Deliverable Phase 2 – Climate risk assessment

Climate Risk Analysis for Garmen (CRAG)

Bulgaria, Municipality of Garmen

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Document Information

Deliverable Title	Phase 2 – Climate risk assessment
Brief Description	This deliverable provides the refined climate multi-risk assessment for the municipality of Garmen, which was accomplished through the application of the CLIMAAX framework common methodology for multi-risk assessment (i.e. three workflows) and the incorporation of local data and stakeholder engagement to ensure a comprehensive and policy-oriented analysis of the results.
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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
D1	Deliverable 1
D2	Deliverable 2
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 2 – Climate risk assessment" (CRA) report under the project "Climate Risk Assessment for Garmen (CRAG)" constitutes the refined CRA for Garmen municipality. It presents how the initial CRA resulting from the successful application of two CLIMAAX workflows using European data – i.e. the one on river floods and the one heatwaves respectively, has been refined with local data for more precision, detail, analytical depth, and most importantly to Garmen as local government – to be operationalized and made more pragmatically relatable for policy purposes, including for the non-expert decision-maker and policy-shaper. A third workflow was also added to bring additional insight into the river floods hazard. The refinement was accomplished by adding new data to the elements of hazard, vulnerability, and exposure as determinant of the respective risk, following closely the CLIMAAX framework.

The current document goes over the scoping of the refined CRA, as a point of departure, detailing its objectives, context, participation, and ownership. Essentially, it seeks to provide a robust scientific basis for political decision-making that is well rooted in local data and corresponding to stakeholder needs on the ground, so as to inform municipal strategies on climate change adaptation and risk management, support the mobilization of funding for adaptation measures, and enhance coordination at the regional level. The municipality bears primary responsibility for the risks and its limited capacity to manage their impacts has driven the implementation of the CRAG project to strengthen adaptation efforts as the more responsible but also less costly approach.

The document then presents the actual refined CRA. During Phase 2, the analysis pursued two complementary objectives: validating Phase 1 workflow results against local stakeholder perspectives and data, and enriching those results with greater local detail and precision. Overall, the outputs from the two workflows applied in Phase 1 were strongly validated, with European climate data deemed appropriate for the region, while stakeholders emphasized the need for more operational, actionable outputs to be ensured with the addition of local data. This was addressed by refining hazard, exposure, and vulnerability elements for the two risks, including locally specific data. Enhanced flood-risk findings supported the prioritization of adaptation measures by incorporating information on riverbed condition, protective infrastructure, business concentration, and socially critical buildings with vulnerable groups. A supplementary workflow on river discharge further confirmed the potential interplay of this risk with the drought risk. For heatwaves, the integration of population and business data enabled targeted prioritization based on impacts on the local economy and economically significant sectors, particularly tourism.

The report also provides monitoring and evaluation reflections, along with a work plan for Phase 3 and an assessment of progress to date. Phase 2 of the project is seen by the municipality as highly valuable. Its outputs constitute a stable foundation for Phase 3 of the project, whereby its key findings and conclusions will be used to upgrade the municipal strategic and action documents, as well as to conduct stakeholder outreach for the mobilization of funds and better coordination for adaptation efforts. Phase 2 with the integration of local data into the workflows has continued to serve as a significant capacity-building exercise for the municipality, building sustained and deep understanding of the CLIMAAX framework and how it can be utilized to generate valuable added value even when some analytical aspects cannot be literally computed by the workflow software. It is this framework of analyzing climate risks that will produce positive policy results for the municipality well beyond the project's duration, giving CRAG results sustainability.

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 Second Phase of the CRAG project is to produce a refined multi-risk climate assessment that will use the CLIMAAX workflow outputs as the foundation for adding local data and knowledge to the analysis to make the final CRA as detailed and actionable for the municipal leadership and administration as possible. The second phase also has the additional objectives to make the analysis more detailed, more precise, and more understandable for local policy-makers and implementers, as well as to contribute to the increased sense of local ownership by institutional and non-governmental stakeholders, and citizens. The process and the analysis produced during the second phase has served and will continue to serve as the basis for in-depth stakeholder engagement. This engagement has on the one hand shaped the document in a way which will enable the next phase of using the CRA for the update and upgrading of the Climate Change Adaptation Strategy of Garmen municipality (adopted August 2024) and 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). The precision and further detail from local data added with the process of phase 2 is what has not only validated the workflow outputs but made the assessment more relatable and suited to use for advocating for national funding or attracting investments for climate adaptation measures in the municipality. The additional insights provided by phase 2, only enabled by the strong foundation of the workflow outputs that guided data collection and analysis efforts and provided the mental framework for the analytical work, will enable the municipality to advocate for an improved regional approach to planning and prevention in respect to climate change impact and disasters by demonstrating the end product of a methodologically streamlined process with a clear scientific foundation and toolbox on the one hand and local data for added precision, validation, and detail on the other.

This refined multi-risk assessment produced in phase 2 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 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.

1.3 Project team

The team consists of the CLIMAAX Municipal Team (CMT) – three municipal employees designated by the mayor, and a subcontracted External Expert Team (EET). The two teams work closely in constant communication following the IFP Work Plan. The CMT ensures the EET receives the relevant information/feedback from the municipal administration, that the administration takes full advantage of the project as a learning experience, and monitors that project activities and deliverables provided by the EET are of high quality. The CMT comes from the municipal department of EU projects and ensures exchange of information and capacity building for their colleagues of other units, e.g. public works and architecture, spatial planning, green systems, environment, civil protection. The EET supports the CMT and delivers commissioned actions and deliverables as per the Work Plan. The EET provides the expert support enabling project implementation.

1.4 Outline of the document's structure

The core component of this document is the refined Climate Risk Assessment (CRA) for Garmen Municipality – Phase 2 deliverable of the CRAG project (Section 2), which follows the CLIMAAX framework. It begins by outlining the scoping elements of the CRA process, including objectives, contextual factors, stakeholder participation, and governance framework. It then examines climate-related risks by combining CLIMAAX workflow outputs and incorporating local data to add more granularity to the analysis along the analytical logic of exploring risks through the elements of hazards, vulnerability, and exposure. The document then, on the basis of the refined findings, goes on to analyze risk severity, urgency, and adaptive capacity, and looks into monitoring and evaluation reflections and takeaways, as well as the work plan for the following project phase. Section 3 offers the main conclusions and key findings, while Section 4 provides a progress evaluation—covering key performance indicators and milestones—and discusses how achieved progress informs subsequent project phases. Supporting documentation and references are provided in Sections 5 and 6.

2 Climate risk assessment – phase 2

2.1 Scoping

2.1.1 Objectives

The refined CRA aims to enhance the understanding about the nature and projections for two priority risks that have considerable impact on the municipality by adding detail and precision from local data. It builds on Deliverable 1 by adding local data to enhance the understanding 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. Like deliverable 1, Deliverable 2, also aims 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. On the other hand, 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 refined CRA continues to aim to 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 refined climate multi-risk assessment, will be used to inform and upgrade Garmen's 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.

Phase 2 further confirmed what we stated in Deliverable 1, namely that the CLIMAAX methodology also helps us overcome an ongoing challenge – using the available European data to its potential, and overcoming the difficulties of selecting, refining, and utilizing local data. The CLIMAAX methodology through its workflows and its analytical framework facilitated the process of finding and incorporating local data by providing the framework to think about the best data to plug in for more clarity.

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 Garmen CRA development process. During the first stage of the project, stakeholders were identified and the ongoing participatory approach as described in the work plan was started. The relevant stakeholders 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 during phase 1 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. In phase 2, stakeholder engagement expanded to local residents at large, and other relevant local stakeholders, e.g. businesses, media, etc. - to prepare for outreach to regional and national level stakeholders after the completion of this second phase. Engagement of officials and representatives of vulnerable groups and areas from Phase 1 has continued during Phase 2, representatives of the later were individual citizens as locals have not self-organized in any form of association – this however does not pose any difficulty as the community is not divided in opinion and dialogue runs smoothly. Upon completion of phase 1, during phase 2 the municipality has communicated the results to its residents so as to raise awareness and ownership of the refined CRA by incorporating feedback and reactions, as well as of adaptation initiatives to come. After the completion of Phase 2 the municipality will continue outreach to local stakeholders but also reach out 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.

Risk ownership is 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. Hence the municipality is the entity that is responsible to identify, assess, and mitigate specific risks, although it lacks the expert and human resources capacity, especially when it comes to climate related risks. Also 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 where the municipality should plan to intervene in prevention by adaptation measures to reduce temperatures or by health and social measures to reduce exposure.

Figure 2-1: Stakeholder engagement and flow of information direction.

Information on the level of acceptable and tolerable risk is entirely based on local knowledge and estimation of durability of infrastructure and resilience of the population and what constitutes a strain on their health, resources, and livelihoods. This local knowledge is based on input from residents, past experience and community/institutional memory of past disasters, national and regional data and analysis – when available, expert input from local institutions relevant to the respective risks.

2.1.4 Application of principles

The CRAG project has ensured the aspect of social justice by its inclusivity and ongoing stakeholder engagement approach. Stakeholder participation is key to the project, especially in the light of scarce local climatic data, stakeholder input, validation and ownership becomes ever more important to the successful implementation of the project and its impact on actual policies. The two prioritized risks for the CRA include an element of an underlying social driver of climate risks (age in the case of urban heatwaves) and an element of an unevenly distributed cost (location of place of residence/work/business in the case of river floods). Building just local climate resilience has been ensured during the CRA process by making sure to incorporate these population groups in scoping and risk analysis, along with a muti-stakeholder process to discuss, validate, and finalize outputs and future plans.

The quality and rigor of the analysis has been ensured by the strict application of the CLIMAAX framework and the workflow methodology. Our team has been fully committed to the analytical and operational space and approach that the CLIMAAX methodology provides as it guarantees a standard of quality and analytical orientation with staunch scientific foundation and pragmatic policy-oriented outputs. In the course of the CRAG project we have taken full local ownership of the process and the tools, as well as put tremendous efforts to contribute to the maximum transparency of the analysis by adding local data and knowledge to increase its granularity, add detail, precision, and pragmatic aspects for local audiences and in particular policy-makers.

Precautionary approach to local data is taken in the analysis because the climatic conditions in the municipality differ slightly from its neighboring municipalities within the administrative region and climatic measurements from nearby regional center Blagoevgrad (air temperature for instance) are not always relevant and/or useful while there are no functioning NIMH measuring stations locally.[1] Therefore precedence is given to data that is local in nature and adds clarity by giving more detail and precision to either the vulnerability or exposure elements.

[1] The peculiarity of the local Garmen climate that makes measurings in nearby municipalities/regional center irrelevant, as well as the lack of measuring stations were confirmed by NIMH representatives at an in-person meeting at the Institute.

2.1.5 Stakeholder engagement

During Phase 2, the project team continued ongoing stakeholder outreach. Bilateral ad hoc meetings and communication was held with municipal and regional experts, and disproportionately affected groups from the local population on different aspects of the CRA, when making decisions on local data selection and utilization.

At the same time, we have reached out to the broader public locally by holding a public consultation and presenting the results from Phase 1 to receive feedback. The presentation focused on outputs and findings, not so much on process and data, as the target audience is nonexpert and we aimed to convey the acquired findings for validation and demonstrate the advantages that the CRA gives us as a local community to take further adaptation steps. The received feedback allowed us on one hand to validate the results, whereby no considerable contradictions were established and the outputs and conclusions from the workflows were confirmed. On the other - to collect inputs on what aspects of the analysis needed further detail and would be mostly useful. One major takeaway was that as much precision is needed as possible when it comes to locations to be prioritized with adaptation measures. Therefore, the team put particular emphasis on incorporating local data on hazards, vulnerability and exposure, such as cadastral information, population data, infrastructure conditions, etc. The project outputs will impact the daily lives of most meeting participants as they will benefit from the adaptation measures to be advocated for based on the CRA and to be implemented with priority with own municipal and attracted national/EU resources, again on the basis of the CRA.

In June, we had a press release published in local media on the team's participation in the Barcelona workshop that also informed on the progress with the CRAG project implementation and future steps. We plan a press release with key findings and insights once we have deliverable 2 confirmed by the CLIMAAX team, so as to disperse the final findings and continue to build ownership for the forthcoming policy adjustments and adaptation measures for which we will seek funding based on the refined CRA and the upgraded municipal Climate Adaptation Strategy.

For phase 3 we have also planned a series of 3 online publications including infographics through social media to give more publicity to the major takeaways from the CRA and what advantages and benefits it will give to the local population. Another target group, apart from the local community, are other municipal, regional and national institutions – to which we plan to reach out in formal with letters conveying information about the CRA process and results as this will enable them to replicate the approach and reach back to us to explore our know-how. We will also disperse information to the rest of municipalities in Bulgaria through the network of the National Association of Municipalities in Bulgaria to convey not only project results and advantages but also knowhow and how they can get acquainted and use the CLIMAAX methodology independently if they have the expert capacity and resources.

A major difficulty in stakeholder engagement so far has been posed by the need to "translate" outputs into understandable and actionable language so as nonexpert publics can relate and see the advantages and added value. The pragmatic aspects of the analysis had to be enhanced to this purposes, which we have continued to do as a team as a strategy for the refined CRA.

2.2 Risk Exploration

2.2.1 Screen risks (selection of main hazards)

During Phase 2 the municipality of Garmen has not changed the number of risks – river floods and urban heatwaves - it will focus on for the CRA, but has added one additional workflow to help it further analyze the river flood hazard. The decision to do an additional workflow of the river flood risk was taken because it is a risk of sudden onset that requires more prompt actions and better preparedness and as a result of stakeholder feedback during the process of key risk assessment and prioritization.

In Phase 2, guided by the workflow logic, the CLIMAAX methodology, and the framework of analyzing risks through the elements of hazard, exposure, and vulnerability, we were able to collect, select and utilize local and regional data that helped us add more detail and granularity to the workflow outputs of deliverable 1. Since the risk screening for the initial CRA there have not been any substantial changes in the elements included in the screening process and therefore the initial information on risk screening from Deliverable 1 remains completely current for Deliverable 2 as well.

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 Kanina river 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 needed 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 have taken 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 that has considerable shortcomings and challenges in terms of quality and human resources already. 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. 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. Garmen has been no exception to this trend, quite the opposite – it is one of the warmest places nationally despite the surrounding mountainous relief. The municipality has observational knowledge about 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 locally under the impact of 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.

2.2.3 Choose Scenario

For the selected two risks we have taken into consideration a number of climate scenarios and socio-economic developments. In the river floods workflow, the team has explored 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 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 have taken into account economic damages as a lot 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 adaptation measures in protection, including nature-based solutions, and spatial planning that minimizes the risks.

In respect to the risk of heatwaves, for the climatic hazard the team has considered the climate scenarios RCP4.5 (medium) and RCP8.5 (extreme) to draw a comparison of the effect of different climate scenarios on the frequency of heatwave events for the future climate. 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. This information is vital to draw conclusions on the time horizon the municipality has to take steps in adaptation. Given the unique local climate that differs from nearby bigger regional urban centers and the lack of air temperature measurements recorded locally, for the risk assessment the municipality has selected as most useful at the municipal level, the work flow that produces an estimation of the risk based on exposure of vulnerable population in combination with high-resolution observation data for surface temperature. Surface temperature is the most accurate approach in the case of Garmen, bearing in mind the mountainous region around urbanized areas but at the same time the fact the municipality is among the warmest places in the country due to elements of the transitional Mediterranean climate, penetrating from the valley of the Mesta River. 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, non-climate contextual factors have been considered, i.e. the expected continued trend of aging of the local population, the population density around urban areas conducive to the heat island effect, the concentration of business in risk hotspots, 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 Regionalized Risk Analysis

2.3.1 Hazard #1: River Floods - fine-tuning to local context

Table 2-1 Data overview workflow #1

Hazard data	*Vulnerability data*	*Exposure data*	*Impact metrics/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*		
State of existing protective infrastructure along the river bed	*Concentration of local business along the river bed*		*Zoomed-in picture of potential damages for the areas identified by the workflow outputs*
Condition of the river bed, e.g. cleaned, obstructed, narrowed, with buildings and other construction elements changing the natural riverbed and increasing the risk of river floods	*Location of buildings of social importance and for provision of social services, especially for vulnerable groups, such as children and the elderly.*		*Zoomed-in picture of potential damages for the areas identified by the workflow outputs*

2.3.1.1 Hazard assessment

In phase two we added local data to the river floods workflow to obtain more precise results about the locations that were under most imminent risk. The local data served two purposes – it helped alleviate workflow limitations related to non-climatic factors - thus non-climatic drivers related to the hazard were considered such as the condition of the river bed, the existence and state of local protective infrastructure that could be more or less conducive to river flooding. As mentioned in the previous sections, the decision to add this information was guided on the one hand by stakeholder demand and feedback, on the other – was prompted by the scarce availability of climatic and hydrological data due to lack of measurements on the territory of the municipality, both by local institutions and by the National Institute of Meteorology and Hydrology.[2]

The added local data had an added value only against the outputs of the workflow, whereby it was used to zoom-in on locations of increased risk identified by the hazard workflow. For the sake of clarity of the analysis, an overview of the workflow computations is included in this section before jumping into more detail in the details provided by the local data, which we will elaborate on in the next section jointly with the analysis of the refined risk findings.

Thus, in phase 1, the river floods hazard assessment workflow allowed us to compute and visualize river flood extent under the current climate with different return periods, as well as the impact of climate change scenarios (RCP4.5 and RCP8.5) on this hazard. In applying the workflow, we used the available European data clipped to the region of interest. 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.

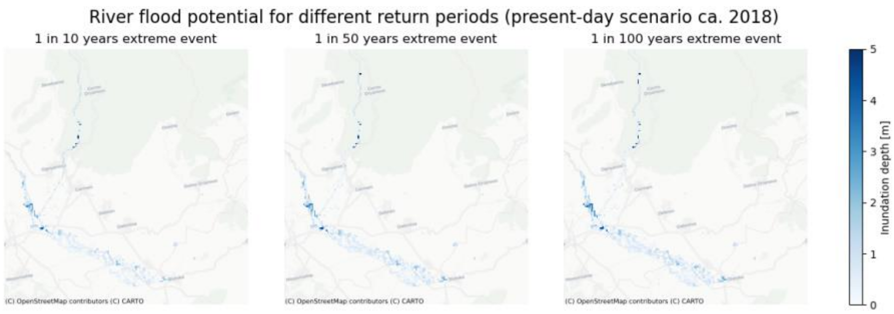

Figure 2-2 Flood inundation maps for the area of the Municipality of Garmen for extreme events with different return periods based on European high-resolution dataset

At this stage, two limitations of the workflow were discussed, i.e. it only includes the river basins larger than 150km2, and that 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). The first limitation as concluded in deliverable 1 was not relevant because 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. As to the second limitation, our assumption was that it was of negligible impact as there are not a lot of man-made protections or adaptation measures and these do not amount to considerable effective prevention as of the current moment. Although this assumption, our team believes, still hold relatively true, we have added available local data on such structures to make the analysis more precises and the analysis has benefited from this aspect as it provides more detail on which

[2] Confirmed by the NIMH in a meeting with their representatives.

locations to prioritize as a combination of high risk and no protective infrastructure or bad condition of the infrastructure. This is especially important for locations with social infrastructure servicing vulnerable groups – e.g. schools, kindergartens, residence care for the elderly. During Phase 2, we concluded that in our case there is also an additional third limitation to the methodology, which is stipulated by the local conditions and might not hold true for other locations with better observed regulations for observing the natural riverbed intact– i.e. the state of the river bed, which has in some locations been considerably deteriorated by human actions and this has been conducive to floods. At the same time, in respect to future climate scenarios, the computation of the impact of the RCP4.5 and RCP8.5 climate scenarios on river floods with the Aqueduct Flood Hazard Maps dataset, the coarse resolution again was not perceived as a constraint and combined with the local data mentioned above provided sufficient insight into expected direction of change in flood depth for the different return periods and whether river flooding will likely increase or decrease under the two scenarios in the selected years.

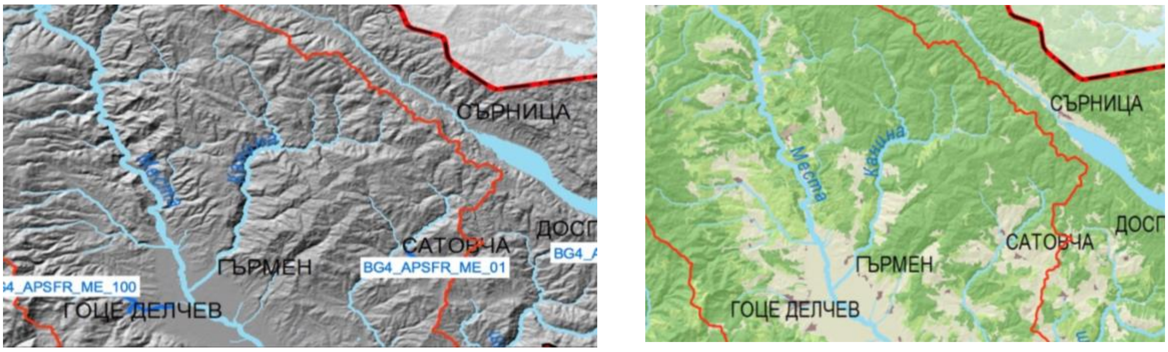

Figure 2-3 Maps with an overview of riverbed geography and topography as per the National Plan for River Flood Disaster Management

The river floods hazard assessment workflow outputs testified to 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) showed 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.

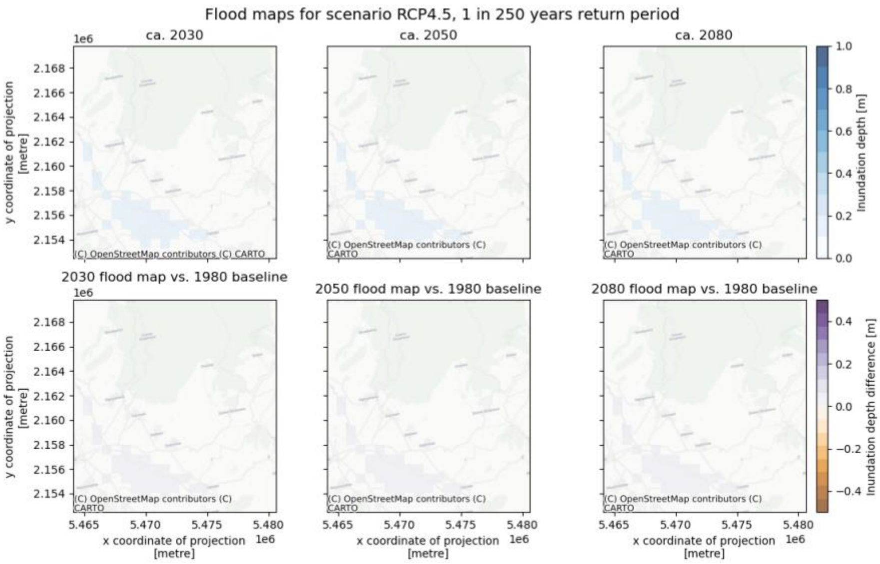

Figure 2-4 Flood maps for the municipality of Garmen for scenario RCP4.5, 1 in 250 years return period

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 revealed a surprising decrease of inundation depth and extent to practically non-existent hazard for the years 2030 and 2050 compared to the baseline year. Given these 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.

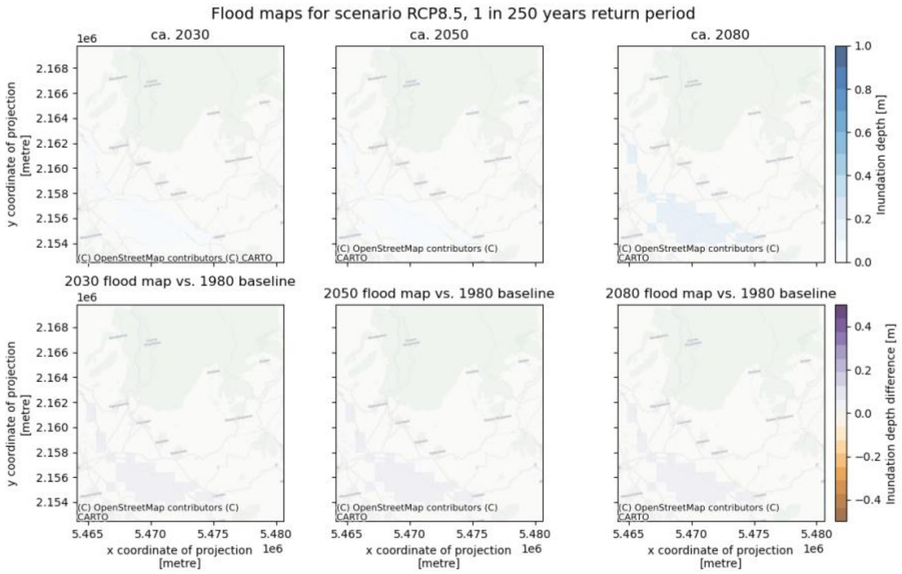

Figure 2-5 Flood maps for the municipality of Garmen for scenario RCP8.5, 1 in 250 years return period

Since this hazard was prioritized as most important by local stakeholders and the municipality, the team has decided to run another workflow on it – the newly available "river flood discharges" workflow. The workflow is based on SMHI CDS data and provides insight into mean and extreme discharges, whereby we had particular interest in the modelled ones, especially in respect to RCP8.5, where the flood maps workflow indicated that there might be some interplay with the drought risk. Since we do not have local observational data from recordings, we cannot validate the results, but the outputs of the workflow (especially the relative change in projected extreme river discharges) gave us additional information on the severity of the hazard and seems to confirm both that 1/ the analysis using the JRC floodmaps for the present climate are conservatively representative of the future risks as well and 2/ the potential the interplay with the drought risk as alluded by the surprising discharge decrease in some models for the future climate.[3]

[3] For more details on workflow outputs, please see the Zenodo supporting materials, since given the absence of local observational data, this workflow is not incorporated in the central analysis of the CRA.

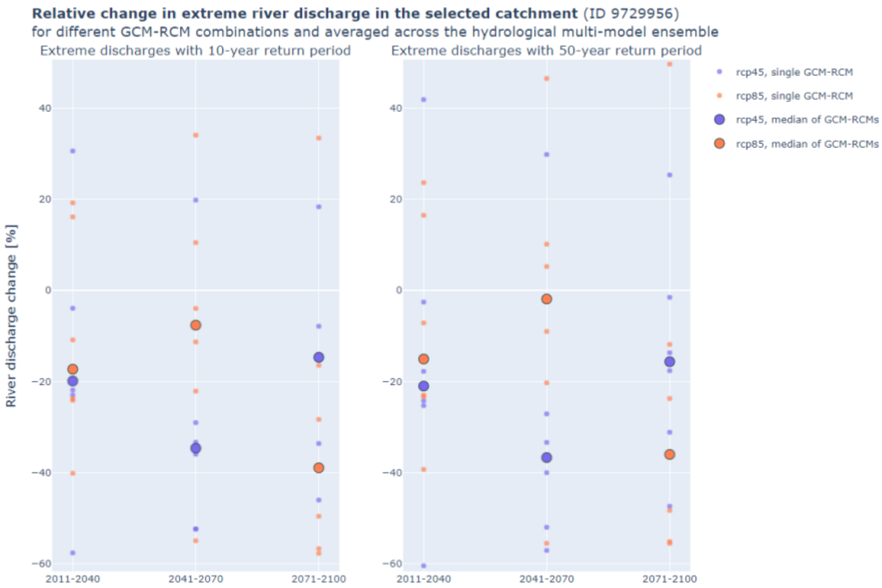

Figure 2-6 Relative change in extreme river discharge in the selected catchment, ID 9729956

2.3.1.2 Risk assessment

In phase two in respect to the risk analysis, we added new data to the non-climatic factors related to vulnerability– the present along the river bed of concentration of local business and buildings of social importance, e.g. for the provision of social services such as daycare for children and residency care for the elderly. Together with the added local data relevant to the hazard in terms of condition of the riverbed and protective infrastructure status, this gave us a more detailed picture of the hotspots of potential damage that would help us prioritize adaptation actions in respect to timing and magnitude.

For the sake of transparency and traceability of the analysis, and since the added data only makes sense against the outputs of the risk workflow, we provide an overview of the computations conducted in phase 1. We used the river floods risk assessment workflow[4] to compute the river flood risk through the combination of river flood maps with exposure and vulnerability data, calculated as economic damage functions. For hazard data 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 incorporation of JRC depth-damage curves for different damage classes on infrastructure allowed to combine the maps of flooding, land use, and infrastructure to assess multiple types of risk from river flooding. 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), vulnerability curves for economic damages for the LUISA land cover types were generated. The potential economic damage to infrastructure was computed via DamageScanner, with 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. Thus, the results of damage calculations for all scenarios and return periods were computed. 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 2-7. 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 2-8 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.

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, 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.

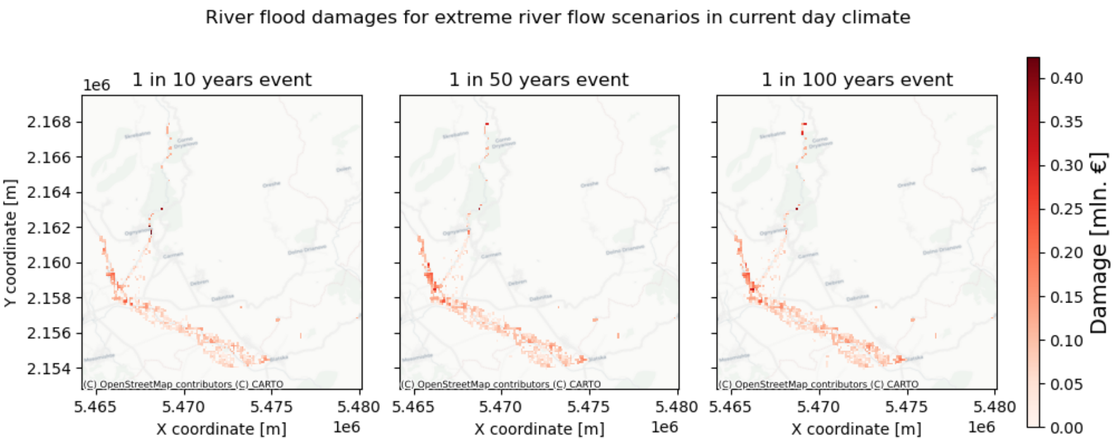

Figure 2-7 River flood damages for extreme river flow scenarios for the municipality of Garmen in current day climate

In the second phase, in response to stakeholder feedback, we strived to add more precision to the identified hotspots of potential economic damage – what infrastructure was located, what corresponded on the ground to the assigned land use type, concentrated land use of economic significance with high vulnerability due to local factors, such as bad or absent protective infrastructure and bad condition of the river bed. As the main sector of income but also the one prone to the negative impact of floods is tourism and balneo-tourism, attention was particularly given to the concentration of tourist infrastructure. At the same time, given that the municipality does not have a big budget, infrastructure for social services, such as schools, kindergartens, and others has been inserted as restoration of these would be of significant financial burden to the municipality but also because non-reversible damages could be done to these groups due to difficulties with imminent evacuation and the inability to self-evacuate. This local data was collected from municipal records but also from municipal and other local officials with extensive local knowledge and was combined for the first time in maps to inform the analysis and serve municipal policy-making aims. On the basis of this data collection and compilation experience, the municipality is considering ongoing data collection on these aspects in the future so as to have up-to-date records available on demand and to update the CRA periodically in the future.

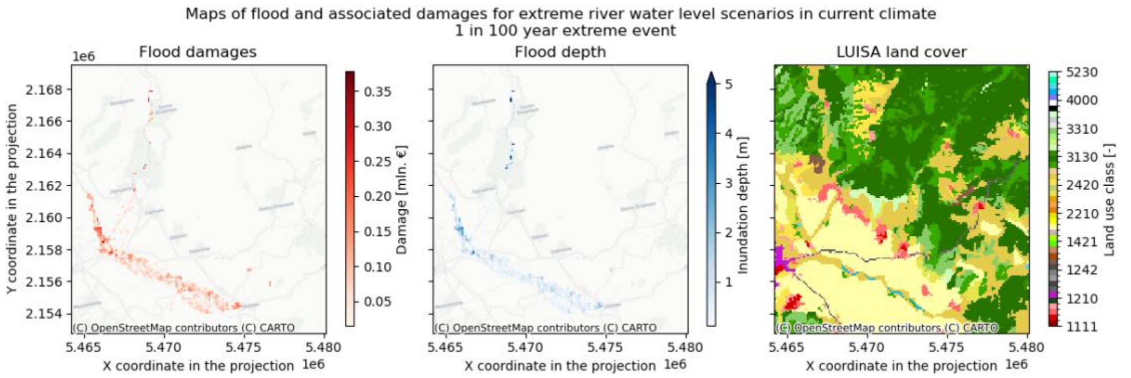

Figure 2-8 Maps of flood depth, associated damages, and land use for the municipality of Garmen for extreme river water level scenarios in current climate, 1 in 100 year extreme event

The plotted maps in Figure 2-8 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. The added local data points to areas from the hotspots with reduced risk due to recent actions, for instance the correction of a gullies through Garmen and Ognyanovo in 2022 in some sections. However, the bad riverbed condition, the old protective infrastructure and the concentration of businesses and social amenities in both locations shows that these sections still need to be a high priority. This example highlights the need to target measures and prioritization very well with precision, detail and based on facts, which is only possible with local data. The situation in Ognyanovo and Garmen is actually most complecated with the necessity to plan for multiple adaptation measures. The high narrowing and bad condition of the river bed around the damages hotspot of the region of “Ognyanovski minralni bani” calls for prioritization of this river section. The proximity of social infrastcuture especially for servicing vulnerable groups to the river bed in the damage hotspots is a factor calling for prioritization of such locations – this is the case for instance for a school and a kindergarten in Dolno Dryanovo and a primary school in Debren, that are in very close proximity. In the village of Baldevo there is a damage hotspot with bad river bed condition and a concentration of local business. In another major damage hotspot – Gorno Dryanovo – the river bed is in bad condition and at the same time there is no protective infrastructure – the case for prioritizion here is also strengthened by the presence of a kindergarten, school and concentration of local business in the hotspot right next to the sections with riverbed in bad condition. The damage hotspot of Hvostyane is the case where measures can be of less priority because new protective infrastructure is in place and offers sufficient protection.

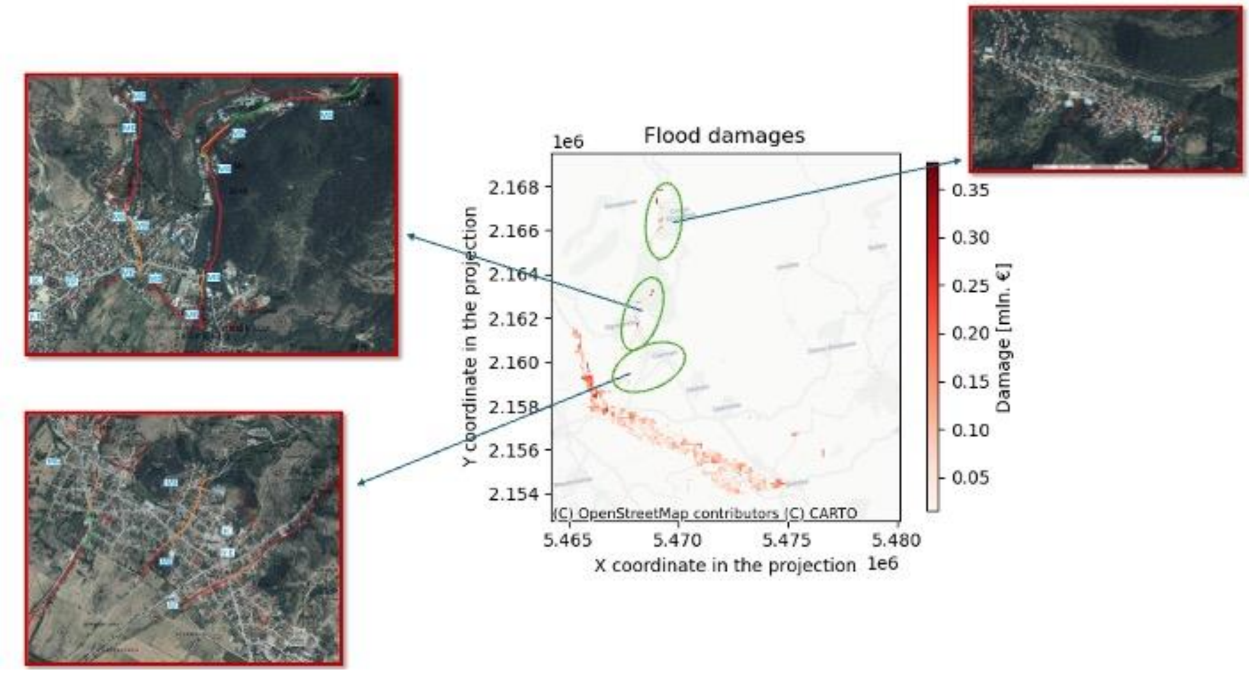

Figure 2-9 Map of flood damage hotspots with zoomed-in cadastral maps of added local data: red lines for bad condition of the riverbed, green lines for new protection infrastructure, orange for old protection infrastructure of compromised quality, white squares with text for business concentration and socially significant buildings.

2.3.2 Hazard #2: Heatwaves- finetuning to local context

Table 2-2 Data overview workflow #2

Hazard data	*Vulnerability data*	*Exposure data*	*Impact metrics/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.*
…	*Local population data*		*Zoomed-in picture of risk maps with local data of population concentration*
	Concentration of businesses data		*Zoomed-in picture of risk maps with local data of business concentration*

2.3.2.1 Hazard assessment

In Phase 1 we used the urban heatwaves hazard workflow to compute 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 Garmen 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 2-10). 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. The heatwaves hazard assessment clearly showed 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.

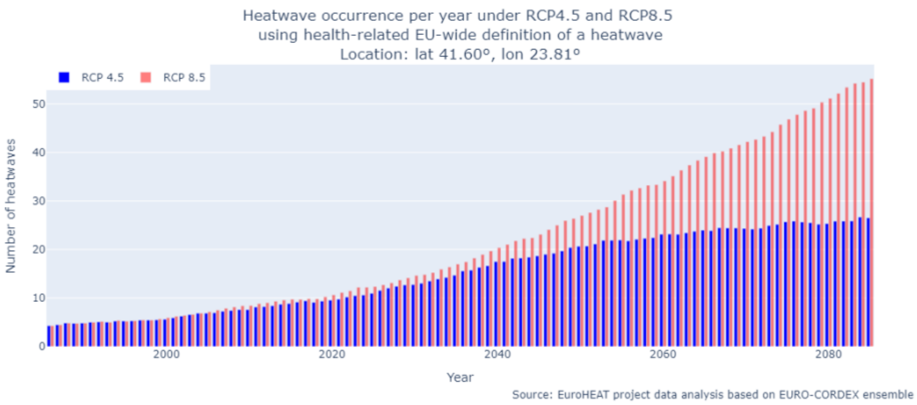

Figure 2-10 Heatwave occurrence per year under RCP4.5 and RCP8.5 using health related EU-wide definition of a heatwave for the location of Garmen

In Phase 2 we build upon the outputs of the urban heatwaves workflow from Phase 1 in two directions – we looked at the national definition of hot days, which takes the threshold of maximum 32 degrees and we sought to see if there is a trend in the increase in the number of hot days annually from archival and current data of the National Institute of Meteorology and Hydrology– according to their Annual Hydrometeorological Bulletins (2019-2024), the number of hot days (with maximum temperature above 32 °C) shows a steady increasing trend of about 0.4 days/year for areas with altitude up to 1000 m (National Institute for Meteorology and Hydrology, 2025). At the same time, both their annual and monthly bulletins that look into the deviations in air temperature on a regional level, constitute that for the Blagoevgrad region, where Garmen is located, there is an increase of around 2-3 degrees Celsius in the average annual temperature. Although air temperature measurements in the region outside Garmen municipality do not provide enough precision, given the unique local conditions and hence climate, this data on the macro level provides additional testimony to the increased severity of the hazard under the current climate. Hence, combining the workflow output with the available conclusions on regional trends based on historical data for the current climate by the NIMH we were able to validate and enrich the findings in respect to the hazard under the current climate.

2.3.2.2 Risk assessment

In Phase 1 the municipality of Garmen used the urban heatwaves risk assessment workflow based on historical satellite-derived data. In essence, it enabled the municipality to plot 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 compute 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.

Since in Phase 1 the resolution of the data in the vulnerable population density map posed some challenges to the analysis, although the interactive map plotting the risk helped the municipality better identify risk-prone areas, in Phase 2 we incorporated data on concentration of population and businesses in the hotspots identified by the workflow outputs.

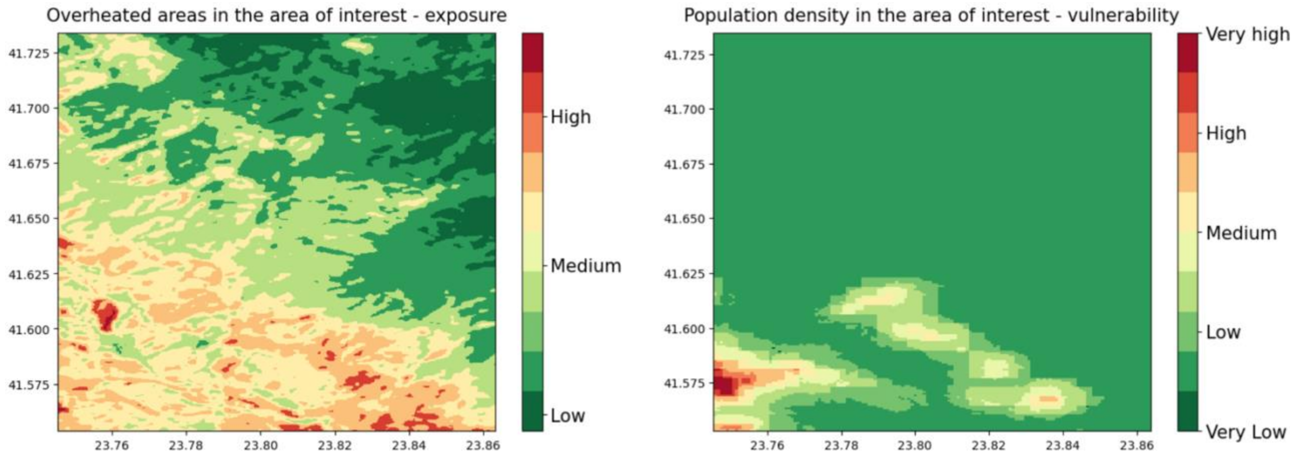

Figure 2-11 Maps of overheated areas (exposure) and population density (vulnerability) in the Municipality of Garmen

The heatwaves risk assessment showed that the most heated areas with the biggest population density of vulnerable groups 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 and is increasing under the current climate according to NIMH regional data, 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 healthcare, 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 mitigate the negative impact of heatwave exposure for vulnerable population groups.

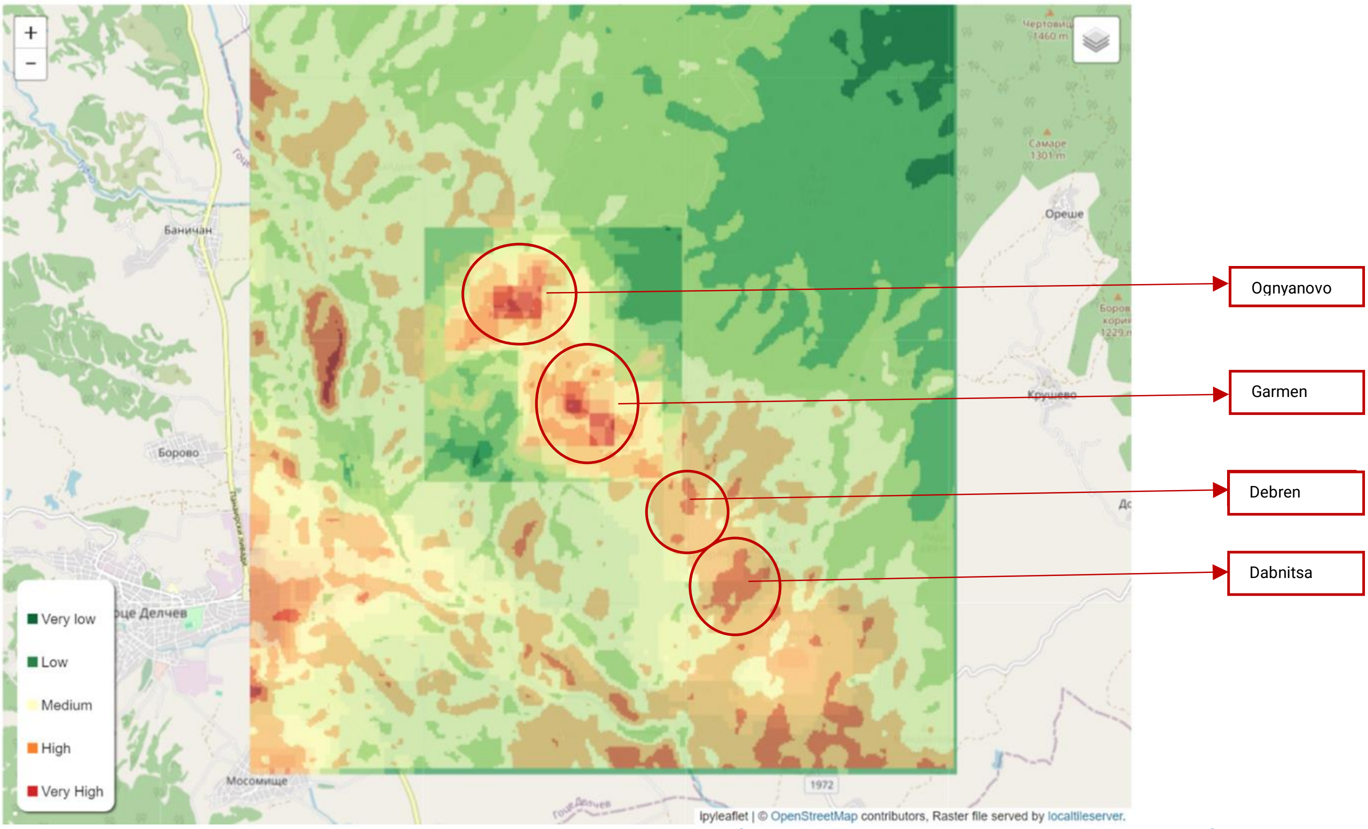

Figure 2-12 Heatwave risk to vulnerable population in the Municipality of Garmen, with annotated urbanized centers of bigger population density and concentration of business according to local data.

In the second phase, in response to the poorer resolution of the population density data at the European level but also in reaction to stakeholder feedback we zoomed into the risk hotspots, identified by the workflow and sought the see where population and business concentrations occurred in these identified risk hotspots. This local data allows us to prioritize adaptation measures and plan in a way to have bigger positive impact and also target it towards the local economy – such would be the case if adaptation measures in Ognyanovo for instance are prioritized, although it is not the biggest urbanized area, it has the biggest concentration of vulnerable groups, general population, and businesses in the risk hotspot area.

In terms of climatic data, there are no local/national records of surface temperature or measurements of air temperature in Garmen so we were not able to refine with such further climatic data. Measurements of air temperature in the bigger regional center were not suitable because of climatic peculiarities of Garmen municipality that make it unique to the area – i.e. it is located in a mountainous region but still one of the warmest places in the country, which according to NIMH testifies to the peculiar local climate and makes regional data less utilizable for concrete computations. Given this peculiarity, surface temperature is confirmed as the most accurate approach to identify heat islands and this yet again testified to the fact that the satellite-based surface data workflow is best suited for the case of Garmen.

2.4 Key Risk Assessment Findings

2.4.1 Mode of engagement for participation

The mode of engagement was described in section 2.1.5. The gathered feedback focused around two core aims of the communication – 1/ to receive validation and/or challenge the workflow outputs for D1; 2/ to receive more input on the risks for the refinement of the CRA in D2. The project team somewhat expected that stakeholder engagement would validate the workflow results and this is what happened. The expectation was based on ad-hoc bilateral validation interactions and an internal validation team meeting that were initiated even prior to the submission of D1. So the team had no major concerns related to validity and at the same time was eager and curious to find out if and how the results could be challenged from a variety of stakeholders with different relation to the risk, backgrounds, and perceptions. Such challenges, however, did not occur and there is an overall consensus among stakeholders that the workflow outputs are reliable and reflect realities as experienced on the ground. A major point of feedback, however, was the need for more detail on exactly what the results meant – a better rooting of identified risk hotspots by both workflows in local context, i.e. infrastructure, protective and adaptation measures, population, etc. Stakeholder demands basically amount to zooming-in into workflow outputs with local data to make the CRA more operational and actionable, as well as more easy-to-understand and for stakeholders to get a more clear orientation on what is at stake and which areas and risk aspects should be addressed with priority in adaptation efforts.

2.4.2 Gather output from Risk Analysis step

The project team has utilized workflow outputs both on the risks and the hazards. In respect to the river flood risk, on hazard the findings on the river flood potential for different return periods has been used, whereas the risk was presented through the outputs in the river flood damages maps and the hotspots of potential economic damages. In respect to the urban heatwaves risk, the output on the increased occurrence of heatwaves under RCP4.5 and RCP8.5 has been utilized, as well as the outputs on overheated areas and the heatwave risk to vulnerable population interactive map.

The team found it crucial to explain the interplay between the climatic hazard and the elements of exposure and vulnerability, which could be of non-climatic character, and how these defined the risk analysis. Stakeholders in general thought that this framework of analysis made climate change risks seem more more relatable and palpable, as well as less theoretical and obscure.

2.4.3 Assess Severity

Garmen municipality has assessed two key risks for their severity – river floods and urban heatwaves – the foci of the municipal CRA. The analysis of severity is based on two pillars, namely – workflow outputs and stakeholder assessment. Important to note here is that the municipality (municipal administration representatives and experts) are considered stakeholders and at times these are uniquely positioned to provide additional insights based on experience and observation.

The river floods hazard assessment workflow results show an increase in severity under the historic and RCP4.5 climate scenarios. These results were confirmed by stakeholders as aligning with their expectations. The river floods risk assessment workflow in the current day scenario for the return periods of 10, 50, and 100 years showed 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. 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. This analysis was confirmed by stakeholders presented with the initial CRA and the level of severity has been determined as substantial for the current climate and critical for RCP 4.5 due to increased inundation depth. Stakeholders confirmed the locations, as well as the disruptions that the risk generates and demanded more detail to be added to the situation of the infrastructure and the river bed at each location so as to have more precision and a fuller picture when adaptation measures are designed.

In respect to the heatwaves risk, the hazard workflow output clearly shows a considerable increase in the frequency of heatwave occurance under both future climate scenarios – RCP4.5 and RCP8.5. This trend was confirmed by stakeholders as 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. Stakeholders also have acknowledged the fact that 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 the municipality of 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. Stakeholders have particulartly emphasized that the bad sccess and low quality of healthcare pose additional challenges that call for actions to mitigate the negative impact of heatwave exposure for vulnerable population groups. Due to this last consideration stakeholders have rated severity as moderate and substantial under the current and future climate respectively.

Stakeholders’ different perspectives have been decisive in validating and calibrating the workflow outputs and determining the final severity score as each stakeholder group enriched the analysis with first-hand knowledge, experience, and observations. Given the lack of reliable climatic local data, it was important that various stakeholders validated the workflow outputs from their perspective as a precautionary approach. Vulnerable groups were particularly helpful as they suffer disproportionately from the analyzed risks and provided insights into their concerns in respect to systems and risk consequences that will be valuable for policy design.

Last but not least, decision-makers at the municipal level are not trained in understanding climate risks and due to this fact it has been particularly important to make the CRA as easy-to-understand in respect to results and findings, as well as much actionable as possible.

2.4.4 Assess Urgency

The river floods risk already has major impact that will increase under the current climate for different return periods, as well as under the RCP4.5 climate scenario. The severity does not increase too dramatically for the future climate as the locations remain relatively the same with some exceptions of new locations but it does increase due to the increased inundation depth. This means that severity at present is substantial, especially given local capacities, and 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, together with the local data, 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 to build upon and upgrade 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. However, this still means that strategy needs to be formulated now and next steps, gradual as they may be, need to be planned at this point in time. If the population structure trends continue this non-climatic driver will make the risk even more pressing and lack of reform in the healthcare system at large also adds an element of gravity to the situation and its potential to unfold negative consequences at a more rapid rate than expected. Another aspect that needs to be taken into consideration is the considerable cost and relatively long time horizon for implementation of related adaptation measures as these are frequently related to changes in the urban environment that take longer time to plan, fund, and carry out, it is important to start planning for adaptation measures in response to this risk as soon as possible.

In respect to both risks, vulnerable groups and exposed populations' perspective has weighed in on the aspect of urgency. Experts with insights on capacity and timelines for planning adaptation measures have been the other major consideration when deciding on the urgency scores for the two risks.

2.4.5 Understand Resilience 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.

2.4.6 Decide on Risk Priority

Risk prioritization was carried out using the CLIMAAX Key Risk Assessment Protocol and the dashboard. The elements were rated as a result of team meetings discussing own knowledge, experience, and expertise, as well as inputs based on records of stakeholder feedback provided both in bilateral settings and during multi-stakeholder public consultations – both the one as part of the Phase 2 process and others organized outside the CRAG project that touched on either of the two risks, where feedback has been recorded. Since stakeholder feedback does hold an element of subjectivity due to risk perception based on personal experience and proximity, the project team weighed-in in respect to the capacity risk, as the administration is most well-positioned in terms of knowledge to assess it and this is the element where third-party feedback was less decisive in attributing a score.

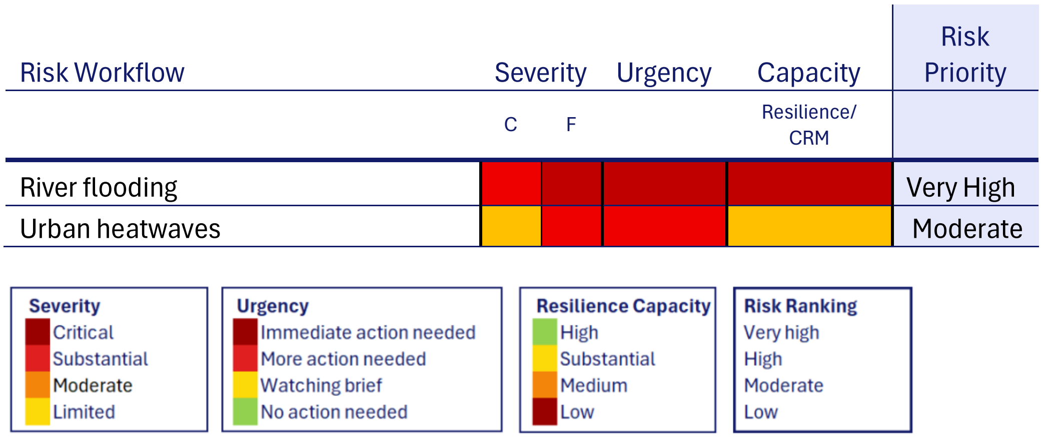

Figure 2-13: Risk prioritization of the two selected risks to analyze under the CRAG project.

2.5 Monitoring and Evaluation

The second phase of the CRAG project was crucial for looking deeply into local knowledge, data, and archival information related to the two risks and collecting, selecting, and organizing this scattered information. The lack of nationally/regionally collected and available data from the state institute responsible for the collection of climatic and hydrological data (the National Institute on Meteorology and Hydrology) and the specificities of the local climate, made us turn to the option of seeking local knowledge and information that had not been compiled and systemized so far to be utilized for this purpose. In the process, we learned that this information was valuable and that non-climatic drivers could have a decisive impact on how climatic hazards play out, e.g. the state of the riverbed and the impact of human activity. So new data was added to the CRA by data collection, systematization and extraction from patchy local sources, including through interviews with municipal experts, and national/regional sources that would capture an aspect of the analyzed risks. To understand the risks better, more local climatic data could be useful, although it is not certain how much additional added value it would have had, given that for the purpose of our analysis the European datasets were sufficient and non-climatic factors needed more local information to make the analysis more precise and relatable. As a result of Phase 2, the municipality will look into how it can record or have such climatic and hydrological data recorded in the future.

During Phase 2, we also learned that the challenge of low understandability of the climate change topic by staekholders could be overcome to a sufficient degree by presenting results and discussing their validity based on stakeholder observations and experience, as well as by elaborating on policy options based on these results and seeking stakeholder input. In our experience, stakeholder consultations validated the workflow outputs and pointed towards the limitation of the need for more local detail, often on non-climatic aspects – this is what motivated us to zoom-in into the workflow results by adding local data to increase the detail of identified risk hotspots for the two hazards. Stakeholders expressed appreciation for the elements included in the exposure and vulnerability aspects of the workflows and stated that these aspects make climate change risks relatable for them and prompt them to see the practical application of the insights produced by the CRA and how these can translate into policy decisions, strategic documents, and an action plan for adaptation. Local stakeholders expressed pride and satisfaction with the fact their municipality is among the first in Bulgaria to implement the CLIMAAX framework and said that this approach by the municipality makes them feel part of the solution to climatic challenges and has increased their knowledge about how policy has and will unfold.

A major difficulty during Phase 2 was the lack of climatic data – the NIMH does not collect any relevant information on the territory of the municipality, and the collected data on the region does not reflect the local climate as it has unique features – a conclusion we came across multiple times in expert discussions but was also confirmed by NIMH in a meeting with their experts from the climate and hydrology departments.

Learning of the municipal team is ensured within the CRAG project by regular internal reflection sessions, whereby we share progress, but also challenges and ideas about how to address these challenges or suggest new practices to the administration to make sure in the future those challenges are minimized. For instance, in the course of Phase 2 we generated ideas about what data the municipality can create a database for and fill with information continuously, e.g. create a database of all protective infrastructure with information on its status and a tracking system to record when an update is made – this information does not exist in one place currently and for the sake of Phase 2 we had to collect and compile it but the creation of a database would be of great practical added value. Another idea was to create a database and start collecting information on river flooding and the corresponding river wave – such systemized records do not exist at present.

The municipality plans to communicate the final outcomes of the CRA by holding another public consultation, which was not initially part of the Work Plan to present the results and most importantly – how local data and stakeholder feedback has helped to refine the initial workflow results and conclusions. In respect to regional and national stakeholders – we will communicate the final results in official letters, presenting key takeaways, and suggesting how the know-how we acquired can contribute to the regional and national level of analysis, strategizing, and planning.

In terms of internal team learning, we believe we have used our resources efficiently, whereby the municipal team was instrumental in data collection and validation and kept in close coordination with the external expert team to fulfil the activities related to the finalization of the refined CRA. It was vital that the lack of local climatic and hydrological ready-to-use data did not discourage the team and we continued to seek ways to obtain data and knowledge from a variety of sources to compensate so as to refine the CRA enough to make it more readily usable for policy-making and stakeholder engagement. Our approach, because it eventually delivered the information we strived for, although being quite challenging, has built our internal confidence as a team on the one hand, while on the other – deepened our understanding of the risk=hazard*vulnerability*exposure analytical framework, whereby despite not being able to compute concrete outputs though a software we were confident the analysis was going in the right direction guided by this methodology. Our efficiency and determination as a team, including the external expert team, were decisive for the completion of the refined CRA.

Data collection in respect to the two risks subject to analysis in the CRA was based on ongoing reflections on what was needed and follow-on adaptations once it became clear whether we would be able to obtain the respective information or not. So this has been a separate learning process on its own. As a result, we believe that only at this point we are now able to put together a systemized monitoring system in place that would continuously collect data on risk-significant aspects.

The impact of the CRA – not only in terms of content of the final analysis but also as a process of developing it, has been extremely valuable for the municipality. It has enabled it to engage the public in a more relatable way that allowed concrete input and gave particular opportunities to demonstrate how stakeholder feedback influences the process and the analysis. Thus, it has helped us build public awareness, engage stakeholders and build stakeholder confidence in the process of consultation on climate change issues. It has also increased the institutional understanding of the risks and allowed us to consolidate existing capacities, as well as mark plans for the development or streamlining of future capacities. It guides us to plan efficiently to use our limited institutional resources in the most impactful way by basing decisions on the CRA and having a strategic and coherent approach over time. Apart from that, the CRA process has been a skill-building experience for the municipal administration. Last but certainly very important in terms of impact - the refined CRA will be a stepping stone for us to attract state funding, apply for EU funds, and draw investments to adaptation measures and initiatives – the document will give us the staunch foundation to base our requests and advocacy on, as well as to present opportunities to potential investors.

2.6 Work plan Phase 3

Phase 3 is the stage of the CRAG project, whereby the finalized refined CRA is translated into municipal policy and used to guide adaptation choices of concrete measures in response to the analyzed risks. It is comprised of two subsequent stages as follows:

Stage 1: The EET study the municipal Climate Adaptation Strategy and suggest to the CMT how it can be upgraded based on the final CRA, both in respect to improving the level of analysis of threats and risks but especially in respect to further developing and motivating the adaptation approach, measures, and actions. The EET provide the CMT with concrete amendments to the text based on the CRA. The municipality will update the strategy (Deliverable 3).

Stage 2: Stage 2.1: The municipality with the support of the EET will use the multi-risk climate assessment to start the drafting of a municipal risk action plan with a particular focus on prevention and support for disproportionately affected by climate risks segments of the local community (building on Deliverable 3); Stage 2.2: The municipality with the support of the EET will 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); Through both stages, the municipality with the support of the EET will take communication actions accordingly.

3 Conclusions Phase 2- Climate risk assessment

During Phase 2 a refinement of the initial CRA was conducted, whereby local data was added to the workflow outputs along the logic of analyzing risks through the interplay among hazards, vulnerability, and exposure. This refinement produced the current final CRA that, as a result of the local data that was used to “zoom-in” on the workflow outputs and increase the granularity of the results, presents a more relatable, ready-to-use, and understandable document for policy-makers and non-expert stakeholders. The fact that the refinement was guided by stakeholder feedback in response to the initial CRA has also immensely contributed to this end. As a result of Phase 2 and the increased level of detail and precision of the analysis, we believe that the CRA has become more and sufficiently actionable for local policy documents and decisions to be based on it.

During the second phase, the core of project activities was aimed to add additional layers of local data to make the analysis easier to understand and more robust. Most challenges faced were related to the task of finding, selecting, verifying, extracting, collecting and systemizing local data. As expected, climatic data was scarce or non-existent and we therefore focused on zooming-in into the workflow outputs by adding local data to a large extend predominantly to the elements of exposure and vulnerability. We are convinced that the workflow outputs with European-level (climatic) data and combined with this additional local data for detailing exposure and vulnerability have substantially increased the pragmatic values and clarity of the workflow outputs and made the CRA results and findings more actionable and understandable for local policy-makers, implementers, and other stakeholders.

In Phase 2 we fully realized the importance and at time huge impact that non-climatic factors and drivers, as well as relevant systems can have to operationalize the workflow outputs and gradually we came to the conviction that the prevailing absence of local climatic data records, despite initially seen as a considerable challenge and deterrent, has prompted the team to look in all possible directions, to explore all relevant factors, to be creative and to think really hard how to enrich the analysis along the risk = hazard*vulnerability*exposure framework. As a team, therefore, we believe we turned this challenge into an opportunity and in our opinion the resulting refinement of the CRA offers and excellent foundation for policy-making, for planning and implementation of adaptation measures.

Having set up the infrastructure (technology and software) and process for conducting a CRA using the CLIMAAX framework in Phase 1, in Phase 2 we experienced far less technical challenges. Still, as we implemented a new workflow, the CLIMAAX technical support remained highly valuable as we run into an error during the computation phase. The CLIMAAX CoP webinars continued to be useful and the topical shift of these online meetings towards policy shaping, implementation, and funding was very appreciated by the municipality. By learning about opportunities and experiences, we feel that being part of the CLIMAAX family has made us bolder and more decisive in our plans to act in addressing climate change risks based on the CRA findings.

Phase 2 confirmed the importance of stakeholder engagement in terms of local non-expert knowledge that has a multifaced added value but most importantly can validate the CRA findings, thereby rooting it into real-life experience and expectations. We also found it challenging to “translate” some of the aspects of the workflow analysis process to the non-expert audiences and therefore emphasized results and their meaning. In the process, we established that stakeholder feedback actually provided guidance for the refinement of the CRA by stressing the need for more details from the local context to clarify the results, e.g. what a certain hotspot for river flood risk for instance had as protective infrastructure, population, condition of the river bed, etc. to be able to prioritize adaptation actions and make the CRA results conducive to concrete decisions by the responsible institutions and stakeholders, the municipality at large.

During Phase 2, key findings were two-pronged on the macro-level: one direction sought validation and/or challenges for the workflow outcomes from local stakeholders and data to make sure the findings of phase 1 corresponded to realities on the ground as perceived by stakeholders, especially the ones that are experiencing or addressing the risks first-hand; another direction sought local data to add detail and precision to the findings. In conclusion, workflow outputs were overwhelmingly validated, climate-relevant European data was not questioned as unfit for the region, and stakeholders demanded operationalization through the addition of pragmatic precision to the outputs, which we have accomplished by adding new information to the elements of hazard and vulnerability for the river floods (flood maps) workflow and to the elements of exposure and vulnerability in the heatwaves workflow. Key findings from the flood hazard and risk in phase 2 contributed substantially to prioritizing locations for the temporal organization of adaptation measures by adding layers of information on the state of the river bed (hazard) and the presence and condition of protective infrastructure (hazard), as well as on the concentration of local business (vulnerability) and buildings/infrastructure of social significance, especially for services for vulnerable groups that are difficult to evacuate (vulnerability). We also run a third workflow (river floods discharges) for the river floods hazard, which confirmed that the severity of the hazard under the current climate is representative for future climates. Key findings in the heatwaves workflow in the second phase were related to zooming in on the workflow outputs with local population data (vulnerability) and concentration of businesses (vulnerability) that allowed again for prioritization of efforts based on proportionality of the impacts of the future measures on the comfort and health of the population, as well on the thriving of local businesses that are significant for the local economy, especially those in the tourist sector that are disproportionately affected by this risk.

On the political level, based on the findings of Phase 2, and the additional precision it offers for operationalizing the CRA findings, the municipality has reaffirmed its ambition to start work on both as soon as possible. The municipality therefore plans, upon the completion of the CRAG project, to continue to follow work at EU level that looks more closely into implementation support and to continue to advocate for such at the regional and national levels.

4 Progress evaluation

This second deliverable with the refinement of the initial CRA by the addition of local data will serve Garmen municipality as the foundation for the entire Phase 3, which will see this deliverable and its contents channeled into policy by upgrading, based on its findings, the municipal Climate Change Adaptation Strategy and initiating a process of designing an implementation plan for it.
The refined CRA will also be the basis for the outreach to national and regional stakeholders to advocate for funding for concrete adaptation measures and for a more broader adoption of the CRA-based approach to strengthening regional adaptation planning and coordination.
Deliverable 2 will also be used as the basis for dissemination and stakeholder engagement activities to continue to seek stakeholder input at the stage of policy-making on the one hand, and to build local ownership of policy decision and the climate change issue at large.

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;* - *dissemination of project results through the National association of municipalities to its members.*	*Completed in Phase 2:* - *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;* - *press release sent out and published on project progress and the participation of the Garmen team at the Barcelona workshop;* - *social mead publication on project progress and the participation of the Garmen team at the Barcelona workshop* *The rest of the communication KPIs foreseen will be completed in Phase 3 of the project.*
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. During Phase 1: Citizens, local businesses, municipal administration officials, and regional authorities have been involved to the extent that they could provide input in the process leading up to the completion of this deliverable.* *During Phase 2: a multi-stakeholder public stakeholder consultation meeting was held to present the D1 CRA findings,*

Key performance indicators	*Progress*
	gather feedback to validate and refine the results. Stakeholder input was taken into consideration for the refined CRA.
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
M7: A library of resources with additional regional/local data created (Phase 2).	Completed
M8: Attend the CLIMAAX workshop in Barcelona (Projected for Phase 2 but depends on CLIMAAX coordinator).	Completed
M9: Submission of the Refined local multi-risk assessment (Deliverable 2) (Phase 2).	Completed (with the submission of the current report)
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).	Completed 01/08/2025
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 local data on Workflow 1: River floods (submitted in Zenodo, DOI: 10.5281/zenodo.18292058)
- Zip file with local data for Workflow 2: Heatwaves (submitted in Zenodo, DOI: 10.5281/zenodo.18292058)
- Zip file with visual outputs and workflow notebook for Workflow 3: River floods discharges hazard analysis (submitted in Zenodo, DOI: 10.5281/zenodo.18292058)
- Zip file with media coverage materials (submitted in Zenodo, DOI: 10.5281/zenodo.18292058)
- 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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