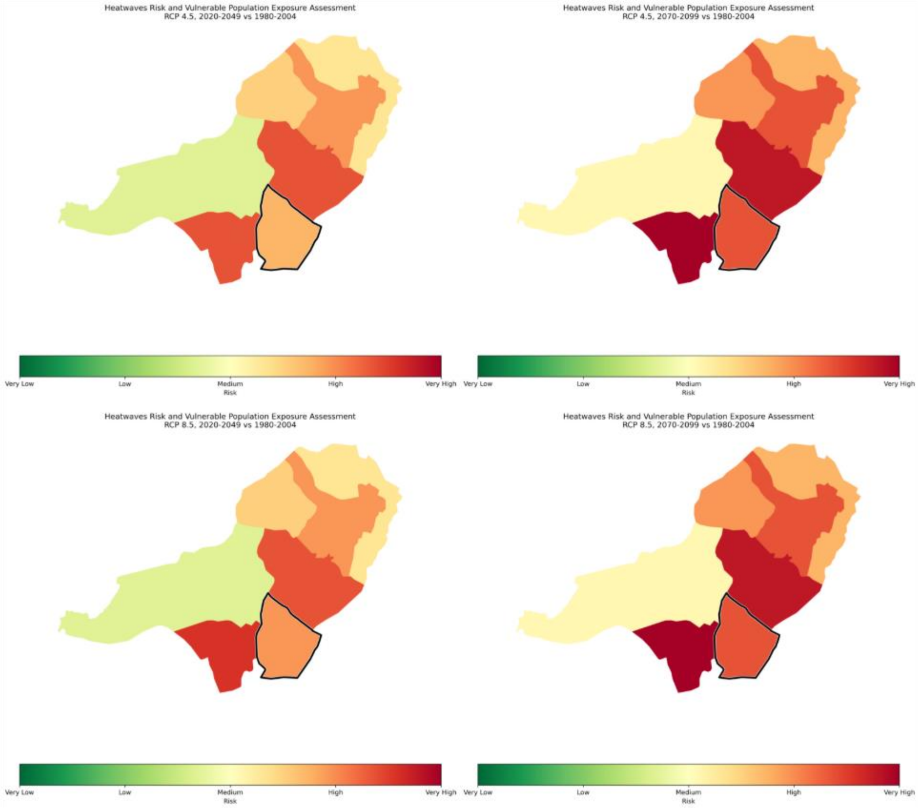


Figure 2.14. 5-scale classification of Heatwave risk level to vulnerable population exposure in the historical period 1980–2004 and for RCP 4.5 and RCP 8.5 the near future (RP1:2020–2049) and far future (RP2:2070–2099) periods, for the West Athens and the Municipality of Aigaleo (outlined area).

2.3.2 High-resolution level

Hazard data

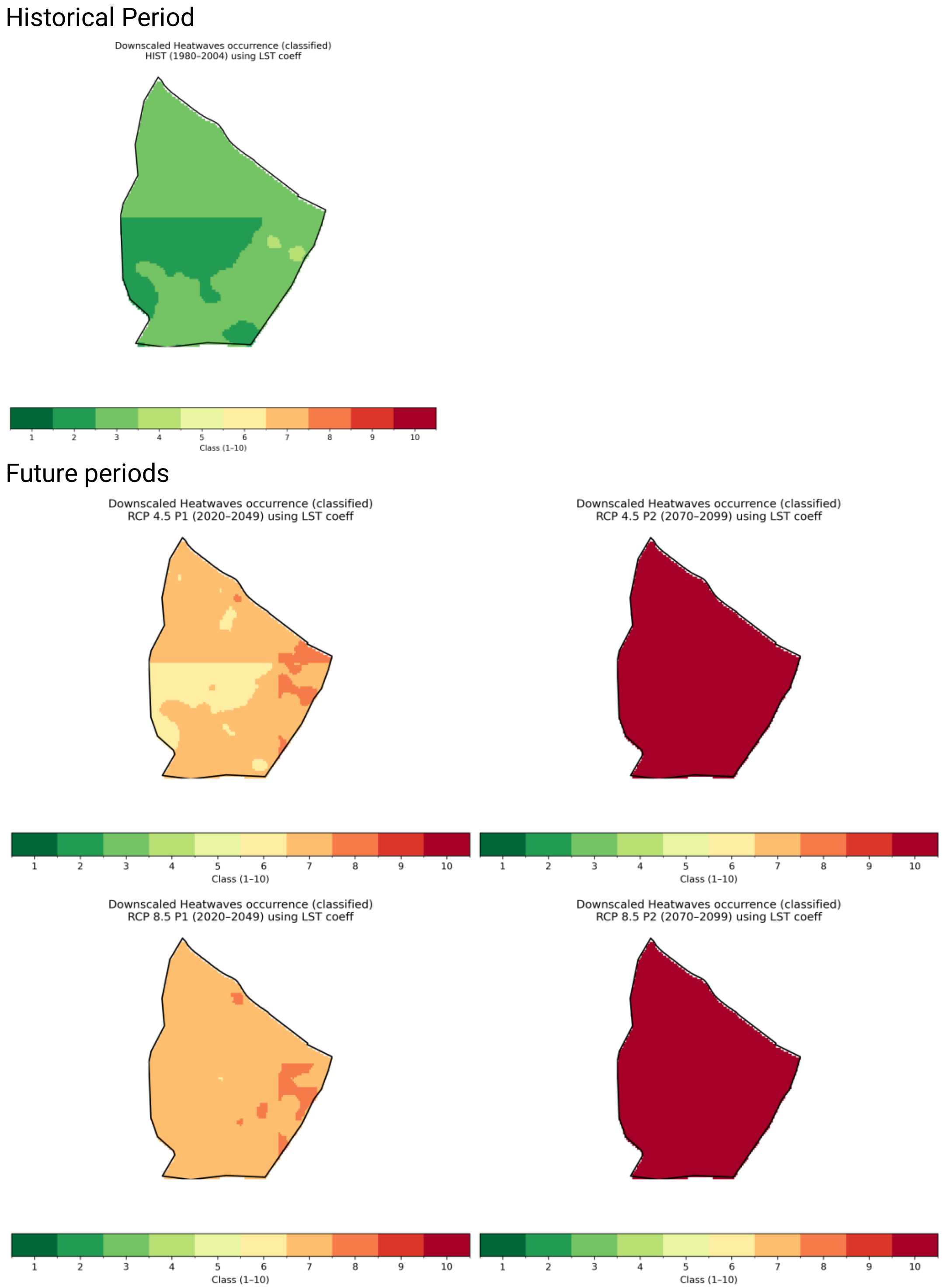


Figure 2.15. High-resolution classified (in 10-classes) mean heatwaves occurrence for the historical period 1980–2004 (top), for RCP 4.5 and RCP 8.5 in the near future (RP1:2020–2049) and far future (RP2:2070–2099) periods (bottom).

Exposure data

Figure 2.16. . 5-scale classification heat exposure data at high resolution scale

Vulnerability data

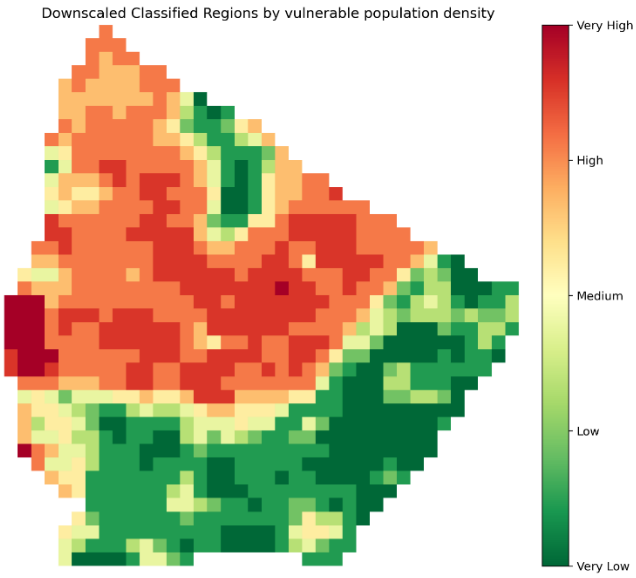


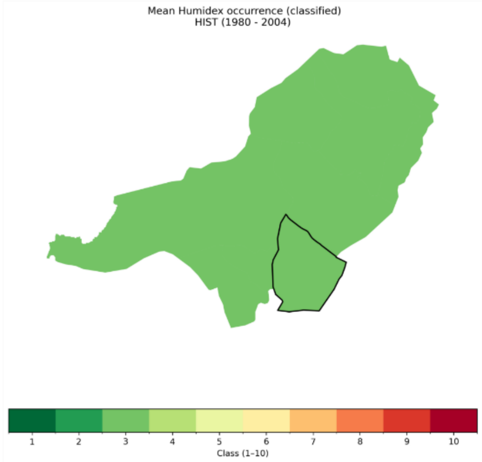
Figure 2.17. Scaled to 5 classes (very low to very high), high-resolution vulnerable population density for the Municipality of Aigaleo.

2.4 Hazard #1.4 – Health Exposure to HW

2.4.1 Municipality Level

Hazard data

Historical period



Future Periods

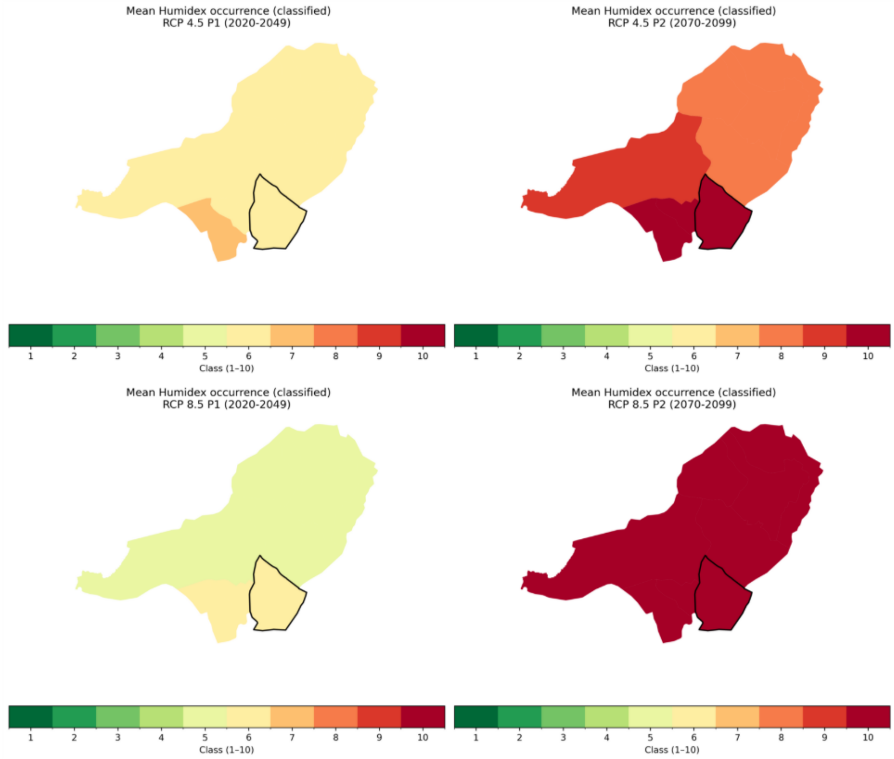


Figure2.18. Classified (in 10 classes) mean number of days with Humidex>40 for the historical period 1980–2004 (top), for RCP 4.5 and RCP 8.5 in near future (RP1:2020–2049) and far future (RP2: 2070–2099) periods (bottom).

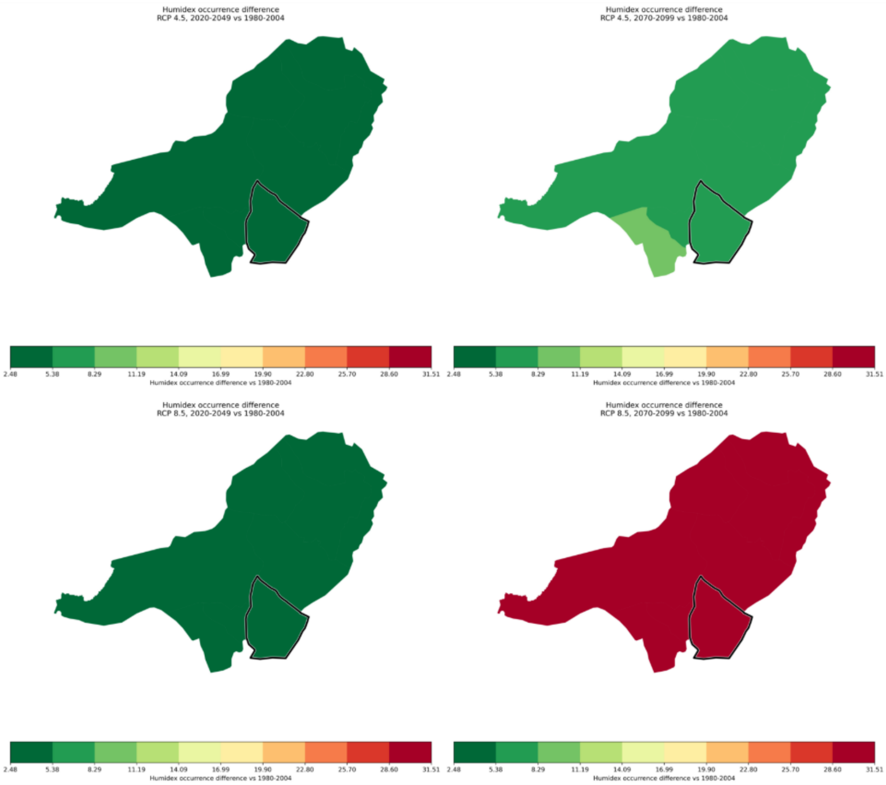
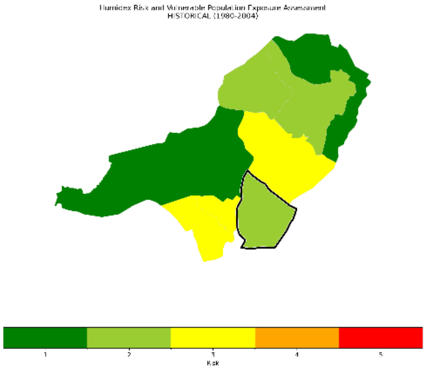


Figure 2.19. Absolute changes in the number of days with Humidex>40 relative to 1980–2004 for RCP 4.5 and RCP 8.5 in near future (RP1: 2020–2049) and far future (RP2: 2070–2099) periods.

Risk levels

Historical period



Future periods

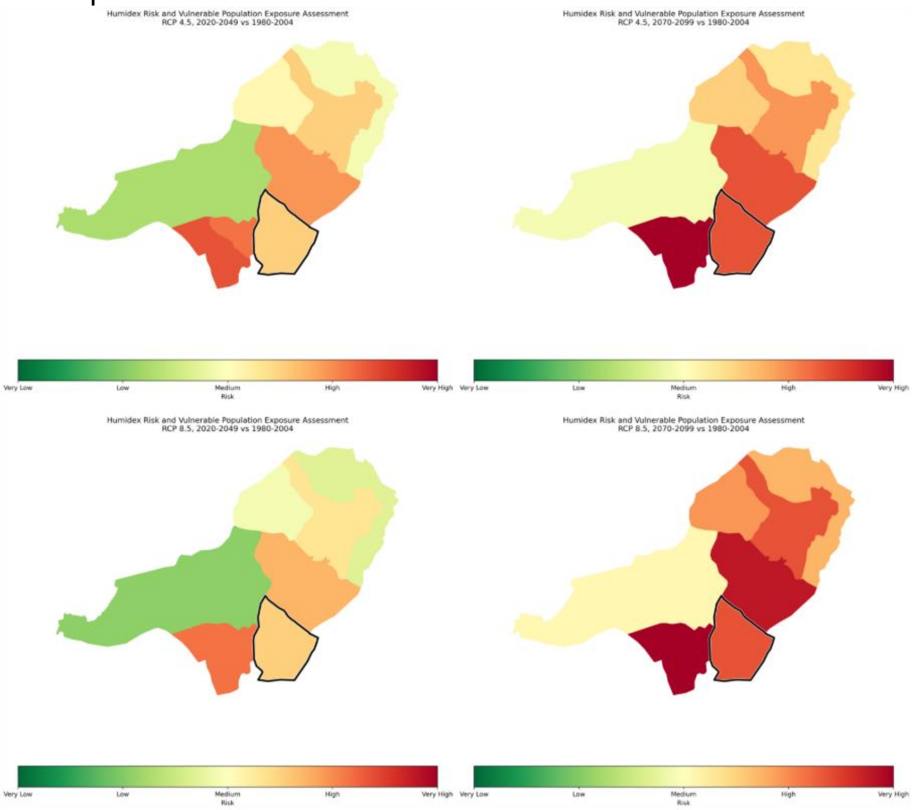


Figure 2.20 5-scale classification of Health risk level (based on Humidex) to vulnerable population exposure for the historical period 1980–2004, for RCP 4.5 and RCP 8.5 in the near future (RP1:2020–2049) and far future (RP2:2070–2099) periods, for the West Athens and the Municipality of Aigaleo (outlined area).

2.4.2 High-resolution level

Hazard data

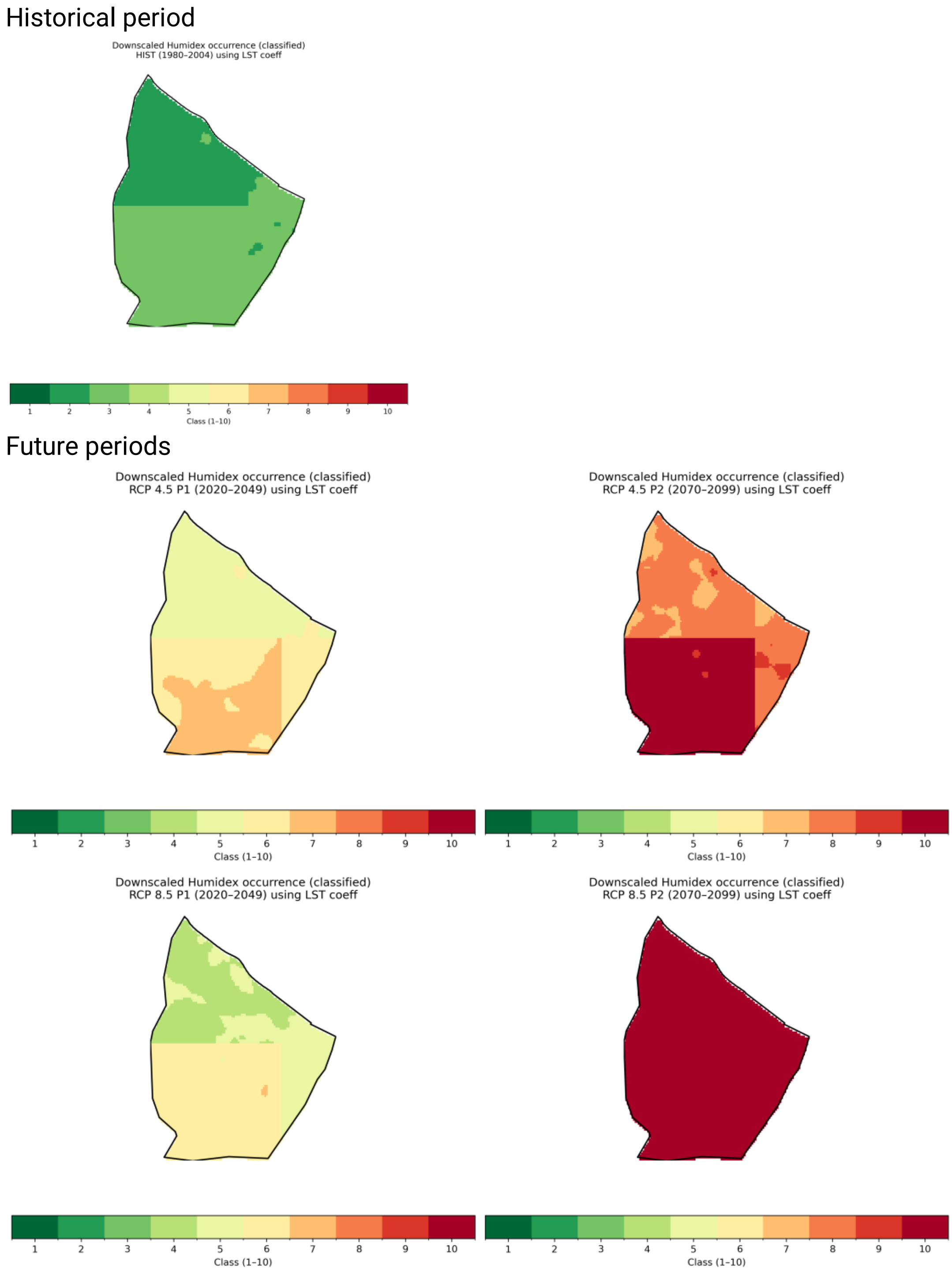


Figure 2.21. High-resolution classified (in 10 classes) mean humidex days (>40) occurrence for the historical period 1980–2004 (top) for RCP 4.5 and RCP 8.5 in the near future (RP1:2020–2049) and far future (RP2:2070–2099) periods (bottom).

Exposure data

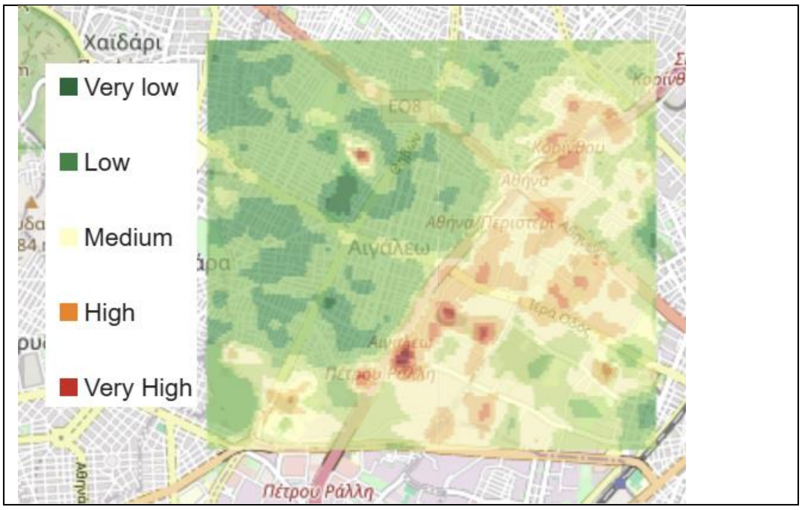


Figure 2.22.. 5-scale classification heat exposure at high resolution scale

Vulnerability data

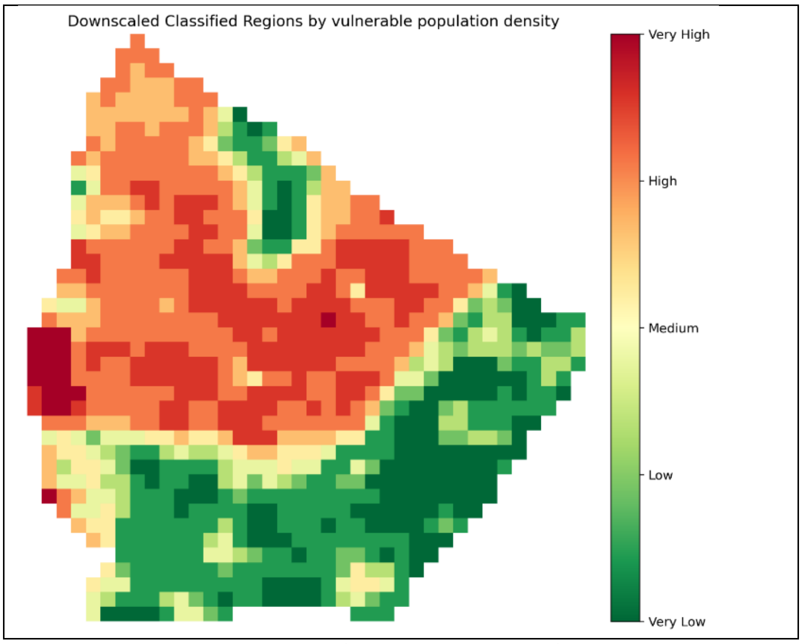


Figure 2.23. Scaled to 5 classes (very low to very high) high resolution vulnerable population density for the Municipality of Aigaleo.

2.5 Hazard #1.5 – Workers' exposure to HWs

2.5.1 Municipality Level

Hazard data

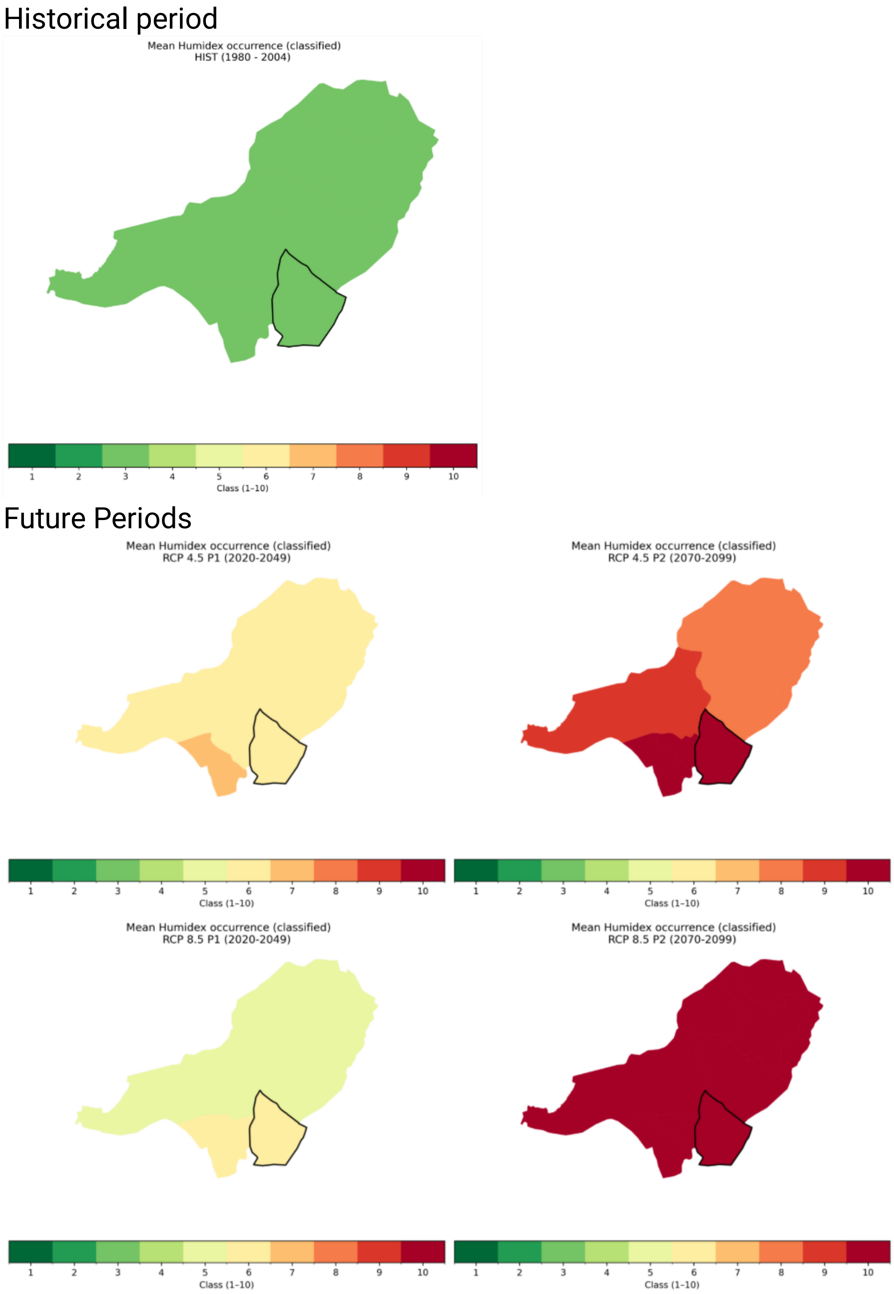


Figure 2.24. Classified (in 10 classes) mean number of days with Humidex>40 for the historical period 1980–2004 (top), for RCP 4.5 and RCP 8.5 in near future (RP1: 2020–2049) and far future (RP2: 2070–2099) periods (bottom).

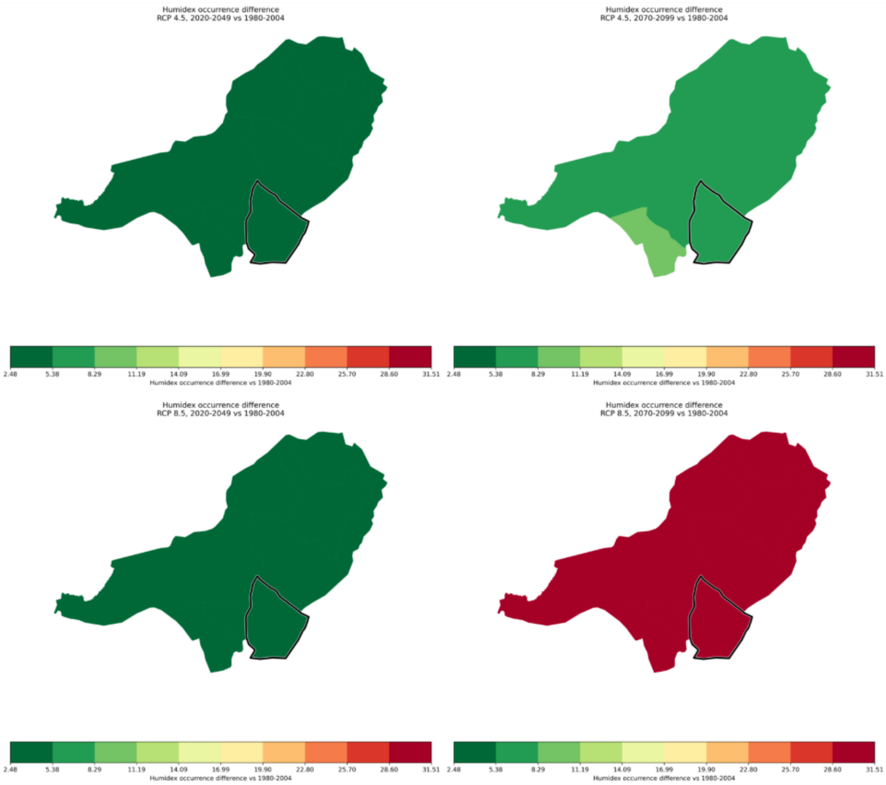
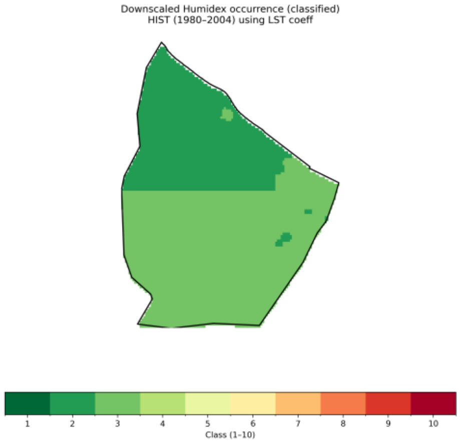


Figure 2.25 Absolute changes in the number of days with Humidex>40 relative to 1980–2004 for RCP 4.5 and RCP 8.5 in near future (RP1:2020–2049) and far future (RP2:2070–2099) periods.

2.5.2 High - Resolution level

Hazard data

Historical period



Future periods

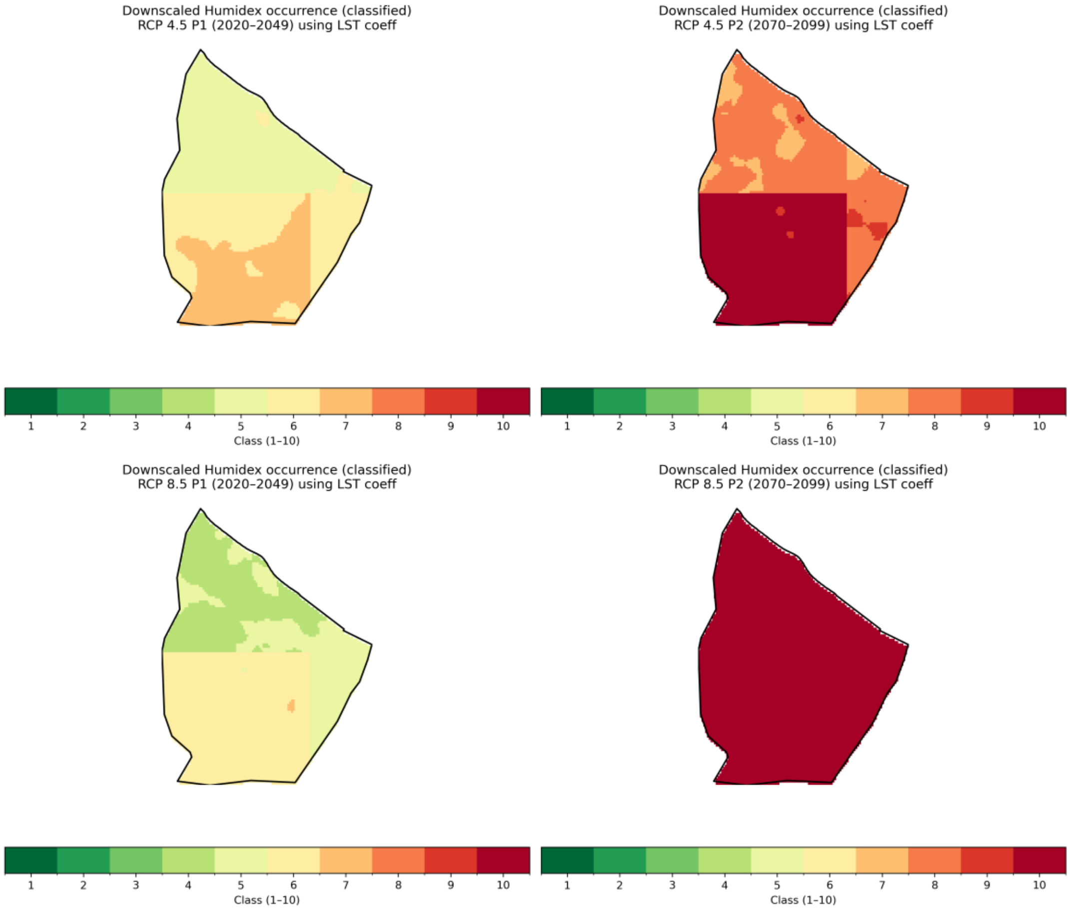


Figure 2.26. High-resolution classified (in 10-classes) mean humidex days (>40) occurrence for the historical period 1980–2004 (top) for RCP 4.5 and RCP 8.5 in the near future (RP1:2020–2049) and far future (RP2:2070–2099) periods (bottom).

Vulnerability data

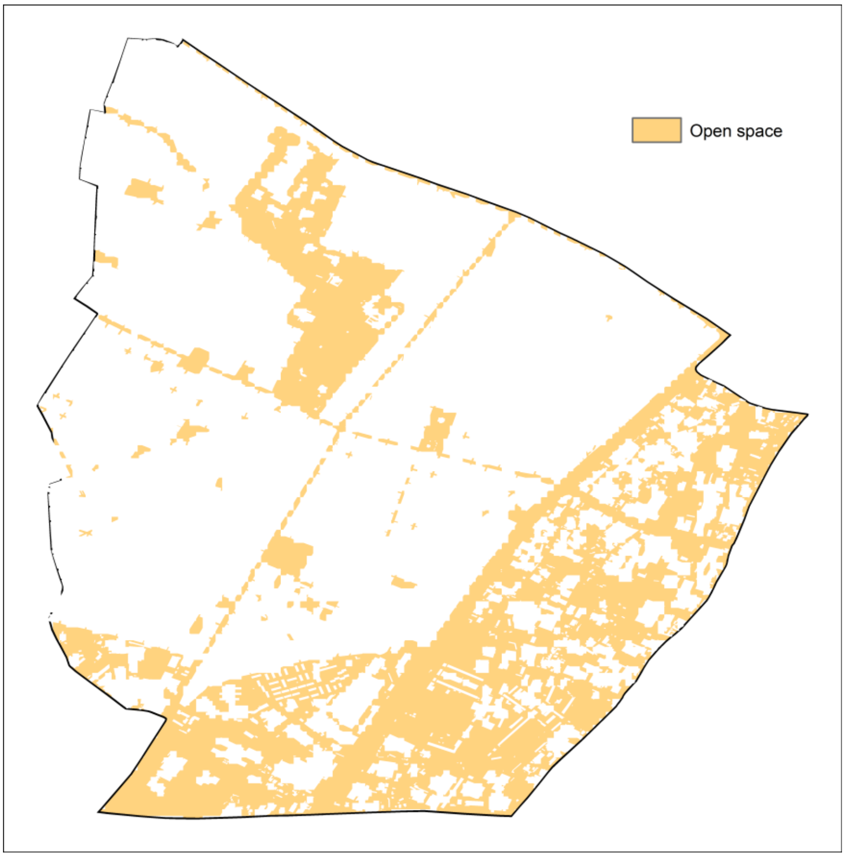


Figure 2.27 Density area of urban (in white) and open spaces in the Municipality of Aigaleo. Open space area is considered the area where green services, street cleaners, delivery and transportation services are active.

3 PUBLIC ENGAGEMENT AND PARTICIPATORY WORKSHOP PROCESS

This section describes the process of public engagement and awareness-raising regarding the risk assessment results, as well as the workshops and focus groups conducted to inform stakeholders, gather feedback, and foster active participation from local authorities and residents.

3.1 Objectives and engagement approach

- Awareness-raising and information dissemination on climate risks (heatwaves, wildfires, summer energy poverty) at the municipal and neighbourhood level.
- Collection of feedback and insights from residents and local stakeholders to validate and refine risk assessment results and proposed adaptation measures.
- Co-design of potential interventions (e.g., cooling measures, energy efficiency programs, heat-health action plans).

3.2 Engagement process and methods

- **Preparation of communication materials:** simplified maps, infographics, and non-technical summaries for broader accessibility.
- **Stakeholder mapping:** identification of key local actors (municipal departments, NGOs, community groups, vulnerable population representatives).
- **Participatory workshops and focus groups:** structured sessions including:
  - Presentation of hazard and risk maps.
  - Interactive mapping exercises for local validation.
  - Group discussions on perceived risks and adaptive capacity.
- **Public online dissemination:** use of the NCSR Demokritos website to share results

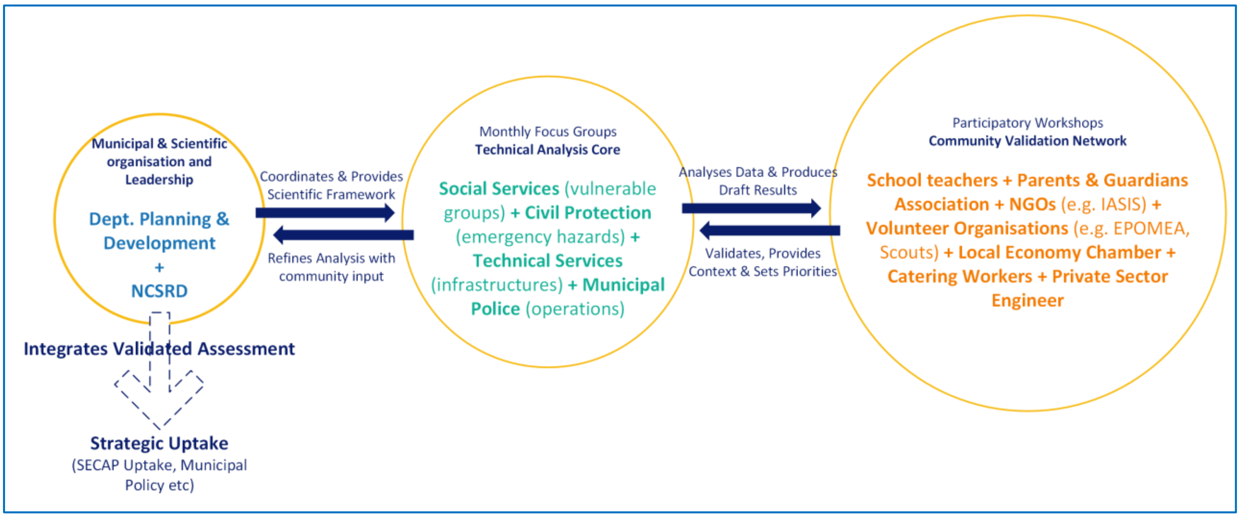
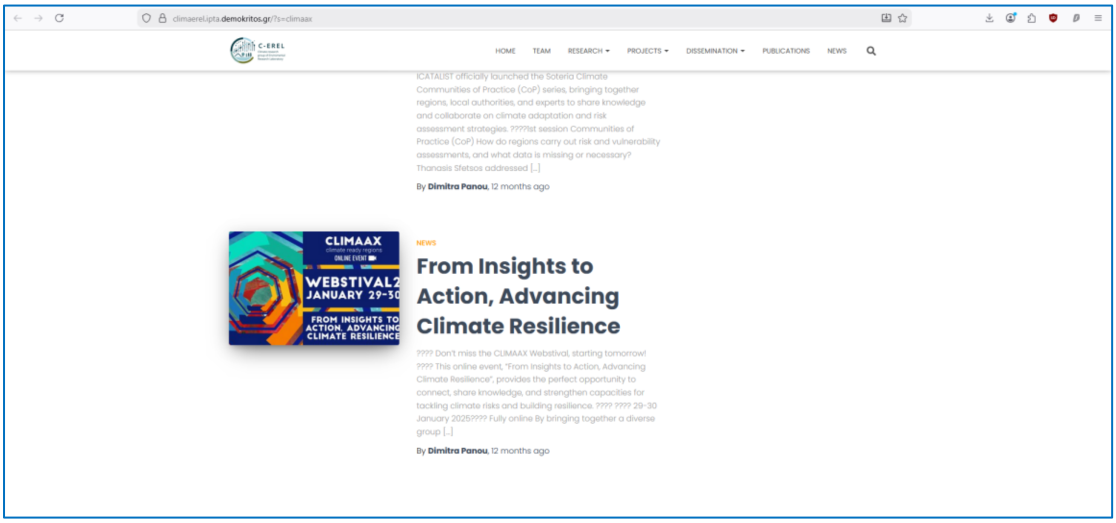
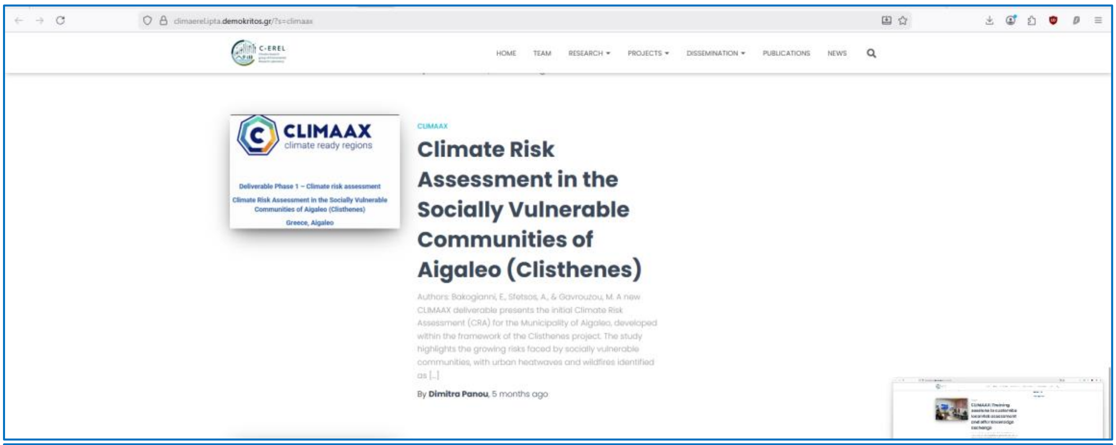


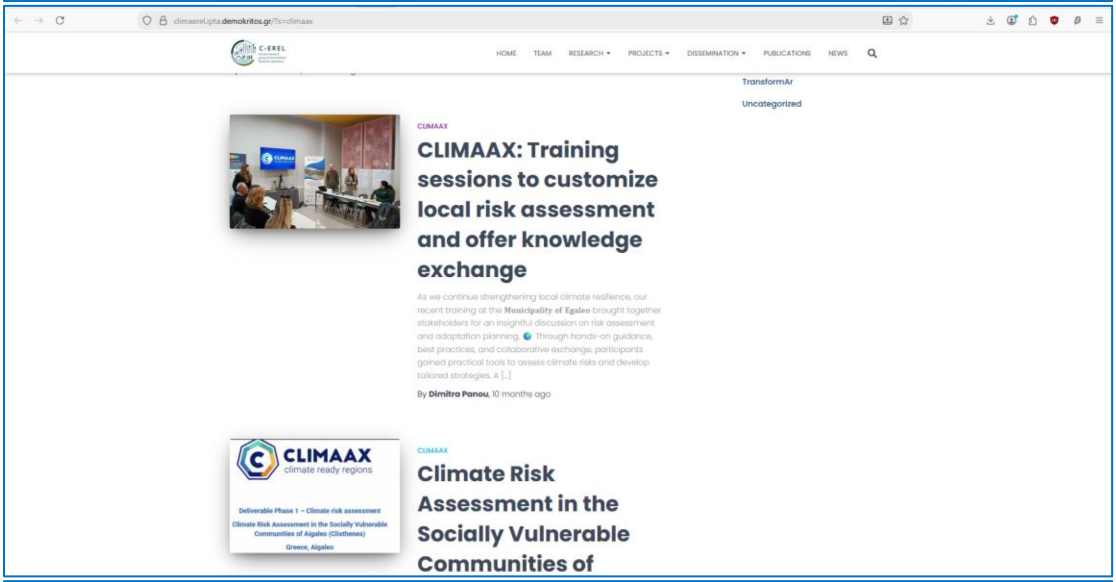
Figure 3.2.1 Organigram of engagement methodology

3.2.1 Online outreach and web-based engagement

To ensure broad accessibility and continuous communication with the public and stakeholders, key findings, workshop announcements, and visual outputs were shared through the website of the National Centre for Scientific Research “Demokritos” (NCSRD/ EREL scientific group). Selected posts included announcements of workshops and visual summaries of risk maps. Below are indicative screenshots from the dissemination activities for more detail visit site here:




climaerel.upta.demokritos.gr/?s=climaax
C-EREL
HOME
TEAM
RESEARCH
PROJECTS
DISSEMINATION
PUBLICATIONS
NEWS
CLIMAAX
climate ready regions
Deliverable Phase 1 – Climate risk assessment
Climate Risk Assessment in the Socially Vulnerable Communities of Aigaleo (Clisthenes)
Greece, Aigaleo
CLIMAAX
Climate Risk Assessment in the Socially Vulnerable Communities of Aigaleo (Clisthenes)
Authors: Bakogianni, E., Sfetsos, A., & Gavrouzou, M. A new CLIMAAX deliverable presents the initial Climate Risk Assessment (CRA) for the Municipality of Aigaleo, developed within the framework of the Clisthenes project. The study highlights the growing risks faced by socially vulnerable communities, with urban heatwaves and wildfires identified as [...]
By Dimitra Panou, 5 months ago


climaerel.upta.demokritos.gr/?s=climaax
C-EREL
HOME
TEAM
RESEARCH
PROJECTS
DISSEMINATION
PUBLICATIONS
NEWS
TransformAr
Uncategorized
CLIMAAX
CLIMAAX: Training sessions to customize local risk assessment and offer knowledge exchange
As we continue strengthening local climate resilience, our recent training at the Municipality of Egaleo brought together stakeholders for an insightful discussion on risk assessment and adaptation planning. Through hands-on guidance, best practices, and collaborative exchange, participants gained practical tools to assess climate risks and develop tailored strategies. A [...]
By Dimitra Panou, 10 months ago
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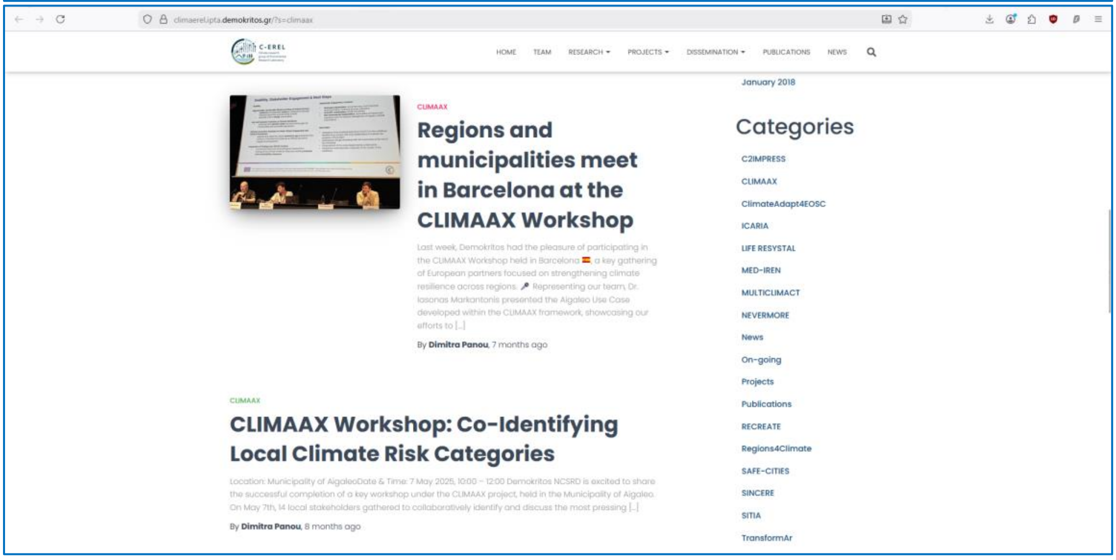
Deliverable Phase 1 – Climate risk assessment
Climate Risk Assessment in the Socially Vulnerable Communities of Aigaleo (Clisthenes)
Greece, Aigaleo
CLIMAAX
Climate Risk Assessment in the Socially Vulnerable Communities of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CLIMAAX
Regions and municipalities meet in Barcelona at the CLIMAAX Workshop
Last week, Demokritos had the pleasure of participating in the CLIMAAX Workshop held in Barcelona, a key gathering of European partners focused on strengthening climate resilience across regions. Representing our team, Dr. Iasonas Markantonis presented the Aigaleo Use Case developed within the CLIMAAX framework, showcasing our efforts to [...]
By Dimitra Panou, 7 months ago
CLIMAAX
CLIMAAX Workshop: Co-Identifying Local Climate Risk Categories
Location: Municipality of AigaleoDate & Time: 7 May 2025, 10:00 – 12:00 Demokritos NCSRD is excited to share the successful completion of a key workshop under the CLIMAAX project, held in the Municipality of Aigaleo. On May 7th, 14 local stakeholders gathered to collaboratively identify and discuss the most pressing [...]
By Dimitra Panou, 8 months ago
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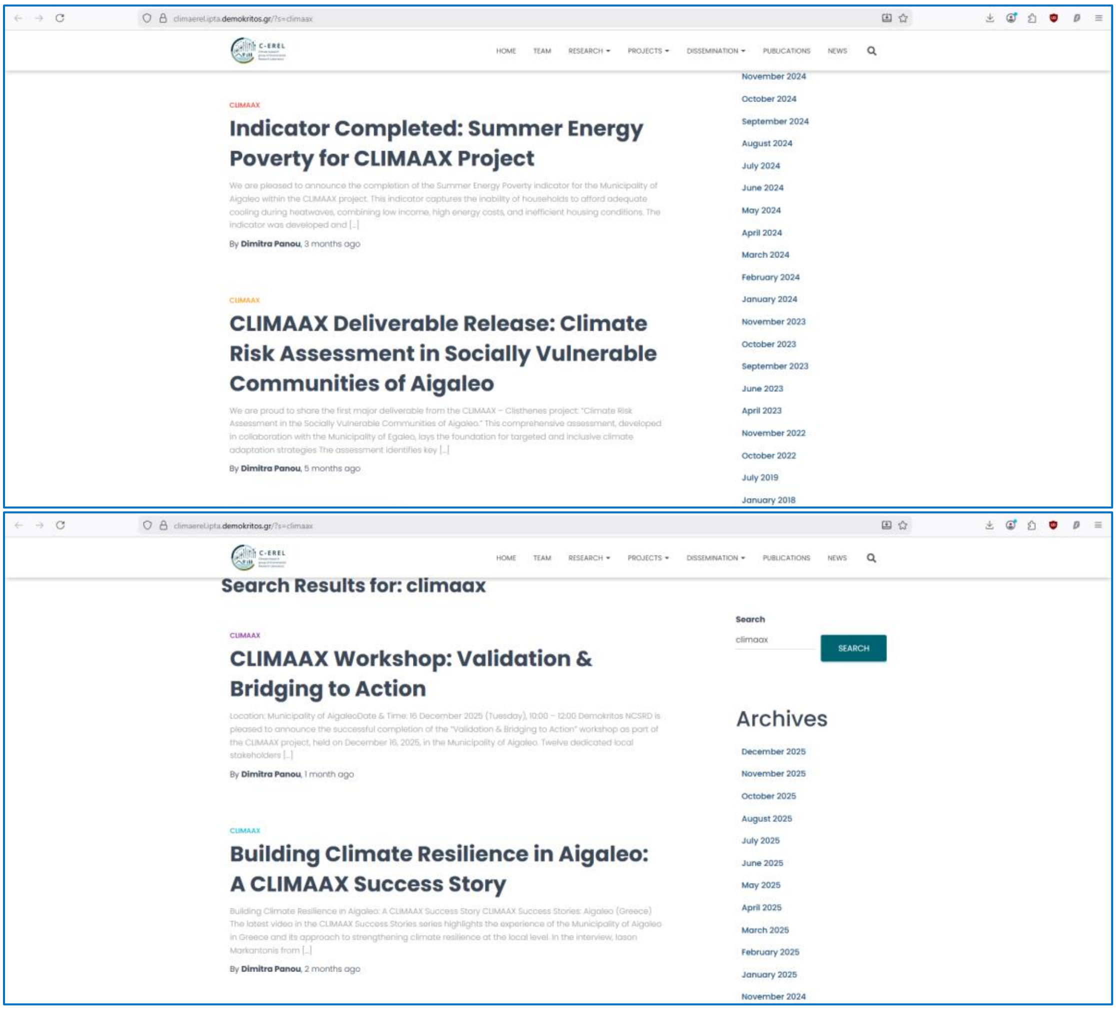

Figure 3.2.8 Screenshots from NCSRD website posts

3.3 Documentation of workshops and focus groups

A series of structured workshops and focus group discussions were conducted between M7 and M15 of the project. These sessions were designed to ensure inclusive participation and gather qualitative insights to complement the quantitative risk assessments. Selected photographs and tables from the workshops and focus groups are included below to illustrate the participatory process and engagement level.

focus groups

No	Date	Time - Duration	Main topic	Participants	Description/outcomes
1	Month 7_ 10 April 2025 (Thursday)	11:00 - 12:30	Project Kick-off & Methodology Presentation	11 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	Alignment on project structure, CLIMAAX methodology, and common understanding of objectives among the core team.
2	Month 8_ 19 May 2025 (Monday)	11:00 - 12:30	Identification of New Indicators & Data Collection	9 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	Definition and agreement on the 5 new local climate risk indicators to be developed. Established data collection protocols and validation approach
3	Month 9_16 June 2025 (Monday)	11:00 - 12:30	Heatwave Risk Assessment (General)	10 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	Discussion of general heatwave hazard and exposure data (EuroHEAT). Identification of municipal priorities for heat mapping.
4	Month 10_ 8 July 2025 (Tuesday)	11:00 - 12:30	Health & Occupational Exposure to Heatwaves	8 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	Focus on vulnerable population exposure (elderly, children) and outdoor worker exposure. Linked health data with spatial analysis.
5	Month 12_ 16 September 2025 (Tuesday)	11:00 - 12:30	Building Exposure to Heatwaves	8 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	Analysis of building stock vulnerability (age, materials, insulation). Identified neighbourhoods with high concentration of thermally vulnerable buildings.
6	Month 13_ 14 October 2025 (Tuesday)	11:00 - 12:30	Summer Energy Poverty	9 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	In-depth exploration of energy poverty as a climate-induced vulnerability. Linked high temperatures, building inefficiency, and socio-economic data.
7	Month 14_ 11 November 2025 (Tuesday)	11:00 - 12:30	Wildfire Risk Assessment	10 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	Application and discussion of FWI workflow results. Local refinement of wildfire risk zones, especially for the Aigaleo Grove and Elaionas interface
8	Month 15_ 5 December 2025 (Friday)	11:00 - 12:30	Consolidated Results & Validation	10 persons: representatives of Municipal bodies (engineers of Technical Services, Social Services, Municipal Police, Municipal Civil Protection, Department of Planning & Development) & NCSRD researchers	Final presentation and joint validation of all refined risk assessments (heatwaves, wildfires, socio-economic indicators) based on the integrated local data

Figure 3.3.1 Picture of the focus groups table

participatory workshops

No	Date	Time - Duration	Main topic	Participants	Description/outcomes
1	Month 8_ 7 May 2025 (Wednesday)	10:00 - 12:00	Co-identifying Local Risk Categories: To discuss the project's scope and collectively define the key climate risk challenges for Aigaleo, focusing on social, spatial, and infrastructural impacts of heatwaves and wildfires.	14 persons: representatives of: Municipal bodies (engineer of Technical Services, Social Services, Municipal Police, Municipal Civil Protection) , educators, association of guardians and parents, association of volunteer rescuers, local scouts, NGO for psycosocial support and health, association of trade and market, catering SMEs, free lancer engineer	1. Co-created list of key risk categories. 2. Identification of most-affected social groups and geographic areas (neighbourhoods, infrastructures). 3. Established a common language and priorities for the technical work. This workshop outputs directly fed into Focus Group 2 for formalising the new indicators
2	Month 15_ 16 December 2025 (Tuesday)	10:00 - 12:00	Validation & Bridging to Action: 1. To present and validate the final, refined results from all workflows and Focus Groups. 2. To link findings with existing municipal projects and initiate the discussion on concrete protection strategies.	12 persons: representatives of: Municipal bodies (engineer of Technical Services, Social Services, Municipal Police, Municipal Civil Protection) , educators, association of guardians and parents, association of volunteer rescuers, local scouts, NGO for psycosocial support and health, association of trade and market, catering SMEs, free lancer engineer	1. Community validation of scientific results, the refined risk maps and impact chains. 2. Community validation of the results based on local experience/perception. 3. Strategic linking of identified risks to ongoing/future European projects for potential action. 4. Generation of preliminary ideas for adaptation, creating a bridge to Phase 3.

Figure 3.3.2 Picture of the participatory workshop table

indicators

No	Name	Description & Rasionale
1	Summer Energy Poverty	A measure of the inability to afford adequate cooling during heatwaves, combining low income, high energy costs, and inefficient housing. Critical for understanding a key social vulnerability exacerbated by climate crisis
2	Building's Exposure to Heatwaves	An assessment of the physical vulnerability of the building stock to overheating, based on factors like construction era, materials, insulation levels, and orientation. Directly links hazard to infrastructure resilience
3	Heatwave Risk Assessment	The integrated evaluation of heatwave hazard (frequency, intensity), population exposure, and social vulnerability, providing the overarching risk score for different city areas
4	Health Exposure to Heatwaves	Focuses on the population groups most susceptible to heat-related illness and mortality (e.g., elderly >65, children <5, people with pre-existing conditions) and maps their spatial distribution
5	Workers' Exposure to Heatwaves	Identifies and assesses the risk for occupational groups with mandatory outdoor work or work in non-cooled environments (e.g., municipal cleaners, construction workers, market vendors)
6	Health Exposure to Wildfire	Evaluates the population health risk from wildfire smoke (respiratory issues) and direct physical threat, particularly for communities near the Wildland-Urban Interface (WUI) like areas adjacent to Aigaleo Grove or Aigaleo Mount which is located in the wider area of West Athens

Figure 3.3.3 Picture of indicators table

Figure 3.3.4 Picture of 1st focus group (M7_April 2025)

Figure 3.3.5 Picture of 5th focus group (M12_September 2025)

Figure 3.3.6 Picture of 2nd participatory workshop (M15_December 2025)