Deliverable Phase 1 – Climate risk assessment

Climate Risk Analysis for Garmen (CRAG)

Bulgaria, Municipality of Garmen

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

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Document Information

Deliverable Title	Phase 1 – Climate risk assessment
Brief Description	This deliverable presents a climate multi-risk assessment for the municipality of Garmen, which was devised through the application of the CLIMAAX framework common methodology for multi-risk assessment (i.e. two workflows) and analysis of the results.
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Country	Bulgaria
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Supporting subcontracting Institutions	External expert support - Sunny Hill Park Ltd.
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5.0	…		Final version to be submitted

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Abbreviations and acronyms

Abbreviation / acronym	Description
AR6	Assessment Report 6 from the IPCC
BAS	Bulgaria Academy of Science
CDS	Copernicus Climate Data Store
CMT	Core Municipal Team
CoP	Community of Practice
CRA	Climate Risk Assessment
CRM	Climate Risk Management
DRMKC	Disaster Risk Management Knowledge Center
EEA	European Environmental Agency
EET	External Expert Team
IFP	Individual Follow-up Plan
IPCC	Intergovernmental Panel on Climate Change
NSI	National Statistical institute
NIMH	National Institute for Meteorology and Hydrology
NUTS	Nomenclature of Territorial Units for Statistics
RCP	Representative Concentration Pathways

Executive summary

The “Deliverable Phase 1 – Climate risk assessment” (CRA) report for the project “Climate Risk Assessment for Garmen (CRAG)” presents how the CLIMAAX climate risk assessment framework and toolbox have been used by Garmen municipality, whereby two risk assessment workflows have been successfully applied using European data – i.e. the one on river floods and the one heatwaves respectively. The deliverable was developed so as to provide insights on these two risks and serve as the foundation for refinement of the assessment by plugging in local data of higher resolution in the second phase of the project.

The document gives an overview of the scoping of the CRA, whereby it elaborates on its objectives, context, participation and ownership. In a nutshell, the objectives of the CRA are to provide a science-based foundation for political decision-making and to inform strategic documents in the municipality on climate change adaptation and risk management, to aid in attracting funds for municipal adaptation measures, as well as to contribute to improvement of coordination of efforts at the regional level. The municipality is the main owner of the risks, while at the same time it does not possess the necessary resources to respond to risk impacts, and therefore has been highly motivated to conduct the CRAG project to enable itself to implement adaptation measures in prevention and mitigation of the risks.

The current document then dives into exploring the risks – the central part of the CRA. The two risks in focus were selected based on their perceived level of severity and need for prioritization as defined by stakeholders but also confirmed by recent extreme events. The workflows applied – on river flooding and on heatwaves (the later based on satellite derived data), were selected so as to provide the best fit to the assessment needs of the municipality. The results from the risk assessments demonstrated an increase in the level of severity for both risks. The river floods risk assessment showed the damage hotspots that corresponded to areas with higher levels of inundation depth and extent. It also clearly showed that both under the current climate and RCP4.5 inundation depth will increase. The workflow enabled making the relation between hotspots of damages and land use type, which is important not only for damage calculation but also in decision-making when it comes to temporal prioritization of measures in protection. The heatwaves risk assessment workflow produced results that showed the overlap areas of highest surface temperatures and the highest density of vulnerable population, defined as children below 5 and elderly above 65 years of age. These results are crucial for the municipality in identifying and prioritizing areas where to direct adaptation measures. The increase in frequency of heatwaves under the RCP4.5 and RCP8.5 climate scenarios showed in the heatwaves hazard assessment results not only underlined the increase in severity but also oriented the municipality on the timeline for action. Due to the gradual onset of the heatwaves risk, the urgency to act is less pressing than in the case of river floods, whereby even the current level of risk is hard to tolerate without adaptation measures in the very short term.

The report also offers preliminary monitoring and evaluation reflections, as well as progress evaluation. Phase 1 of the project is considered very beneficial by the municipality. Its outputs will serve in phase 2 of the CRAG project as the foundation for dissemination and stakeholder engagement activities, as well for the refinement of the CRA, while the process of applying the workflows amounted to a capacity building experience for the municipality whose added value will go beyond the lifespan of the project.

1 Introduction

1.1 Background

The municipality of Garmen is located in Southwestern Bulgaria - Southwestern Region (NUTS2), in the Blagoevgrad District (NUTS3). It consists of sixteen settlements with the administrative center of the municipality being the village of Garmen. The population of Garmen municipality, according to data from the National Statistical Institute (NSI) as of December 31, 2023, is 14 772 people (National Statistical Institute, 2023) with a continuous trend of population aging. The territorial and settlement system of the municipality of Garmen was formed on the basis of natural and geographical features and as a result of long-term human activity, which has changed the natural environment. The relief is mainly mountainous and semi-mountainous, which becomes hilly in the Southwestern part of the municipality. The municipality of Garmen is one of the warmest places in the country, regardless of the surrounding mountainous terrain, as it is located on the border of two climatic zones - temperate continental and transitional Mediterranean, penetrating from the valley of the Mesta River. The water resources of the municipality are constituted by the Mesta river and its tributaries (Kanina river being the most significant one in terms of waterflow). On the territory of the municipality there are mineral springs (near the village of Ognyanovo along the Kanina River), 72% of its territory constitute of forests, and territories North-East of the Kanina river fall within the European “Natura 2000” network of protected areas. Based on the nature in the municipality, combined with the presence of historical sites, the tourism sector is one of the fastest growing in the local economy with various types of tourism having potential to unfold further - rural, cultural, eco- and balneo-tourism. Agriculture is another chunk of the local economy with potential for development, whereby in addition to crops traditionally grown in the region, local producers have started growing fruits. Other aspects of the local economy include - light industry, livestock farming, logging, and extraction of minerals.

1.2 Main objectives of the project

The main objective of the CRAG project is to produce a multi-risk climate assessment that will serve as the data basis for strategic and policy documents and actions by the municipality. The specific objectives include: to produce a multi-risk climate assessment (Deliverable 1); to produce a refined multi-risk climate assessment (Deliverable 2); to use the multi-risk climate assessment to update and enrich the Climate Change Adaptation Strategy of Garmen municipality (adopted August 2024) (Deliverable 3); to use the multi-risk climate assessment to start the drafting of a municipal risk management plan with a particular focus on prevention and support for disproportionately affected by climate risks segments of the local community (building on Deliverable 3); to use the multi-risk climate assessment to: 1/ initiate a process of advocating for national funding or attracting investments for climate adaptation measures in the municipality and 2/ advocate for an improved regional approach to planning and prevention in respect to climate change impact and disasters (building on Deliverable 3); to involve a variety of stakeholders to increase understanding and support for climate risk management.

The climate multi-risk assessment will be used to inform and upgrade Garmen’s municipal adaptation strategy. It will be utilized to further inform our action plan for implementation of the strategy and for attracting funding and investments for climate change adaptation measures. The climate risk assessment will act as the foundational evidence level on which our strategic documents will rely to enhance the arguments in favor of selected adaptation approaches and measures. It will be used to ensure a coherent and comprehensive municipal policy in respect to building climate resilience. A vital role of the study will be to help us attract funding for adaptation measures in prevention and to argue in favor of prevention as much more cost-effective and environmentally friendly. It will help us ensure climate justice by enabling us to take actions in support of the segments of our local community disproportionately affected by climate risks. Last but not least, the municipality will take actions to use the study to inform coordination and preparedness locally and regionally for disaster response and early warning. We are firmly convinced the study will have a multitude of multifaceted added value and benefits to the municipality of Garmen but also for the region because we will put substantial efforts to share the results, lessons learned, and know-how to feed into the relevant regional mechanisms, structures, and practices.

For the municipality of Garmen, the CLIMAAX project has particular added value in a number of directions. It provides the municipality with a sound methodological framework and toolbox that ensure the quality of the CRA. It assists the municipality in overcoming the skills and expert gap by providing funding for contracting external support. In essence it is the CLIMAAX project that has enabled the municipality to produce a CRA – an ambition that was formerly unattainable without the CLIMAAX financial, methodological, and technical support. It has also enabled the municipality to build in-house skills and capacity as a result of the CRA drafting process and the interaction with experts and the application of the workflows. By increasing the municipality's understanding of the climate-driven risks and their multi-faceted repercussions, CLIMAAX has also raised awareness of non-climatic drivers' importance and the compound nature of some climatic hazards.

1.3 Project team

The team working on the project consists of the CLIMAAX Municipal Team (CMT) – a team of three municipal employees designated by the mayor; and a subcontracted External Expert Team (EET). The two teams work closely together in constant communication following the Work Plan as described in the IFP. The CMT ensures that the EET receives the relevant information and feedback it needs from the municipal administration, it makes sure that the administration takes full advantage of the project as a learning experience, and monitors that the project activities and deliverables are provided by the EET according to the Work Plan with high level of quality. The three individuals in the CMT come from the municipal department of EU projects and they ensure exchange of information and capacity building for their colleagues of the respective departments and sectoral units, e.g. public works and architecture, special planning, green systems, environment, civil protection. The EET supports the CMT and delivers commissioned actions and deliverables according to the workplan for the project. The EET provides the CMT with the lacking expert and technical support without which the implementation of the CLIMAAX project would have not been possible.

1.4 Outline of the document's structure

The central part of this document is the CRA for Garmen municipality – phase 1 (Section 2). The section follows the logic of the CLIMAAX framework. It starts with scoping information for the CRA process about the objectives, context, participation and ownership. It then explores the risks, thereby selecting the main hazards to be analyzed and taking stock of the relevant data/knowledge. The document subsequently looks at the selected workflows and scenarios and presents the risk analysis, including data review, hazard and risk assessment for each workflow, as well as preliminary key risk assessment findings on severity, urgency, and capacity. The document offers preliminary monitoring and evaluation reflections and data at the end of Section 2, followed by main conclusions and key findings in Section 3, and a progress evaluation (including KPIs and milestones) with deliberations on how attained progress will contribute to the future project phases in Section 4. The list of supporting documentation and references are available at the end of the document under sections 5 and 6 respectively.

2 Climate risk assessment – phase 1

2.1 Scoping

2.1.1 Objectives

The CRA aims to enhance the understanding about the nature and projections for two priority risks that have considerable impact on the municipality. It should on the one hand provide more clarity about the current situation and thereby serve as the foundation for the design of adaptation measures that will alleviate the effects of the current impact and severity. On the other hand, the CRA will aim to show how the risks will change in the future and thus enable local policy-makers to take preventive measures in a coherent, timely, and consistent way. Last but not least, the objective is to offer sound data-driven and methodology-based analysis and conclusions in a language that will be accessible to policy-makers and political leaders in charge of local decision-making. Thus, the CRA should provide the municipality with a robust scientific framework to support political decision-making and the pragmatic selection of technical solutions in support of adaptation measures in prevention, civil protection planning and coordination, emergency and disaster response.

The climate multi-risk assessment, will be used to inform and upgrade our municipal Strategy for climate change adaptation (Garmen municipality, 2024). The CRA will also inform our action plan for implementing the strategy and for attracting funding and investments for climate change adaptation measures. The CRA will serve as the foundational evidence level on which our strategic documents will rely to enhance the arguments in favor of selected adaptation approaches and measures and thereby will ensure a coherent and comprehensive municipal policy in respect to building climate resilience. The CRA will be used by the municipality to advocate for preventive measures at the regional and national level. It will help the municipality to attract funding for adaptation measures in prevention and to argue in favor of prevention as the much more cost-effective and environmentally friendly approach.

The limitations on producing a CRA prior to joining the CLIMAAX project were insurmountable for the municipality of Garmen – i.e. lack of skills and expert knowledge, lack of funding to get external expert support, lack of a sound methodology that would allow for an analysis comparable to other municipalities across the EU and would guarantee a standard of quality, as well as a combination of scientific rigor and policy-oriented pragmatism. Joining the CLIMAAX project allowed us to overcome the lack of in-house skills, to contract external support, and equipped us with the trustworthy methodology we needed. The methodology also helps us overcome an ongoing challenge – previously we had difficulties making sure we use the available European data to its potential, and we experienced problems with selecting, refining, and utilizing local data. The CLIMAAX methodology through the workflows facilitates this process by providing a framework for us to think about the best data to plug in for more clarity – something that we will further work on in respect to local data in the second phase of the project.

2.1.2 Context

The Municipality of Garmen in August 2024 adopted its municipal Climate Adaptation Strategy. The document was developed by an external team and utilized data at the European and national level from the following sources: the AR6 report of the IPCC from 2022, the DRMKC Risk Data Hub, the

Copernicus C3S Atlas, the Bulgarian National Institute on Hydrology and Metrology (NIMH), the Bulgarian Academy of Science (BAS), and Climate Adapt. The strategy is the central document for building local climate resilience. The CRA produced through the CLIMAAX methodology will be used to inform and upgrade the strategy, as well as to develop an action plan for its implementation. Given the previous limitations on the municipality's ability to develop a CRA on its own, the CLIMAAX project is a crucial enabler that will add the foundational layer of multi-climate risk assessment through an inclusive, data-driven, and scientifically-based methodology and framework.

Prior to the design of the strategy, the municipality was able to only act in an ad hoc and reactive way that mostly followed climate change events and natural disasters resulting thereof. Adaptation measures were not part of a strategic approach but reacted to events. The municipal attempts to work in prevention of future occurrence of disasters were not based on climate change projections and therefore funding was hard to find. At the same time the government framework in Bulgaria entrusts the prevention work and coordination to the municipalities. With the increase in severity of the effects of the climate change-impacted hazards and the urgency to act, the municipality decided to take the initiative and became member of the EU Mission: Adaptation to Climate Change, developed a climate adaptation strategy with own resources, and applied for the CLIMAAX project to close the knowledge, funding, and methodology gaps that prevented it from developing a CRA.

The municipality will use the CRA to encourage cooperation for adaptation and prevention at the regional level and to attract funding for adaptation measures from the national levels. The use of the CLIMAAX framework will enable the municipality to achieve these two objectives. At the national level a National Climate Change Adaptation Strategy (World Bank, 2019) exists that was taken into consideration in the development of the municipal one. However, local CRAs are not obligatory and not financially supported by the central government in Bulgaria, which de facto makes the national strategy impossible to implement as real problems, hazards, risks, impacts, and measures are at the local level. This national approach leaves municipalities in a very hard position, which motivated Garmen to seek EU opportunities to produce its CRA as a strong basis for climate risk management (CRM) and risk mitigation.

A number of economic sectors in the region are vulnerable to climate related hazards directly or indirectly – tourism, agriculture, lumber production being the most significant. The climate adaptation strategy (Garmen municipality, 2024) already calls for action and suggests measures that should be taken in the short and medium term. The CRA will help operationalize the recommended measures by providing a solid scientific ground for their better targeting and prioritization, as well as by supplementing the document with knowledge on risks and hazards that could entail the inclusion of additional solutions and recommendations.

2.1.3 Participation and risk ownership

Stakeholder involvement is a central element to the Garment CRA development process. During this first stage of the project, stakeholders were identified and the ongoing participatory approach as described in the work plan was started. The stakeholders identified include citizens, with a particular focus on those from areas affected by climate change relevant hazards; representatives of local businesses in tourism, services, retail, and agriculture, media representatives; municipal administration officials with knowledge and experience in disaster prevention and management; regional authorities – the regional governor's administration, the regional structure of the State Forestry Agency, the regional River Basin Management Directorate, the local Civil Protection Service and the local Fire Department, the Regional Inspectorate for Environment and Water; national authorities - the Ministry of Environment and Water, the Ministry of Regional Development and Public Works, the Ministry of Agriculture. During phase 1 of the project some of the identified stakeholders were consulted on climate risk input, whereby two objectives were achieved: their feedback on climate risks was collected and used in the scoping process as an important element for validation of the hazard and risk selection. Stakeholder engagement at this first stage of the project mainly involved administration officials, representatives of vulnerable groups from impacted areas and local structures of regional authorities, as those were identified as most experienced and knowledgeable of the hazard and risk situation in the municipality. The stakeholder engagement in the second and third phases will reach out more to stakeholders at the national level and the general public.

Risk ownership falls entirely with the municipality, whereby according to the Disaster Protection Act (National Gazette, 2016) it is the municipal administration led by the mayor that is responsible to develop action plans and to activate them in case of disasters. According to the act, the same holds true for prevention and risk management plans, including in the case of adaptation to climate change. However, the practice shows that in the case of civil protection during disasters, which amounts to reactions in case of an already occurring disaster, there are some guidelines and consultation services available from the Ministry of Interior and its regional/local civil protection units, whereas in the case of prevention and in particular adaptation to climate change (as a form of an evidence-based prevention of disasters and climate-driven gravely negative impacts on the population) such support is largely missing.

When a disaster occurs, especially related to river floods, the response goes beyond the financial and human resources of the municipal administration and it reaches out to regional and state authorities for assistance. Therefore, prevention is key to save resources and enable the municipality to deal with climate relevant risks that are chronic and require ongoing attention. The municipality wants to use the CRA to see what adaptation measures would be enough to effectively prevent river flooding. In the case of heatwaves, given the trend of aging population, it is again vital to take prevention measures and the CRA will help identify periods and areas were the municipality should plan to intervene in prevention by adaptation measures to reduce temperatures or by health and social measures to reduce exposure.

Upon completion of phases 1 and 2 it is important for the municipality to communicate the results to its residents so as to raise awareness and ownership of the adaptation initiatives to come, to regional authorities and structures of national agencies to enhance coordination in prevention and response efforts, and to national level authorities to seek funding for adaptation and prevention measures, as well as to promote the CRA approach for replication across the country.

2.2 Risk Exploration

2.2.1 Screen risks (selection of main hazards)

The municipality of Garmen is exposed to a number of climate-related hazards, i.e. river floods, heatwaves, extreme precipitation, flood related landslides, and droughts. The two most pressing hazards identified both by recent events, knowledge in the municipal administration, and stakeholder engagement are river floods and heatwaves as they have the most impact, severity, and frequency and therefore call with more urgency for action. This holds true particularly in light of the fact that river floods and heatwaves as hazards are also drivers for the hazards of flood-related landslides and the potential for droughts, the later also strongly influenced by the non-climatic driver of inefficient water management at the state and regional level. Therefore the municipality will focus on the river floods and heatwaves workflows for hazard and risk assessment.

The Municipality of Garmen has been affected by climate-change related river floods, whereby floods from the Mesta and Kanina rivers have frequented. These floods seriously affect local infrastructure – water supply in particular, businesses, homes, and the environment. River flooding impacts the quality of life and health of local residents, in particular of the vulnerable group of the elderly who have limited reaction capacity to evacuate and bear a higher risk for physical injury and death, as well as residents of lower income which makes the material toll of flooding hard to recover from, even with state or municipal financial support. For instance in 2021 serious floods in December damaged the water supply system and cut off drinking water for residents in the municipality and damaged a number of hotels and homes, roads and energy infrastructure. In cases of river floods inflicting serious damage on critical infrastructure it is not even possible to work on fixing the damage during the period of the flooding. The local business and economy, which rely highly on tourism, are gravely disrupted. The lack of funding for restoration measures after the floods is a serious challenge, whereby damages are not overcome for many months after the floods, including such on people's homes and transport infrastructure. Therefore, the highest priority for the municipality in terms of the river floods risk is prevention. The municipality has designed a project consisting of three phases with measures that offer a temporary solution. The project is based on current knowledge about the most vulnerable sections of the river bed based on observations and past experience. The municipality has managed to attract funding for the first phase but does not have the financial means for the remaining two phases, which are pressing. Therefore, the municipality needs to attract funding on the one hand but also, and more importantly, on the other - to come up with more sustainable nature-based solutions that will offer a long term strategy, such as clearing the river bed, creating barriers through accumulation of earth on the river banks, afforestation, and other appropriate measures. To identify these measures, however, as well as to supplement and operationalize the municipal climate adaptation strategy, the municipality needs to conduct a risk analysis to see how climate change will continue to impact floods as well as what areas will incur the most economic damage to make sure a comprehensive and effective approach is designed for adaptation efforts when it comes to the river floods risk.

Heatwaves on the territory of the municipality are the second hazard that we would like to take as a priority due to the population structure, whereby the trend of aging population creates health risks and risks to the system for medical services locally and regionally. The average temperature in Garmen has increased from 11.8 degrees Celsius in 1979 to 13.4 degrees Celsius in 2023. With the increase in average temperature, heatwaves are becoming common during summer months. The year 2024 was the hottest since 1930 in the Blagoevgrad region and a "red code" was announced on the media to warn people about the health hazards, as well a number of measures were introduced at the regional level, such as water dispensers/bottled water handout in the urban areas, cooling main roads with water sprinklers in the early hours to prevent overheating, limitation on the use of roads by vehicles over 20 tons, etc. The municipality has observational knowledge about some of some of the locations in terms of reached high temperatures but an assessment is needed on what the hotspots are that are most likely to have the biggest negative impact on vulnerable groups. This makes it imperative to identify what would be the trend in occurrence of heatwaves with climate change, as well as what are the hotspots where we have an overlap of the highest occurring temperatures and the highest density of vulnerable population.

2.2.2 Workflow selection

2.2.2.1 Workflow #1: River floods (the risk assessment workflow for river flooding)

The municipality of Garmen chose the river floods workflow to see how fluvial flooding from the Mesta and Kanina rivers is impacted by climate change and what are the areas prone to most economic damages from the floods as this will grant a sound foundation for planning of adaptation measures and the spatial development of the municipality in terms of attracting new investments and infrastructure. Fluvial flooding constitutes high water levels in the river bodies caused by heavy precipitation which has been observed in Garmen in the autumn and particularly in winter months. Based on European-scale river flood maps, the workflow computes the areas where most economic damages are to be expected. The resulting data and maps helped us assess the hotspots of potential economic damage due to river flooding for different return periods. Certain areas along the river beds are most vulnerable and groups of the local population that reside or work there are at most risk. Local (critical) infrastructure - such as the main water supply line, transport and energy routes - is within the exposed areas, as well as businesses from the tourist sector and agricultural land.

2.2.2.2 Workflow #2: Heatwaves (the risk assessment workflow based on satellite-derived data)

The municipality of Garmen chose the risk assessment heatwaves workflow based on satellite-derived data as it is most useful at the municipal, i.e. sub-regional level, on the one hand, on the other – it best corresponds to municipal policy aims and is to benefit the decision-making process the most. Characteristic of the municipality is that the population of Garmen has a trend of aging, health care is not of adequate quality standards, while urban and building infrastructure is not adapted to higher temperatures. These are all challenges that the municipal leadership, the mayor in particular, needs to take into consideration for policy-making. By computing a risk map with the areas on the territory of the municipality most exposed to high surface temperatures against density of vulnerable populations (children 1-5 years of age and elderly above 65 years of age), the workflow equips the municipality with the necessary knowledge to plan adaptation measures with more efficiency. Additionally, the computation of increase in heatwaves occurrence through the EuroHEAT methodology supplements the picture to provide more clarity on the need to decrease the impact of future occurrences in the identified hotspots with vulnerable population.

2.2.3 Choose Scenario

In the river floods workflow, we find it useful to look at 1/ the current climate scenario for a number of return periods so as to assess the river flood hazard in terms of extent and inundation depth (flood maps), as well as at 2/ the RCP4.5 and RCP8.5 climate scenarios across several years (compared to the base scenario for year 1980 in the Aqueduct Flood Maps dataset) to see the impact of climate change on the hazard and the qualitative direction of change in this impact under the different climate scenarios. The river flood scenarios also should take into account economic damages as the majority of damages inflicted by river floods on the territory of the municipality concern transport, water supply, and energy infrastructure, cascading into damages for the tourist sector, direct damages for tourist infrastructure, agricultural land, and homes. At the same time, the population is of lower income, while the infrastructure is not adapted to withstand river floods. Given the limited resources of the municipality to react and recover from already inflicted or occurring damages by river floods, prevention is key both through protection measures, including nature-based solutions, and spatial planning that minimizes the risks.

In the heatwaves workflow, the climate scenarios RCP4.5 (medium) and RCP8.5 (extreme) are used to compare the effect of different climate scenarios on the frequency of heatwave events for the future climate. Thus, the hazard assessment workflow, based on the EU-wide health-related thresholds in the heatwave definition as used in the EuroHEAT project, provides information about the heatwave frequency of occurrence for the selected location for 1986-2086 for RCP4.5 and RCP8.5. The risk assessment workflow selected as most useful for the municipality of Garmen produces an estimation of the risk based on exposure of vulnerable population in combination with high-resolution observation data for surface temperature. The combination of the hazard and risk assessment workflows allows for a good estimate of current and future risks. For the scenarios under the heatwave risk, some non-climate contextual factors need to be considered, such as the expected continued trend of aging of the local population, as well as the deterioration of local access to healthcare given policy ambitions on the national level to optimize the healthcare system by closing down smaller medical amenities of under average conditions at the municipal level. The projected growth in the tourist sector, as well as the importance of agriculture, need to be considered in adaptation measures and risk management plans so as to minimize the potential negative impact of heatwaves on the sectors.

2.3 Risk Analysis

2.3.1 Workflow #1: River floods

Table 2-1 Data overview workflow #1: Rivel floods

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
JRC high-resolution flood hazard maps for Europe in historical climate	*JRC damage curves for land use*	*JRC LUISA land use data (100 by 100 meter resolution land use in Europe in 2018)*	*Economic damage estimate, i.e. damage maps based on flood maps and land use data - spatial view of what places can potentially be most affected economically*
Aqueduct Floods coarse-resolution flood maps - dataset of future river flood potential under climate change	*Vulnerability curves for flood damages for the LUISA land cover types*		

2.3.1.1 Hazard assessment (river flood maps)

This river floods hazard assessment workflow computes and visualizes river flood extent under the current climate with different return period, as well as the impact of climate change scenarios (RCP4.5 and RCP8.5) on the hazard. In applying the workflow, Garmen used European data clipped to the region of interest. As limitation to the datasets were underlined in the methodology, below, we also discuss the impact of these limitations in the case of Garmen, whereby the general conclusion is that they are of negligible importance.

For the computation of flood maps (extent and inundation depth) under the current climate with different return periods, the workflow is based on the March 2024 (v3) version of the high-resolution river flood maps from JRC at a special resolution of 3 arc-seconds (30-75m in Europe depending on latitude). This enabled the municipality to compare flood maps in the present climate scenario across the different return periods. Although a limitation of the dataset is that it only includes the river basins larger than 150km2, in the case of Garmen it included the Mesta and Kanina rivers, which are the cause for river floods on the territory of the municipality. Another potential limitation of the dataset is that the flood modelling in this dataset does not account for man-made protections that may already be in place in populated regions (e.g. dams, levees, dikes). However, in the case of Garmen we believe this limitation has very limited impact as there are not a lot of man-made protections or adaptation measures and these do not amount to effective prevention as of the current moment.

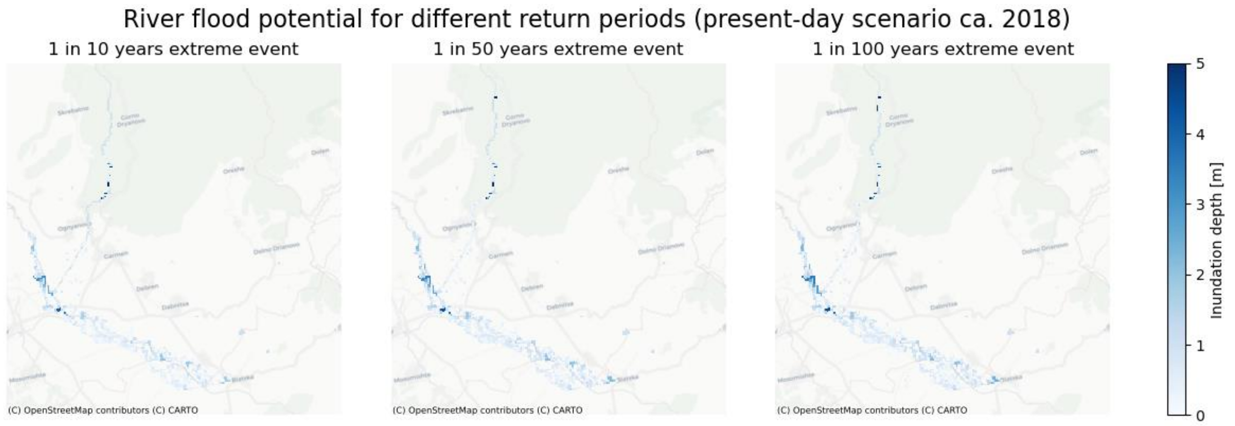

Figure 2-1 Flood inundation maps for the area of the Municipality of Garmen for extreme events with different return periods based on European high-resolution dataset

The second added value of this hazard workflow is that it computes the climate impact on river flood maps under the RCP4.5 and RCP8.5 climate scenarios, which provides insight into how river flood extent and inundation will change under these scenarios. For this purpose, the workflow uses coarse-resolution flood maps from the Aqueduct Flood Hazard Maps dataset with a resolution of 30 arc-seconds or 300-750m depending on the latitude (in Europe). This dataset includes flood maps for extreme flood events in the baseline climate (ca. 1980) and in the future climates (2030, 2050, 2080 for RCP4.5 and RCP8.5 climate scenarios). Despite the coarse resolution, this dataset provides understanding of the expected direction of change in flood depth for the different return periods. It has helped the municipality to establish whether river flooding will likely increase or decrease under the two scenarios in the selected years.

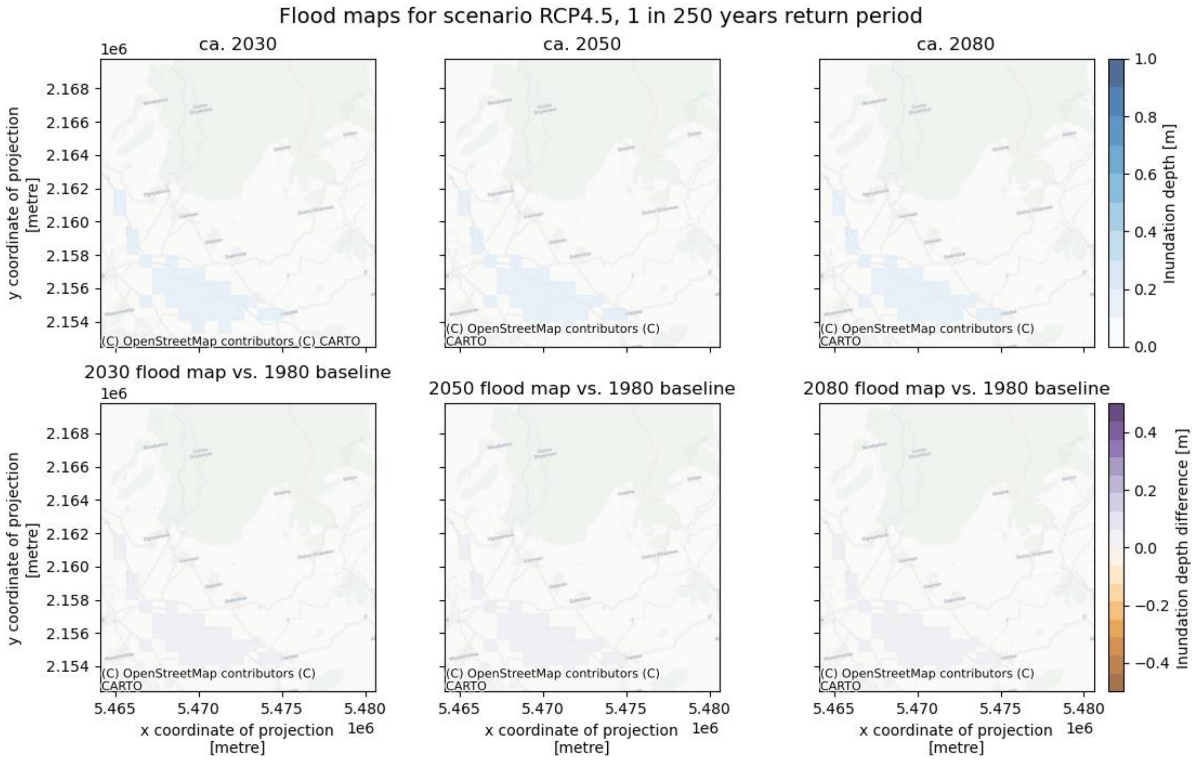

Figure 2-2 Flood maps for the municipality of Garmen for scenario RCP4.5, 1 in 250 years return period

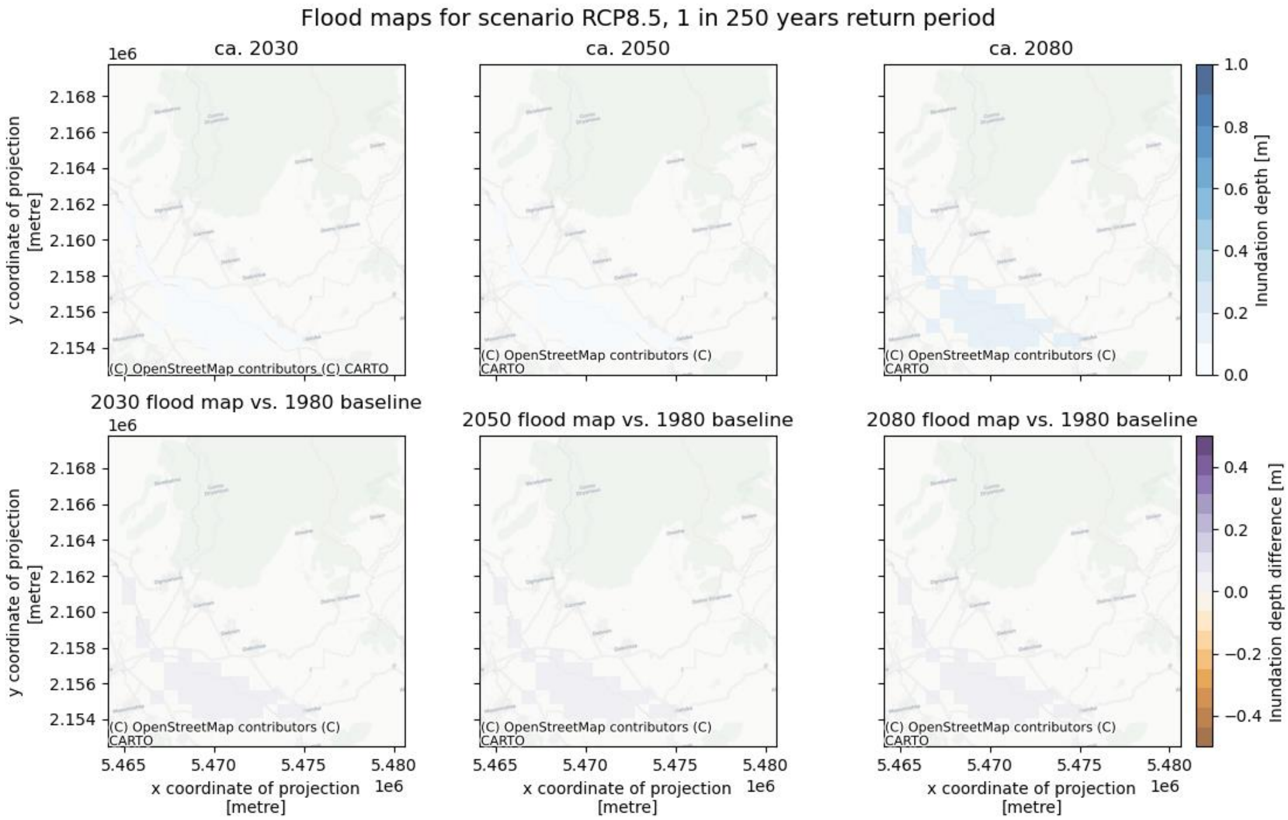

Figure 2-3 Flood maps for the municipality of Garmen for scenario RCP8.5, 1 in 250 years return period

2.3.1.2 Risk assessment

The river floods risk assessment workflow computes the risk through the combination of river flood maps for different flood return periods with exposure and vulnerability data, whereby exposure and vulnerability is calculated as economic damage functions.

For hazard data in this workflow we used the JRC flood maps for the present climate and the flood maps processed in the hazard assessment workflow based on the Aqueduct Floods dataset for future climate scenarios – in both cases clipped to the municipality. For exposure we used land-use data from the JRC data portal clipped for the municipality of Garmen (land use maps with 100 m resolution for 2018), which provided the first exposure layer for the workflow. The next step was to incorporate JRC depth-damage curves for different damage classes on infrastructure that were readily available. This allows to combine the maps of flooding, land use and infrastructure to assess multiple types of risk from river flooding. After the spatial resolutions of the datasets were aligned, we assigned a monetary value to the land use categories in terms of potential loss in euro/square meter by using the LUISA damage curves and inserting the GDP per capita for the region according to the Bulgarian National Statistical Institute (NSI) for the year 2023 (National Statistical Institute, 2025). This generated vulnerability curves for economic damages for the LUISA land cover types. Having processed all these datasets, the next step was the computation of potential economic damage to infrastructure using DamageScanner, which utilizes the following data: the clipped and resampled flood map, the clipped land use map, the vulnerability curves per land use category, and a table of maximum damages per land use category. This computes the results of damage calculations for all scenarios and return periods. Then we plotted the damages to get a spatial view of what places can potentially be most affected economically for the three return periods in Figure 2-4.

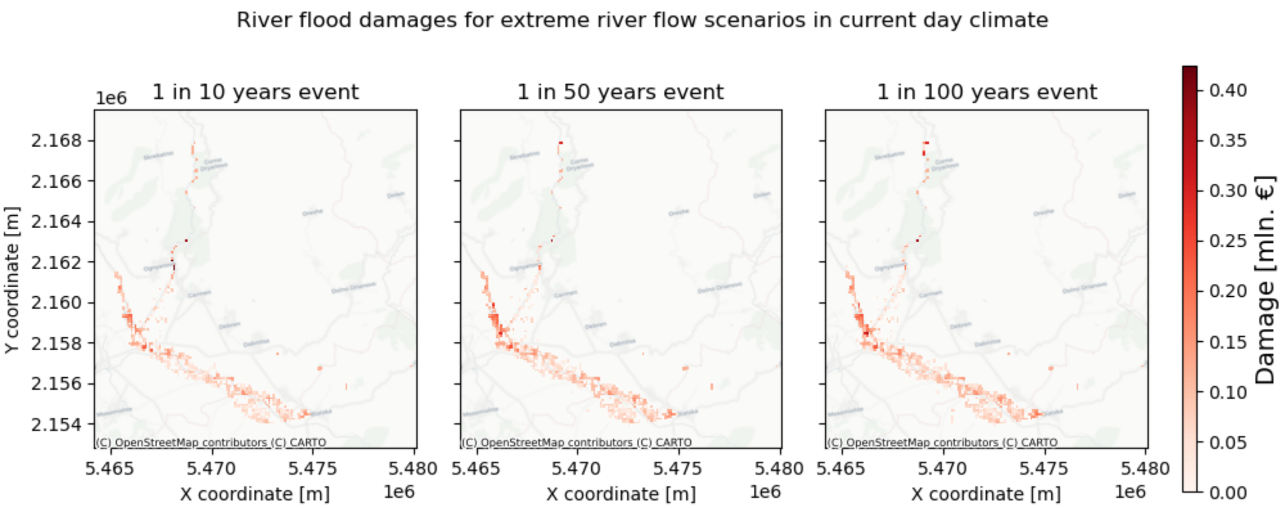

Figure 2-4 River flood damages for extreme river flow scenarios for the municipality of Garmen in current day climate

Flood damage in this workflow is calculated by combining depth-damage curves with maps of inundation depth. The damage is calculated by combining for each grid point the flood depth, land use type, damage curves, and economic country-specific parameters approximating the economic value for different land use.

To get a better indication of why certain areas are damaged more than others, we plot the flood, damages, and land use maps in Figure 2-5 for the 1 in 100 year return period. This gave us an overview of the the potential flood depths and the associated economic damages and helps see which areas carry the most economic risk under the flooding scenarios. From the comparison of inundation depth and damage maps we see that in cases of high inundation high damages occur.

This is the case because these are areas where infrastructure and land use with economic significance is located.

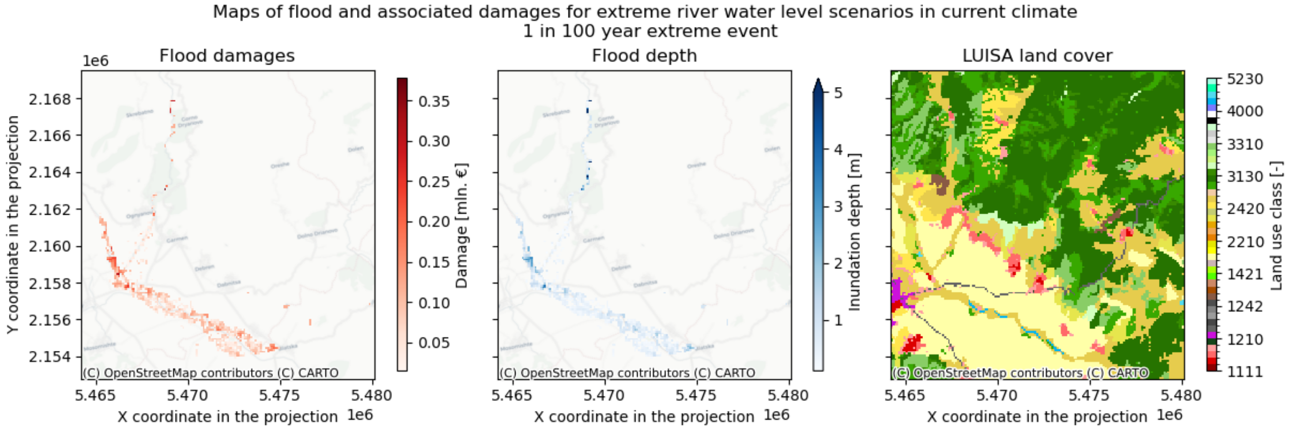

Figure 2-5 Maps of flood depth, associated damages, and land use for the municipality of Garmen for extreme river water level scenarios in current climate, 1 in 100 year extreme event

The plotted maps in Figure 2-5 allowed us to assess the hotspots of potential economic damage due to river flooding for the return period and see the related land use type that would be subject to the damage.

Section 2.4 offers the analysis of the results obtained through the river floods hazard and risk assessments.

2.3.2 Workflow #2: Heatwaves

Table 2-2 Data overview workflow #2: Heatwaves

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
CDS dataset from the EuroHEAT project	*WorldPop data (DOI: 10.5258/SOTON/WP00646) for the most vulnerable groups of the population, i.e. 5, 65, 70, 75, 80 years of age., age structures as of 2020*	*RSLab Landsat8, resolution: 30x30m*	*risk map which shows the possible heat risk level to vulnerable population.*

2.3.2.1 Hazard assessment (EuroHEAT)

The hazard workflow computes how climate change under the RCP4.5 and RCP8.5 climate scenarios impact the occurrence of heatwaves for the location of Garmen. The methodology uses a CDS dataset (data available on a 12x12km grid for years 1986-2085 for the whole EU) from the EuroHEAT project with the health-related EU-wide definition as no national definition is available. For the current CRA the data used was for a ten year period (2015-2024) for the months of June to August as the hottest summer months, whereby heat waves were defined 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. The results show the projected heatwave occurrence per year under the RCP4.5 and RCP8.5 climate scenarios (Figure 2-6). Thus, the workflow results enabled the municipality to evaluate the projected trend in the frequency of heatwave occurrence over time under two climate change scenarios.

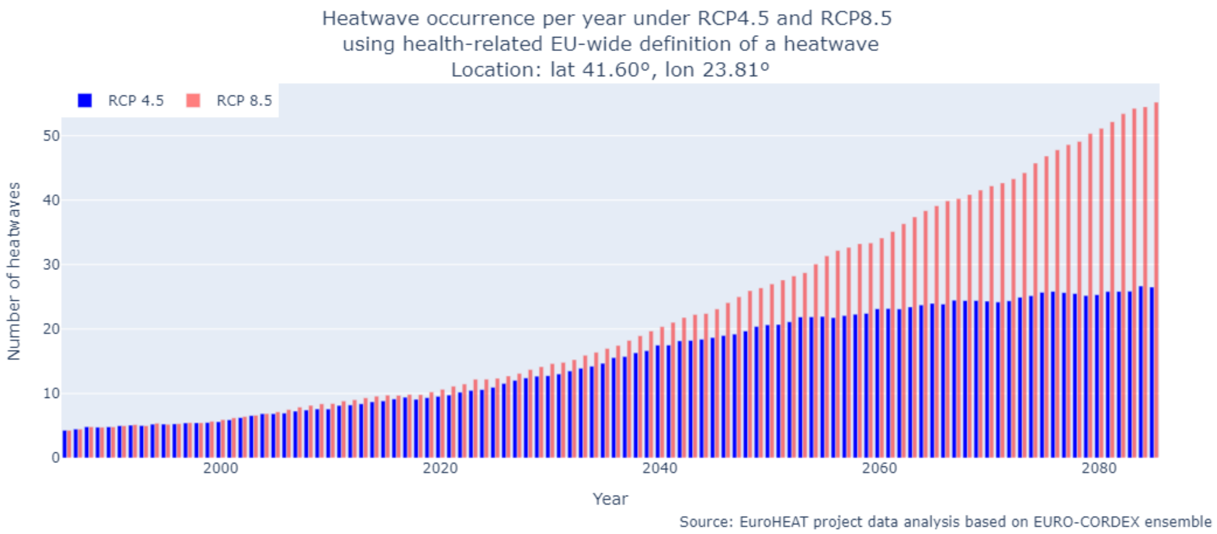

Figure 2-6 Heatwave occurrence per year under RCP4.5 and RCP8.5 using health related EU-wide definition of a heatwave for the location of Garmen

2.3.2.2 Risk assessment (satellite-derived data)

The risk assessment workflow chosen by the municipality of Garmen is based on historical satellite-derived data. In essence, it plots maps of overheated areas (based on land surface temperature satellite data) next to a map of the vulnerable population (children below 5 and elderly above 65 years of age) density to create a 10+10 risk matrix, which serves as the basis for the computation of a risk map that shows the heat risk level to vulnerable population. In applying the workflow, for surface temperature the municipality used RSLab Landsat8 data (MODIS emissivity) on a polygon covering the municipality with a focus on the 5 largest urban areas in the municipality and excluding some of the smaller settlements and forest areas that are less likely to feel the impact of heatwaves. This data provided information on the exposure to be plotted in the workflow. The vulnerable population groups and their density were identified using data from the WorldPop dataset, which gave the vulnerability data for the risk map plotted by the workflow. This risk workflow allowed the municipality of Garmen to identify the places that can be most influenced by the heat and are also most densely populated with the vulnerable population groups. The resolution of the data in the vulnerable population density map posed some challenges to the analysis but the interactive map plotting the risk helped the municipality better identify risk-prone areas. Plugging in local data in phase 2 of the project might further alleviate this challenge.

Section 2.4 offers the analysis of the results obtained through the heatwaves hazard and risk assessments.

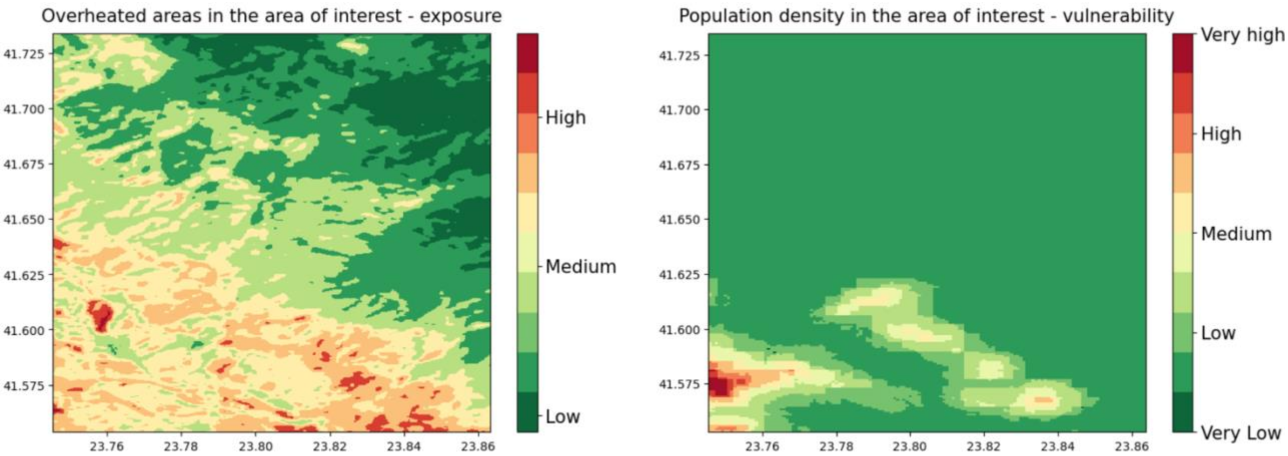

Figure 2-7 Maps of overheated areas (exposure) and population density (vulnerability) in the Municipality of Garmen

Risk matrix 10+10

Heat exposed areas based on the LST	1	2	3	4	5	6	7	8	9	10
10	Medium 11	Medium 12	High 13	High 14	High 15	High 16	Very high 17	Very high 18	Very high 19	Very high 20
9	Medium 10	Medium 11	Medium 12	High 13	High 14	High 15	High 16	Very high 17	Very high 18	Very high 19
8	Medium 9	Medium 10	Medium 11	Medium 12	High 13	High 14	High 15	High 16	Very high 17	Very high 18
7	Low8	Medium 9	Medium 10	Medium 11	Medium 12	High 13	High 14	High 15	High 16	Very high 17
6	Low 7	Low8	Medium 9	Medium 10	Medium 11	Medium 12	High 13	High 14	High 15	High 16
5	Low 6	Low 7	Low8	Medium 9	Medium 10	Medium 11	Medium 12	High 13	High 14	High 15
4	Low 5	Low 6	Low 7	Low8	Medium 9	Medium 10	Medium 11	Medium 12	High 13	High 14
3	Very low 4	Low 5	Low 6	Low 7	Low8	Medium 9	Medium 10	Medium 11	Medium 12	High 13
2	Very low3	Very low 4	Low 5	Low 6	Low 7	Low8	Medium 9	Medium 10	Medium 11	Medium 12
1	Very low 2	Very low 3	Very low 4	Low 5	Low 6	Low 7	Low8	Medium 9	Medium 10	Medium 11

Vulnerable population density

Figure 2-8 Risk matrix combining overheated areas and vulnerable population density

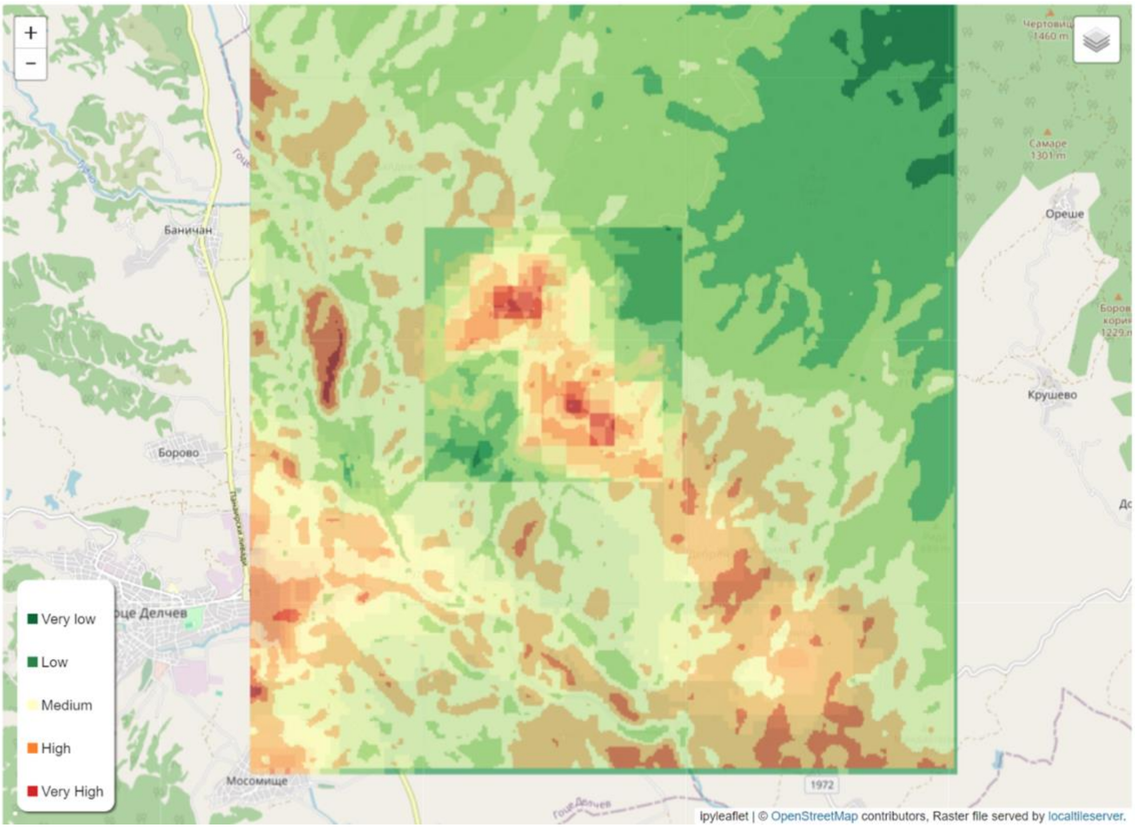

Figure 2-9 Heatwave risk to vulnerable population in the Municipality of Garmen

2.4 Preliminary Key Risk Assessment Findings

2.4.1 Severity

The two major risks the municipality is experiencing and will continue to face with increased severity in the future are river floods and heatwaves. The two risks are analyzed below on the basis of the results from the applied hazard and risk assessment workflows.

The river floods hazard assessment results show an increase in severity under the historic and RCP4.5 climate scenarios. In the present day climate scenario, the flood potential for the different return periods (10, 50, and 100) shows an increase in inundation depth, including at new locations especially along the Kanina river, which increases the risk for a number of settlements, notably Ognyanovo as a tourist destination. Assessing the change in flood hazard potential under different climate scenarios with a 250 return period, the hazard workflow points that in the RCP4.5 scenario the inundation depth increases but there is little change in potentially exposed areas comparing against not only the baseline year but also across the 2030, 2050, and 2080 plot. The RCP 8.5 scenario reveals a surprising decrease of inundation depth and extent to practically non-existent hazard for the years 2030 and 2050 compared to the baseline year. This could be indicative of other climate-relevant hazards, such as droughts that under this scenario substantially increase their impact. The return of considerably higher inundation depth for the 2080 plot compared to the 2030 and 2050 plots points to the compounding nature of the river flood and drought risks under the RCP 8.5 scenario. Given the negative values in the RCP 8.5 scenario, we assume that the JRC flood maps for the present climate are conservatively representative of the future risks as well, with the clarification that under RCP4.5 scenario flood inundation will increase and this is not a negligible change and should be considered for the same hotspots of damage identified under the current climate damage maps.

The river floods risk assessment in the current day scenario for the return periods of 10, 50, and 100 years shows an increase in the damages in terms of coverage and severity, which visually coincide with the points of increased extent and inundation from the hazard assessment flood inundation maps under the current climate. Major increases are along the Mesta and Kanina rivers. Based on the workflow flood damage maps, we can see that the severity will increase with particular impact on several settlements – Gorno Dryanovo and Ognyanovo, Baldevo, Marchevo, Hvostyane. The damage maps, however, show that Gorno Dryanovo and Ognyanovo will incur the highest damages in terms of million euro and are most prone to bigger inundation depth so these areas need to be treated with particular priority when it comes to protection, prevention, and adaptation measures. The areas of increased inundation depth (from the hazard assessment) and increased damage (from the risk assessment) also coincide with transport, water supply, and energy infrastructure that has suffered in past extreme events and is costly and difficult to restore. Apart from the direct risk to infrastructure, cascading risks here emerge for the tourism sector as inconvenient conditions are created for visitors (lack of water, energy, heating), hotels are flooded, and road access could be blocked or limited. Prolonged periods of interrupted supply of water can additionally lead to sanitation and health crises. Prolonged lack of energy, given that floods are more likely to occur in late autumn and mostly winter months, create major challenges for heating. Transport infrastructure damages can potentially impact also the supply of food for settlements. The LUISA land cover map for Garmen municipality also points that agricultural land is prone to damage. This has the potential to affect the local economy, in particular agricultural producers and workers in the sector.

The heatwaves hazard assessment clearly shows a considerable increase in the frequency of heatwave occurance under both future climate scenarios – RCP4.5 and RCP8.5. Even under RCP4.5 the occurance almost doubles within the next fifteen years. Table 2-5 in section 2.3.2.1 shows the projection under the two climate scenarios for Garmen. The results show a clear trend of increase in the occurrence of heatwaves. This trend is a strong indication that the municipality of Garmen needs to take adaptation actions to shield its population and economy from the negative impact and cascading risks from the heatwave hazard.

The heatwaves risk assessment shows that the most heated areas with the biggest population density are the areas around the settlements of Ribnovo, Ognyanovo, Garmen, Debren, and Dabnitsa. Combined with the insight from the hazard assessment that the frequnecy of heatwaves will increase under both RCP4.5 and RCP8.5 climate scenarios this gives the municipality indication where to direct its efforts to decrease the impact of this risk. The heatwaves risk has cascading adverse impact on a number of systems, such as health care, agriculture, tourism, energy infrastructure, water resources and supply infrastructure. The most direct and pressing consequences of the increasing frequency of heatwaves in the urbanized areas are related to the impact on human health and wellbeing, especially of vulnerable groups - the elderly and children. This is particularly a pressing challenge for municipalities as Garmen with a trend of aging population, where buildings frequently are old and don't have air-conditioning, while the lower income profile of the population makes it more susceptible to the negative effects of heatwaves. Heat-related health consequences include mortality, heatstroke, heat exhaustion, dehydration, and deterioration of chronic and pre-existing health conditions. Access and quality of healthcare pose additional challenges that call for actions to mitigates the negative impact of heatwave exposure for vulnerable population groups.

2.4.2 Urgency

The river floods risk already has major impact that will only increase under the current climate for different return periods, as well as under the RCP4.5 climate scenario. This means that the municipality of Garmen needs to take immediate action to prevent and minimize the damages that this impact has the potential to incur. The damage maps from the risk assessment in this regard provide important information not only on the damage prone areas but also on the magnitude of damages that will help the municipality direct and prioritize its efforts for protection infrastructure and adaptation measures in prevention. Given that the hazard of river floods is sudden-onset and therefore hard to predict as it is the consequence of extreme precipitation, this adds to the urgency to act in prevention without delay.

The heatwaves risk is based on a slow-onset hazard, which allows the municipality to act with a lesser degree of urgency. The presence of a palpable impact at present requires targeted adaptation steps and actions be taken now, which at the same time can be upgraded in a gradual manner in the next ten to fifteen years, when the frequency of occurrence would have doubled by 2040 even under the more optimistic RCP4.5 climate scenario. If the population structure trends continue this non-climatic driver will make the risk even more pressing. Another aspect that needs to be taken into consideration is the cost and time horizon for adaptation measures. Given these are frequently related to changes in the urban environment that take longer time to plan, fund, and implement, it would be a good idea to start working on mitigating this risk as soon as possible.

2.4.3 Capacity

The municipality of Garmen's ability to tackle the river flood risk are limited. In terms of prevention, and in particular after the devastating flood of December 2021, the municipality has prepared a project to build protection facilities and to correct the riverbed along the Kanina river but the project covers only 1.8km of the river. In terms of disaster response, the municipality has a disaster response and civilian protection plan for floods (Garmen Municipality, 2019). The response to river flood disasters in the majority of cases cannot be conducted with municipal resources and requires the involvement of regional structures and the activation of the regional disaster response plan. In the aftermath of river floods, the municipality is equally challenged to carry out restoration activities with own funds and relies on national support. The risk management measures and capabilities for disaster response as of the present moment further speak to the need for urgent measures in disaster prevention, climate change adaptation, and building risk management capabilities in respect to river floods. By dealing with this risk in the CRA, we lay the foundations for enhancing our chances for future funding from the national budget for measures managing this risk, as well as increase our ability to seek EU funding and private investments.

In respect to the heatwaves risk, no current risk management measures are in place. The municipality makes sure to announce expected extreme hot weather but has not introduced any particular measures to minimize the impact. We believe that working on the analysis of this risk under the CRA has equipped us with more knowledge and better understanding of the risk, and the results will allow us to target our plans for adaptation, which will not only make it easier for us to plan measures but also to acquire the necessary funding from state and EU sources.

2.5 Preliminary Monitoring and Evaluation

During this first phase of the project, we got acquainted with the CLIMAAX methodology. We created locally the necessary technical setup for the application of the workflows. We were able to test and apply two workflows, as well as to understand their intricacies, added value, and limitations. This allowed us to analyze the results in a realistic manner taking account of and estimating the impact of potential limitations on the results. It also provided the foundation for collecting and selecting locally relevant data for the refinement of the CRA in phase 2 of the project. Most difficulties emerged during the test of the workflows, whereby some technical difficulties would result in errors. These difficulties, however, were efficiently overcome with the help of the CLIMAAX Service Desk in a very timely manner.

Stakeholder feedback was important in validating the selection of the hazards and secured that the municipality selects the two risks and their respective hazards with most priority, severity, and need for adaptation measures. Stakeholder engagement at this point included local and regional counterparts, whose input was suitable for the level of analysis that required local knowledge to feed into the process leading up to deliverable 1 and this strategy proved lucrative. In phase 2 and 3 of the project, the municipality will continue to engage and expand the circle of stakeholders, as well as will an a focus on sharing of CRA results and raising awareness across the general population and the media (dissemination). Additionally, once the refined assessment (deliverable 2), the updated municipal climate strategy (deliverable 3) and its action plan are ready, the municipality will engage national authorities as a separate stakeholder to promote the replication of the CRA-based policy approach across the country, as well as to advocate for funding for concrete adaptation measures.

After this first phase of the project, we feel we have a good understanding of the risks through the CLIMAAX common framework and methodology as some of the methodological limitations are not likely to have a result-altering impact in our case (as discussed in section 2.3 of this deliverable). However, we believe that refinement with local data of the workflows will shed additional light on the risks.

3 Conclusions Phase 1- Climate risk assessment

The performed assessment of hazards and risks has produced valuable insights in respect to climate risk management of the two main priority risks for the municipality – river floods and heatwaves. Some of the major challenges were related to the resolution of data, which in the case of the heatwaves workflow made the analysis harder. However, the results produced (in particular via the use of the interactive map) offer a sufficient level of insights to guide risk management efforts even prior to the refinement of the CRA with local data. In Phase 2 the municipality will attempt to add additional layers of local data to make the analysis easier and more robust.

Challenges addressed in this phase included the technical level of preparedness of the municipality for the computation of risk assessments and the lack of expert knowledge on CRA. Therefore, phase 1 was particularly useful in setting the infrastructure (technology) and process for conducting a CRA using the CLIMAAX framework, which can be reiterated in time after the end of the CLIMAAX project and this is of particular value. Given the lack of previous experience with CRA for the municipality, but also for municipalities at large in Bulgaria, the availability of this structured process is crucial. The CLIMAAX technical support in this respect was highly appreciated by the municipality. In terms of thematic clusters around stakeholder engagement, and previous CRA experiences of other regions and municipalities, the CLIMAAX CoP webinars were a useful resource. In addition, thanks to the CLIMAAX financial support, the municipality was able to contract external expert support. So in conclusion, the first phase has benefited greatly the municipality of Garmen.

A challenge that remained to be addressed in the second phase of the project is the lack of readily available local data of greater resolution and good quality. The project team will work on the collection and selection of such data during phase 2 of the project. This challenge extends not only to climate-related data but also to data relevant for non-climatic risk drivers that could shed more light for instance on vulnerability.

Phase 1 demonstrated the importance of stakeholder engagement in terms of local non-expert knowledge that can add to the context and scoping of the CRA so as to align the study with local expectations, needs, and priorities. Stakeholder consultation so far has highlighted the need to simplify the complexity of the CRA process for stakeholders, focusing on results and framing these in actionable language, especially in respect to what policy-makers can undertake.

In terms of key findings, it is worth highlighting that as a result of the scoping phase, the two risks that were selected for assessment in the current CRA – river floods and heatwaves, were prioritized based on observed (historical) impact. Both proved to increase in severity under different climate scenarios and to require risk management actions by the municipality, whereby the river flood risk is of higher level of urgency because the level of risk is beyond what the municipality can tolerate given its current poor capacity to react in disaster response and the lack of protective and prevention measures. When it comes to the risk of heatwaves, the municipality has a longer time horizon to react due to the gradual onset of the hazard and the higher level of tolerance for the current moment and potentially the next five to ten years. However, taking into consideration the resources that are necessary and the planning involved in effectively implementing adaptation measures in respect to both risks, the municipality has expressed its ambition to start work on both as soon as possible. Both risks also produce cascading and compound impacts that transcend sectors and potentially feed into other climate related hazards. The municipality therefore plans, upon the completion of the CRAG project, to continue to follow work at EU level that looks more closely into compound climate hazards.

4 Progress evaluation and contribution to future phases

The first deliverable with the application of the two workflows produced the first version of the CRA for Garmen municipality. The second project phase will build upon this CRA by identifying existing or possible to collect and compile data to produce a library of resources to enhance the granularity and robustness of the assessment. The data will be plugged into the workflows to produce the refined CRA (deliverable 2).

This first deliverable will also be used as the basis for dissemination and stakeholder engagement activities in Phase 2. In effective communication of risks in climate adaptation towards the general population and stakeholders at large, the audience by definition is non-expert and non-scientific. Therefore, it is more useful to share information on results than process and methodology so as to translate the complex matter of climate multi-risk assessment into messages and storylines understandable for stakeholders that would mobilize engagement and raise awareness. In line with this approach, the municipality has planned to conduct the dissemination activities with a broader spectrum of stakeholders and residents after the start of Phase 2, so as to build its communication and engagement on the CRA results (deliverable 1) with the two-pronged aim of sharing results to raise awareness and collecting feedback in validation as well as for the process of refinement of the CRA. By comparison the meeting carried out during Phase 1 as described in Table 4-1 included a narrower circle of stakeholders as the communication was targeted towards the collection of useful input from local knowledge and experience. Since the methodology for the refined CRA under Phase 2 will remain the same, the experience, knowledge gained, and produced outputs of Phase 1 will be fundamental also for the activities in Phase 2. Phase 3 builds upon the deliverables of the first two phases to update the municipal climate adaptation strategy, design the action plan for its implementation, and conduct the outreach activities to decision-makers and policy-shapers at the regional and national level to seek support for concrete adaptation measures and improved coordination in prevention efforts at the regional level.

Table 4-1 Overview key performance indicators

Key performance indicators	*Progress*
two workflows – 1/ River floods and 2/ Heatwaves - successfully applied on Deliverable 1.	*Completed with European data*
one meeting with local and regional stakeholders to collect input on climate risks but also to share information and build awareness about the ongoing process of climate multi-risk assessment.	*Completed in February 2025*
five communication actions taken to share results/progress with stakeholders, including any of the following media publications and social media posts, and in-person and online events, dissemination and delivery of presentations, whereby two would be the following: - *one meeting with local and regional stakeholders (residents, CSOs, local business, the media, regional authorities) to present the results from the multi-risk climate assessment, share plans for next steps and collect feedback relevant to policy decisions;*	*To be completed in Phase 2 and Phase 3*

Key performance indicators	*Progress*
- *dissemination of project results through the National association of municipalities to its members.*	
five stakeholders involved in activities relevant to the project (citizens, media, local business, regional authorities, national authorities relevant to climate adaptation);	*This is a KPI to be completed for the entire duration of the project. Citizens, local businesses, municipal administration officials, and regional authorities have been involved so far in relation to the meeting with stakeholders under Phase 1 to the extent that they could provide input in the process leading up to the completion of this deliverable.*
two outreach initiatives to policy makers to share results and advocate for next steps building on the multi-risk assessment – one in respect to the relevant regional authority to enable and advocate for the use of the assessment in regional planning and one to the national authorities to advocate for funding for climate change adaptation measures.	*To be completed in Phase 3*

Table 4-2 Overview milestones

Milestones	*Progress*
M1: Test of workflow 1 made (Phase 1)	Completed
M2: Workflow 1 successfully applied (Phase 1).	Completed
M3: Test of workflow 2 made (Phase 1).	Completed
M4: Workflow 2 successfully applied (Phase 1).	Completed
M5: Meeting with local and regional stakeholders to collect input on climate risks completed (Phase 1);	Completed in February 2025
M6: Submission of Climate Multi-Risk Assessment Report (Deliverable 1) (Phase 1).	Completed (with the submission of the current deliverable)
M7: A library of resources with additional regional/local data created (Phase 2).	To be completed in Phase 2 of the project
M8: Attend the CLIMAAX workshop in Barcelona (Projected for Phase 2 but depends on Climaax coordinator).	To be completed in Phase 2 of the project
M9: Submission of the Refined local multi-risk assessment (Deliverable 2) (Phase 2).	To be completed in Phase 2 of the project
M10: Meeting conducted for presentation of the results from the multi-risk climate assessment to local and regional stakeholders – citizens, CSOs, media, business, regional authorities (Phase 2).	To be completed in Phase 2 of the project

Milestones	*Progress*
M11: Climate Change Adaptation Strategy of Garment municipality reviewed and updated in light of the climate multi-risk assessment (Deliverable 3) (Phase 3).	To be completed in Phase 3 of the project
M12: The drafting process of a municipal risk management plan with a particular focus on prevention and support for disproportionately affected by climate risks segments of the local community started (Phase 3).	To be completed in Phase 3 of the project
M13: A process of advocating for national funding or attracting investments for climate adaptation measures in the municipality on the basis of the multi-risk assessment started (Phase 3).	To be completed in Phase 3 of the project
M14: Advocacy effort for an improved regional approach to planning and prevention in respect to climate change impact and disasters, based on the multi-risk assessment, initiated with regional authorities (Phase 3).	To be completed in Phase 3 of the project
M15: Attend the CLIMAAX workshop held in Brussels (Projected for Phase 3 but depends on Climaax coordinator).	To be completed in Phase 3 of the project

5 Supporting documentation

- Main report in PDF (current document, submitted through the CLIMAAX Deliverable Platform)
- Zip file with visual outputs and workflow notebooks for hazard and risk for Workflow 1: River floods (submitted in Zenodo, DOI: 10.5281/zenodo.15109877)
- Zip file with visual outputs and workflow notebooks for hazard and risk for Workflow 2: Heatwaves (submitted in Zenodo, DOI: 10.5281/zenodo.15109877)

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