Deliverable Phase 1 – Climate risk assessment

Climate Risk Assessment - District St. Wendel (CliRAs - WND)

Germany, District St. Wendel

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Abbreviations and acronyms

Abbreviation/ acronym	Description
BauGB	Federal Building Code (Germany)
BMJV	Federal Ministry of Justice and Consumer Protection (Germany)
BMUKN	Federal Ministry for the Environment, Climate Protection, Nature Conservation and Nuclear Safety (Germany)
BMWE	Federal Ministry for Economic Affairs and Energy (Germany)
CAA	Climate Adaptation Activities
CDS	Climate Data Store (Copernicus Climate Change Service)
C3S	Copernicus Climate Change Service
CLIMAAX	Climate Risk Assessment methodology & toolbox under EU Horizon project
CliRAs-WND	Climate Risk Assessment – District of St. Wendel
CRA	Climate Risk Assessment
DAS	Deutsche Anpassungsstrategie (German National Adaptation Strategy)
DLRG	German Life Saving Association
DRK	German Red Cross
DWD	German Meteorological Service (Deutscher Wetterdienst)
ECMWF	European Centre for Medium-Range Weather Forecasts
EU	European Union
GDP	Gross Domestic Product
GERICS	Climate Service Center Germany (Helmholtz-Zentrum Hereon)
GCM	Global Climate Model
GIS	Geographic Information System
IZES gGmbH	Institute for Future Energy and Material Flow Systems (Institut für ZukunftsEnergie- und Stoffstromsysteme gGmbH)
LUISA	Land Use-based Integrated Sustainability Assessment (European Commission, JRC)
LVGL	State Office for Surveying, Geoinformation and Land Development (Saarland)
MUKMAV	Saarland Ministry for Environment, Climate, Mobility, Agriculture and Consumer Protection
OSM	OpenStreetMap
PIK	Potsdam Institute for Climate Impact Research
RACI	Responsible, Accountable, Consulted, Informed

RCM	Regional Climate Model
RCP	Representative Concentration Pathway
SBKG	Saarland Act on Fire Protection, Technical Assistance and Disaster Protection
SRI	Heavy Rainfall Index (Starkregenindex)
WHG	Federal Water Act (Germany)
WP	Work Package
WND	District of St. Wendel
WMO	World Meteorological Organization

Executive summary

The deliverable 1 documentation presents the results of Phase 1 of the CliRAs-WND project, which aims to strengthen climate resilience in the district of St. Wendel through a systematic climate risk assessment. The work responds to the increasing impacts of climate change on local communities and the need to align with the EU Mission on Adaptation as well as Germany's National Adaptation Strategy and Federal Climate Adaptation Act. It builds on existing initiatives at municipal and regional levels while applying the harmonised CLIMAAX methodology to ensure comparability and transparency.

The assessment applied the CLIMAAX Handbook and workflows to identify, quantify, and evaluate local climate risks. During the scoping process, which was conducted with broad stakeholder participation, heavy precipitation, windstorms, and heat were identified as the primary hazards, with droughts and wildfires considered as emerging concerns that require further attention. Stakeholders included local authorities, emergency services, critical infrastructure operators, social institutions, and representatives of vulnerable groups. Their active involvement helped capture local knowledge, validate results, and clarify responsibilities.

The hazard analyses revealed clear trends:

- **Heavy precipitation** events will occur more frequently and with greater intensity. Return periods for extreme rainfall are projected to shorten significantly, with several critical infrastructures (e.g., hospitals and schools) located in high-risk zones.
- **Windstorm risks** are projected to intensify and already represent a significant threat, particularly in terms of building damages and storm-related impacts on forests. Past events, such as tornadoes and downbursts, have already demonstrated the severity of this hazard.
- **Heatwave risks** are expected to increase markedly, especially in the urban centre of St. Wendel and in areas where elderly people, children, and individuals with pre-existing health conditions are among the most vulnerable groups.
- **Drought and wildfire risks**, although currently moderate, were noted by stakeholders and are expected to intensify in the future, especially for agriculture and forestry.

The findings underline that the district's adaptive capacity is constrained by limited financial and human resources. While there is strong political will and stakeholder motivation, sustainable adaptation will depend on efficient prioritisation, the mobilisation of external funding, and strengthened cooperation across sectors.

This deliverable establishes the foundation for Phase 2, in which local datasets will be integrated and risk assessments refined at higher spatial resolution, and for Phase 3, which will focus on the development of a climate risk management plan and a comprehensive local adaptation strategy. By providing decision-makers with a first integrated overview of climate risks, the document enables evidence-based planning and targeted measures to protect vulnerable groups and critical infrastructures, thereby contributing to long-term climate resilience in the district of St. Wendel.

1 Introduction

1.1 Background

The district of St. Wendel is located in the northern part of the federal state of Saarland. Most of it belongs to the Nahebergland region, with the foothills of the Hunsrück mountains to the north. It covers an area of 476.48 km² and has a population of just under 88,000. The district is the administrative unit for the district town of St. Wendel and the municipalities of Freisen, Marpingen, Namborn, Nohfelden, Nonnweiler, Oberthal, and Tholey, with a total of 63 municipal districts. It is headed by District Administrator Udo Recktenwald.

The district of St. Wendel addressed its responsibility for the climate and the environment at a very early stage. Since 2012, there has been an integrated climate protection concept that serves as a guideline for implementing the district's climate protection initiative. Since 2019, more and more aspects of climate adaptation have also been included in the topics covered. In November 2020, for example, the district was honored in the national competition “Climate-Active Municipality 2020” in the category “Climate Adaptation in the Municipality” for its large-scale trial cultivation of the energy crop ‘cup plant’ (cf. Bundesministerium für Wirtschaft und Energie (BMWE) 2020).

Several departments in the district administration are already working closely together on the issue of climate adaptation: Department 41 Building Management and Climate Protection, Department 43 Rural Development, Department 45 Disaster Control and Building Services. However, a systematic climate risk assessment involving all key stakeholders and a local adaptation strategy for the entire district are still lacking.

1.2 Main objectives of the project

The district of St. Wendel is highly vulnerable to climate change, particularly with regard to heavy rainfall, flooding, and storms. The district’s adaptive capacity is low due to financial difficulties and a lack of resources to respond to climate change. In addition, the awareness and financial capacity of the population to adapt are limited. The main objective of CliRAs-WND is therefore to improve climate resilience in the district of St. Wendel by developing a climate risk management plan and a local adaptation strategy based on a systematic analysis of climate risks.

Through the systematic application of the CLIMAAX Handbook and spatial analysis methods, comprehensive identification, quantification, and assessment of local climate risks will be made possible. The standardized methodology structures the approach, while the use of the provided tools facilitates data collection and processing. The focus on local conditions ensures reliable results. In this way, adaptation strategies and appropriate measures can be developed for vulnerable areas, critical infrastructures, and particularly at-risk population groups to reduce climate vulnerability. Given the district’s limited adaptive capacity, it is essential to use the available resources efficiently. The application of the CLIMAAX Toolbox is expected to make a decisive contribution in this regard.

Another goal is to raise awareness and build capacity among key stakeholders and the population regarding climate adaptation, in order to foster initiative and accelerate the implementation of the measures to be developed. It is hoped that the stakeholder engagement approach within the CLIMAAX methodology will provide significant support in this process.

The two additional objectives of CliRAs-WND—“Strengthening disaster preparedness and emergency planning” and “Integrating climate risks into municipal planning”—both require precise risk assessment as well as increased awareness of extreme weather events. Comprehensive and systematically compiled information on risk assessment is therefore of utmost importance for scientific documentation and traceability. Here, too, the CLIMAAX Handbook will be applied. During the scoping phase, the following structured workflows have already been carried out: in a stakeholder workshop, the most important hazards and risks, as well as the responsible or affected stakeholders, were analyzed. In addition, proposals for further project work in phases 2 and 3 were collected. By using various datasets (e.g., DWD heavy rainfall data, demographic data, etc.) and applying the CLIMAAX workflows, current and future climate risks for heat, heavy rainfall, and storms were presented. With continued use of the workflows and a detailed examination of the risks in phase 2, it is expected that the climate risk analysis will provide a sound basis for the development of appropriate adaptation measures. This is to be carried out in particular with the involvement of relevant stakeholders throughout the entire project duration, in the form of workshops, information events, and the dissemination of information.

In a broader context, CliRAs aims to promote networking and knowledge transfer at the regional and national level. The district's existing network will be used to disseminate the project results in order to transfer knowledge to relevant stakeholders at the state and federal level and thereby accelerate overall adaptation to the consequences of climate change.

1.3 Project team

The project is being led by the **district of St. Wendel**. **Dirk Schäfer**, head of Office 45 'Disaster Control and Building Services' in Department 4 'Education, Infrastructure and Safety' of the district administration office, is responsible for overall coordination and strategic direction. Dirk Schäfer is also the district fire inspector and, in this role, is also involved in the project as a stakeholder.

Diana Jung was hired to coordinate the project between the district and the scientific partner, the Institute for Future Energy and Material Flow Systems gGmbH (IZES). She supports communication between the project and the CLIMAAX consortium as well as with stakeholders in the district. Ms. Jung has a Bachelor of Arts degree in Industry and has worked for many years in business as a project manager and at the University of Kaiserslautern-Landau (RPTU) in the field of third-party funding controlling.

The **Institute for Future Energy and Material Flow Systems (IZES) gGmbH** was commissioned by the district to carry out the climate risk analysis and provide scientific support. IZES gGmbH is a non-university research institution funded by the Saarland that takes an application-oriented and systemic approach to climate (adaptation), energy and material flow analysis. The Infrastructure and Municipal Development Department is responsible for the content-related work for CliRAs – WND.

Simon Spath heads up project work at IZES. He holds a Bachelor of Science degree in Industrial Engineering for Renewable Energies and a Master of Science degree in International Material Flow Management from the Environmental Campus Birkenfeld, Trier University of Applied Sciences, and has several years of project experience in the field of climate adaptation. His work focuses in particular on strategy, measures and concept development in relation to climate protection and climate adaptation at the municipal level and for private actors, as well as sustainable material flow management.

Dorothee Siemer holds a degree in spatial planning (Dortmund Technical University) and is also a researcher at IZES. Her work focuses in particular on sustainable regional development and spatial planning, municipal planning, policy and municipal consulting, and stakeholder management. In recent years, Ms. Siemer has also developed in-depth expertise in the field of climate impact and vulnerability analysis.

The IZES team is supported by **Lili Meiser**, a student of environmental engineering (B.Eng.) at Saarland University of Applied Sciences and a student assistant at IZES. Her work focuses on supporting content-related and administrative activities. She also contributed to the project with a bachelor's thesis on the topic of “Strengthening climate resilience in the district of St. Wendel: Adapting to heat and heavy rainfall in Marpingen.”

Furthermore, **Mike Speck**, Head of the Department of Municipal and Infrastructure Development at IZES, who holds degrees in Civil Engineering and Environmental Engineering supported the substantive and administrative work of the project.

1.4 Outline of the document’s structure

This report deals with current and future climate risks in the district of St. Wendel, their analysis and evaluation. It begins by outlining the background, objectives and stakeholders of the project. Chapter 2 presents the individual results of the climate risk analysis. As part of the scoping process, this includes the identification, classification and evaluation of hazards. The severity of the hazards, the urgency of action, and the district's adaptability are briefly described; these aspects will be specified in more detail as the project progresses. Chapter 2 concludes with a review of the project steps taken so far and a plan for the next steps. The most important conclusions of the first project phase are summarized in Chapter 3.

In addition, Chapter 4 contains a progress assessment with key performance indicators and future milestones, Chapter 5 lists all the results produced in this phase, and Chapter 6 lists the references used.

2 Climate risk assessment – phase 1

This section outlines the steps taken in performing a first CRA using the CLIMAAX methodology and evaluating the initial findings.

2.1 Scoping

During the scoping phase, the following objectives and stakeholders have been defined and described in the subsequent sections. A complete sub-report with answers to the scoping questions is provided within the supporting documentation.

2.1.1 Objectives

The main objective of CLIRAs-WND is to improve climate resilience in the district of St. Wendel by developing a climate risk management plan and a local adaptation strategy based on a systematic analysis of climate risks. Endangered areas, critical infrastructures and particularly vulnerable population groups will be identified. These measures will enable the district to better cope with climate-related extreme weather events and effectively protect its citizens, with a particular focus on vulnerable groups and critical infrastructure.

This objective is to be incorporated directly into regional policy and decision-making processes by developing specific measures with a particular focus on disaster prevention, spatial and urban planning and the protection of critical infrastructure. Results will be embedded into existing governance frameworks (e.g. guidelines, administrative procedures), making climate risk considerations a standard part of policy cycles. Furthermore, the municipalities in the district are supported in taking climate risks (e.g. heavy rainfall, heat) into account in spatial and urban development, urban land-use planning and infrastructure projects. The emergency plans and equipment of the municipal civil protection services will be improved through more precise risk assessments and increased awareness of extreme weather events. The initiative of citizens, companies and the agricultural and forestry sectors is strengthened by raising awareness and providing information about climate risks and adaptation options.

The limitations and boundaries of the CRA include the severely restricted availability of high-resolution local climate and socio-economic data and the inherent uncertainties of future climate scenarios. Furthermore, significant financial constraints and limited human resources in the county and its municipalities, limited risk perception among the public and some stakeholders, and the non-binding status of adaptation tasks are hurdles.

2.1.2 Context

In the district of St. Wendel, climate hazards and their effects have not yet been systematically and holistically assessed. Previous and ongoing projects have dealt with individual hazards at individual locations (municipality of Tholey/ heavy rainfall cf. Landkreis St. Wendel n.d.b; selected social facilities/ heat cf. IZES gGmbH 2024). Thanks to an initiative by the federal state of Saarland, all municipalities in the district now have heavy rain hazard maps, but there are no comprehensive adaptation strategies including measures or links between the hazards of heat, heavy rain and storms, for example.

In 2023 a weather monitoring system was in place to support disaster response as part of the “Smart Wendeler Land” (cf. Landkreis St. Wendel n.d.c) digitalization project. It enables precise, regionalized analyses of weather developments.

At Saarland level, the SAAR climate project (cf. Schinkel et al. 2020) addressed the cumulative effects and interactions of climate change, demographic change and economic change using the example of the Saarpfalz district and the Saarbrücken regional association and presents the resulting challenges for various fields of action.

The Geoportal Saar provides information on heavy rainfall hazards and river flooding. The Saarland's extreme heavy rainfall maps (cf. Landesamt für Vermessung, Geoinformation und Landentwicklung (LVGL) n.d.a) enable state-wide preparation and provide a basis for better preparedness and faster responses to large-scale extreme events, beyond municipal boundaries. The flood hazard maps of the Saarland (cf. Landesamt für Vermessung, Geoinformation und Landentwicklung (LVGL) n.d.b) show the flooded areas and their water depth for a specific event. They depict the predominant use of the areas at risk and provide additional information such as the number of inhabitants affected or the location of protected areas and relevant industrial companies.

Risk assessments at EU and national level are available, but on a larger spatial scale:

- Copernicus Interactive Climate Atlas (European Centre for Medium-Range Weather Forecasts (ECMWF) 2025)
- German Climate Atlas (Deutscher Wetterdienst (DWD) 2025a)
- Climate outlooks for counties (Climate Service Center Germany (GERICS) n.d.)
- Monitoring Report Germany 2023 (van Rüth et al. 2023)
- Climate Impact and Risk Analysis for Germany (Kahlenborn et al. 2021)
- Klimafolgenonline (Potsdam institute for climate impact research e.V. (PIK) 2025)

A systematic, holistic approach is lacking. The CRA in the district of St. Wendel is therefore pursuing a comprehensive, integrated approach that looks at the major climate hazards on the ground together and focuses on locally specific vulnerabilities and capacities. The project focuses on disaster prevention and the integration of an adaptation strategy into municipal planning.

The governance context in the district of St. Wendel is shaped by the EU Mission on Adaptation (cf. European Commission n.d.) and Germany’s National Adaptation Strategy (cf. Bundesministerium für Umwelt, Klimaschutz, Naturschutz und nukleare Sicherheit (BMUKN) 2025). This strategy sets out measurable targets for climate adaptation in Germany. Indicators are assigned to the targets so that progress towards achieving them can be measured. The Federal Climate Adaptation Act (Bundesministerium der Justiz und für Verbraucherschutz (BMJV) 20.12.2023) came into force in July 2024. This provides a binding basis for adaptation. To support federal states and municipalities, there are two funding programmes that specifically promote climate adaptation managers (‘DAS’) and climate adaptation in social institutions (‘AnpaSo’). In addition, the Climate Adaptation Centre (cf. adelphi consult GmbH 2025) has been established. It acts as the first point of contact for municipalities and social institutions on all issues relating to climate adaptation.

At the country level, there are the Saarland Climate Protection Act (Ministerium der Justiz Saarland 12.07.2023) and Saarland-wide goals for sustainable development (cf. Ministerium für Umwelt, Klima, Mobilität, Agrar und Verbraucherschutz (MUKMAV) n.d.). There are also sector-specific regulations. E.g. Disaster protection is a legal mandate (§ 17 SBKG Saarland), urban land-use plans should promote climate adaptation (§ 1 (5) BauGB) and the formal designation of floodplains, which is an essential component of flood protection in Saarland. For all areas affected by a significant flood risk (§ 73 of the Federal Water Act - WHG), floodplains must be designated in accordance with § 76 (2) WHG. The statutory implementation obligation indirectly highlights the potential hazard situation and helps to raise awareness of the respective flood risk among those affected.

But an integrating strategy is still missing and climate adaptation is not mandatory, making resource allocation difficult.

The locally relevant sectors that are considered particularly vulnerable to the effects of climate change include the disaster control, vulnerable groups, critical infrastructures and municipal planning (main focus). Further: Economy (Tourism, companies etc.), Agriculture and Forestry.

Possible adaptation measures include the improvement of emergency preparedness and early warning systems, structural adaptation of buildings and infrastructure, nature-based solutions (blue-green infrastructure, urban greening), information for the population and forestry/agriculture to strengthen their own preparedness and, for example, draft resolutions for the implementation of adaptation measures in municipal planning.

2.1.3 Participation and risk ownership

In a first step, the district and the subcontractor IZES gGmbH jointly identified the stakeholders relevant to the project. The aim was to ensure broad representation of actors from disaster control and other diverse interests, as well as to activate local knowledge. Local and regional authorities (e.g. representatives of the district, mayors), emergency organisations (e.g. fire brigade, German Red Cross), representatives of vulnerable or marginalised communities (e.g. childcare facilities, retirement homes) critical infrastructure and business representatives were identified as important stakeholders. The stakeholders were initially divided into two categories (main and other). Figure 2 1 provides an overview.

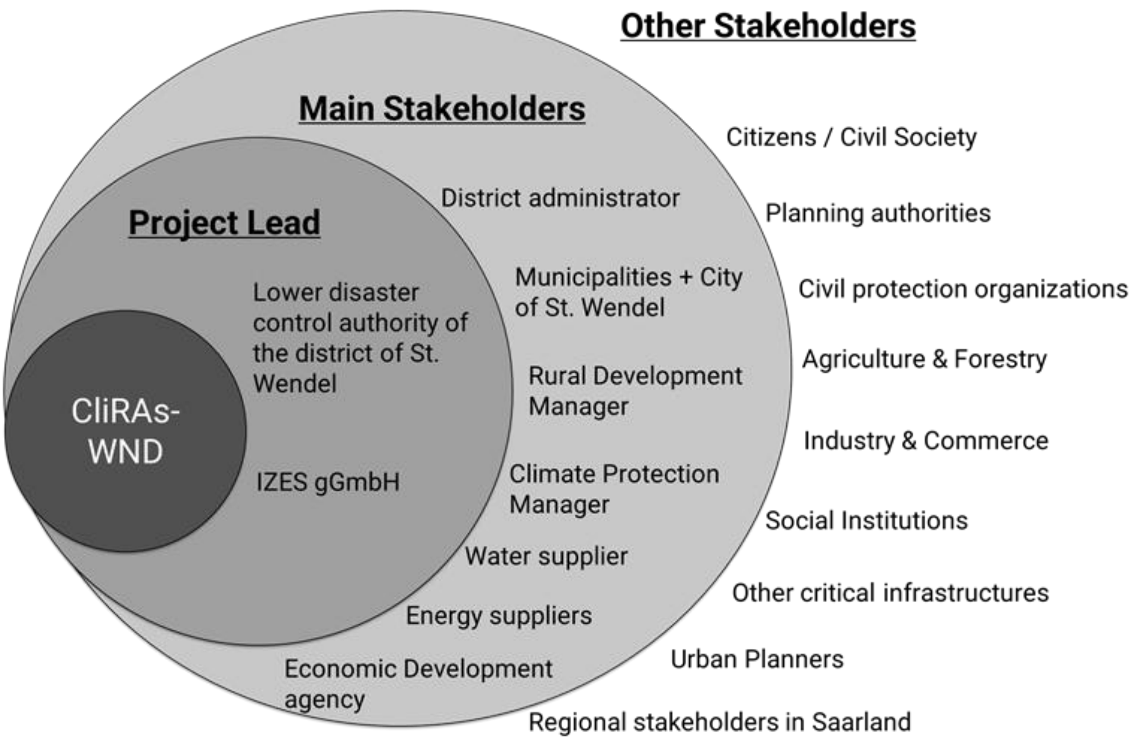

Figure 1: Stakeholders (© IZES gGmbH)

Basically, the district of St. Wendel holds overall responsibility for the CRA process. The disaster control authority (Dirk Schäfer) leads the process, supported by the subcontractor IZES gGmbH. Stakeholders are involved regarding the respective risks. In this context, responsibilities were assigned to the individual persons according to the RACI method (Responsible, Accountable, Consulted, Informed). This was done in an iterative discussion process within the project management team.

During an initial workshop on July 30, 2025, to which all identified stakeholders were invited, they were informed about CliRAs-WND and their knowledge of local climate hazards was recorded and mapped. They were given the opportunity to exchange ideas and network with each other. Hotspots for individual climate hazards were identified. In addition, those interested in actively participating in the climate risk analysis and the development of measures were identified. The stakeholders themselves assigned responsibilities for the various risks and provided the CliRAs team with information about who could and would like to be involved in the further process and how.

Based on the results of the stakeholder workshop, a RACI matrix was designed for all stakeholders provisionally involved (

). This will clearly assign responsibilities in order to optimize decision-making and coordination between interest groups. The main focus for CliRAs-WND is to make communication and cooperation between the very different stakeholders targeted, transparent, and effective by determining who is responsible, who needs to be consulted and who needs to be informed in different situations (cf. Sesli 2024).

Based on their prior knowledge and capacities, stakeholders are assigned the following roles: Responsibility for the implementation of climate adaptation activities lies with the relevant district administrator, the management of critical infrastructure, the management of social institutions, company management, and citizens. Personal responsibility plays a major role here. Responsibility for financing climate adaptation activities lies with the district, the mayors of the individual municipalities, and, at the private level, companies and citizens. Various departments within the district (Disaster Control, Climate Protection, Health Department, Rural Development, Economic Development), municipalities, representatives of critical infrastructure, social institutions, agriculture and forestry, and aid organizations (Fire Department, German Red Cross, German Life Saving Association) have information, knowledge, and experience that may be important for a climate risk analysis. Finally, many stakeholders must also be kept informed of the results: the climate adaptation department at the Saarland level, various offices in the district administration, the municipalities, the umbrella associations of aid organizations, critical infrastructure and social institutions, representatives of agriculture and forestry, consumer protection, companies and citizens.

Responsible: The person is responsible for the content of climate risk assessment (CRA) and climate adaptation activities (CAA).
Accountable: The person is responsible for financing CAA.
Consulted: The person should be heard because he or she has information, knowledge, or experience that is important for CRA and implementing CAA.
Informed: The person should be informed about CRA and CAA.

Table 1: Stakeholder RACI-Matrix

Responsible	**Accountable**
• District (department head) • Critical infrastructure manager • Head of social institutions • Citizens • Industry & Commerce	• District • Mayor • Citizens • Industry & Commerce

Consulted	Informed
• District Disaster Control • District Climate Protection • District Health Department • District Rural Development • District Economic Development • Municipalities • Critical Infrastructure • Social Institutions • Agriculture & Forestry • Emergency Services (Fire Department, German Red Cross, German Life Saving Association)	• State level Climate adaptation • District Climate protection • District Social affairs department • District Health department • District Smart cities • Municipalities • Umbrella associations of aid organizations • Social institutions • Agriculture & Forestry • Consumer protection • Citizens Industry & Commerce

St. Wendel shows a moderate risk tolerance for flooding, heavy rain, and storms. This stems from past experience with such events; disaster protection organizations are familiar with how to handle them and are equipped to a certain extent. This accumulated knowledge and existing preparedness contribute to a sense of manageability, leading to this moderate tolerance. Due to the expected increase in heavy rainfall events, and since this currently represents the main risk, the project places a particular focus on this hazard.

However, there is only a low risk tolerance for heat, drought and wildfires. These extreme events, especially with their increasing intensity and frequency, are a new development for the district, with limited prior experience. Disaster protection organizations are not sufficiently equipped for these specific challenges. There's a lack of specialized gear or expertise needed to manage widespread droughts or large-scale wildfires. The population, buildings, agricultural/ forest areas and infrastructure are currently not adequately adapted to prolonged heat periods, water scarcity or wildfires. This includes everything from insufficient shading and cooling concepts in buildings to inadequate provisions for secure water supply during extended dry spells.

Target groups for communication are local political decision-makers and municipal councils, operators of critical infrastructure, citizens (especially in high-risk or vulnerable areas), civil society organizations, regional/national bodies (e.g. Saarland government, German District Association).

The following formats are planned to involve the groups: Stakeholder workshops and technical meetings, public information events, regional media coverage (print, radio, online), policy briefs and dissemination online publication of results and risk maps.

2.2 Risk Exploration

2.2.1 Screen risks (selection of main hazards)

The risk screening conducted is based on two pillars. The experiences shared and risks named during the conducted stakeholder workshop and during discussion of the topic with the lower disaster control authority and the results regarding different hazards of the Copernicus atlas and risks maps from klimafolgenonline.de (Potsdam institute for climate impact research e.V. (PIK) 2025; European Centre for Medium-Range Weather Forecasts (ECMWF) 2025).

The main hazards identified using the Copernicus Atlas were heat and heavy precipitation. For climate signals regarding wind, the Copernicus Atlas did not show clear indications. Nevertheless, based on past events, wind-related risks are present and a worsening is expected.

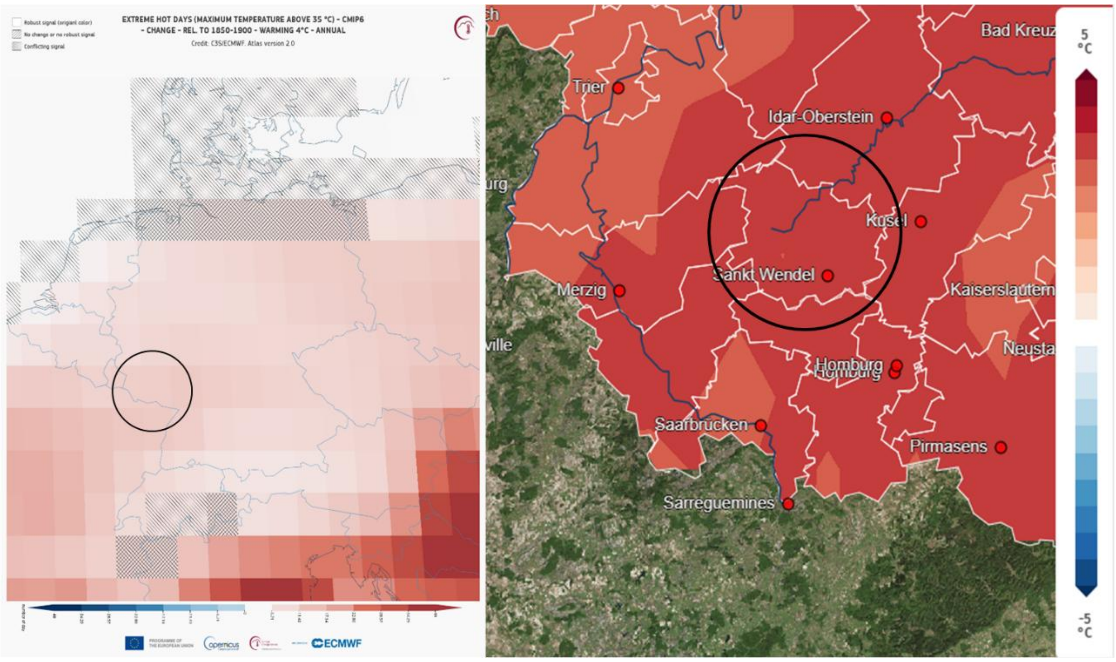

Figure 2: Copernicus Atlas and klimafolgenonline.de results regarding heat (European Centre for Medium-Range Weather Forecasts (ECMWF) 2025; Potsdam institute for climate impact research e.V. (PIK) 2025)

The map from Copernicus Atlas in the left shows extreme hot days in Germany in the 4-degree scenario compared to the years 1850 to 1900. It illustrates that Saarland is one of the regions most affected by extreme hot days compared to other regions in Germany. The map on the right side from klimafolgenonline.de shows the mean temperature in the districts of Saarland according to the RCP 8.5 scenario. It can be seen that the district of St. Wendel has a difference of 3.6 °C between 2071 and 2100 compared to the period between 1981 and 2014.

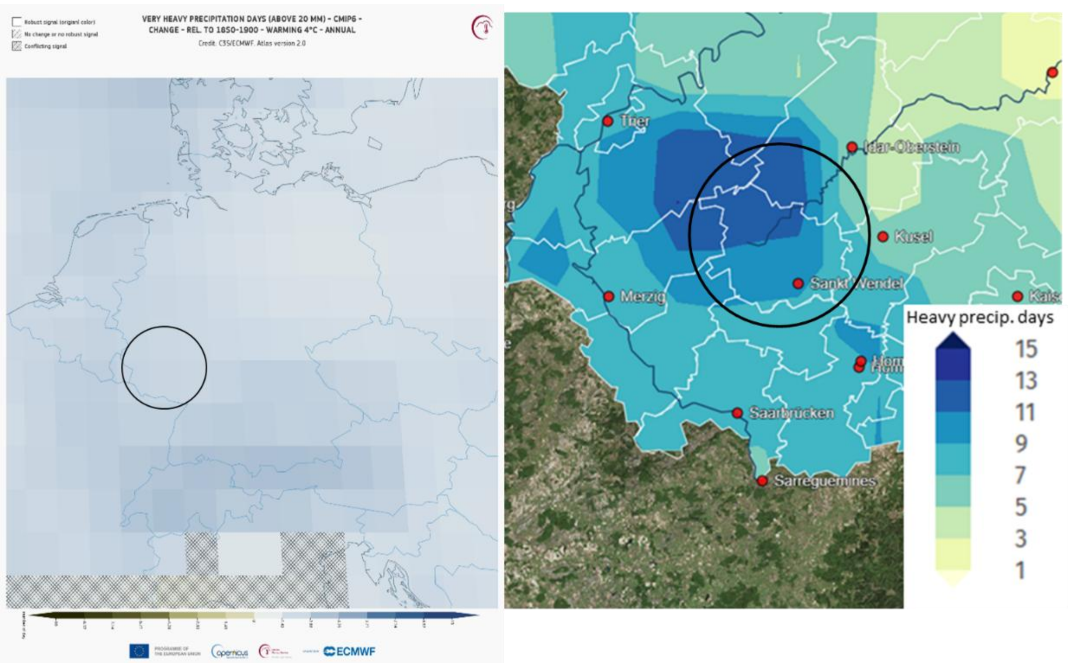

Figure 3: Copernicus Atlas and klimafolgenonline.de results regarding precipitation (European Centre for Medium-Range Weather Forecasts (ECMWF) 2025; Potsdam institute for climate impact research e.V. (PIK) 2025)

The map from Copernicus Atlas in the left show heavy precipitation days in Germany in the 4-degree scenario compared to the years 1850 to 1900. It illustrates that Saarland is one of the regions most affected by heavy precipitation days compared to the regions in north east of Germany. The map on the right side shows heavy rainfall days in the districts of Saarland in the period 2091 to 2100. It can be seen that the district of St. Wendel is expected to have the highest number of heavy precipitation days in the region.

The risks mentioned by the stakeholders within the workshop in July 2025 are presented in the following map. It illustrates affected areas in the district of St. Wendel. More detailed information regarding the results of the stakeholder workshop are described in the partial report for the stakeholder workshop.

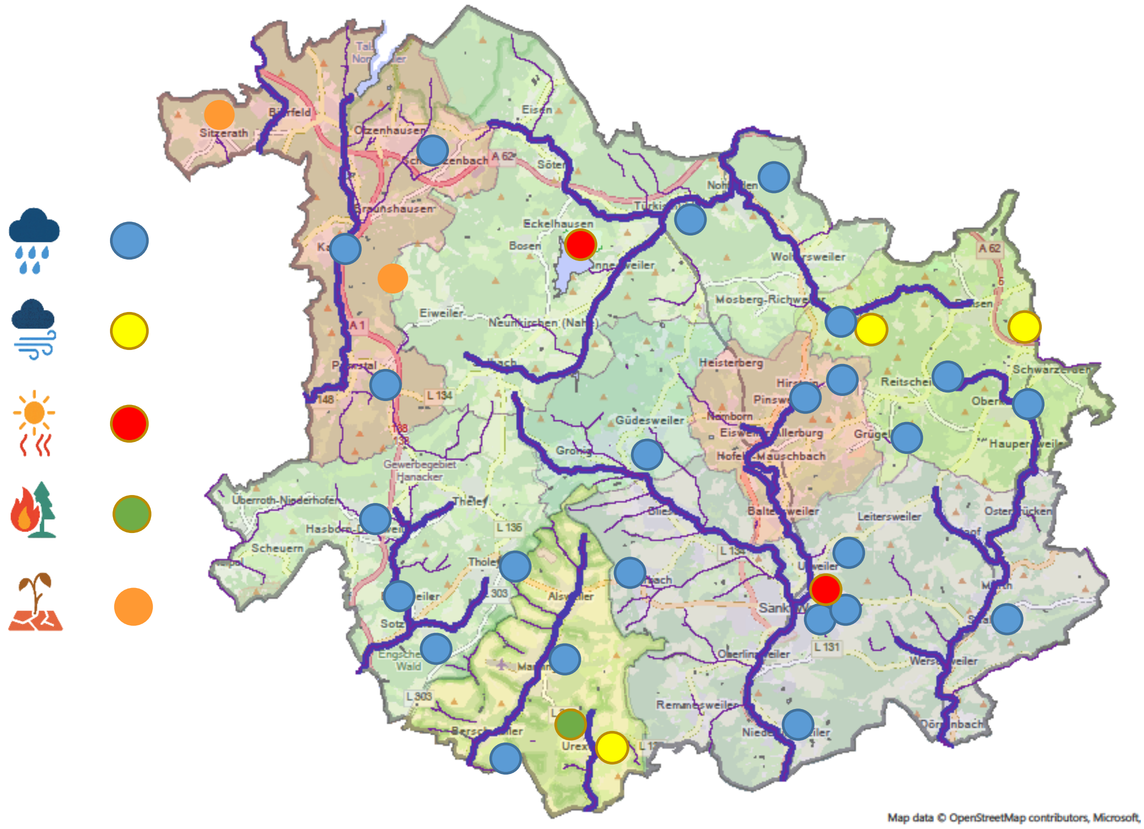

Figure 4: Mapped risks in the district of St. Wendel according to the stakeholders (own illustration; Open Street Map)

The results show that the stakeholders present are currently most concerned about flooding and heavy rainfall events (blue dots). In some cases, storm (yellow dots) and heat (red dots) hotspots were also identified.

Risk regarding heavy rain were located all over the district. Risks in municipalities located in valleys and next to streams and small rivers were named the most. In the past, risks from landslide resulted from heavy rain events became more severe. Regarding heat risks, the city of St. Wendel and touristic sides at the lake “Bostalsee” without shadow were listed. Regarding storms, in recent years a tornado and a downburst have occurred, causing severe damage. Regarding droughts, the spruce stands at Peterberg and the agricultural areas in the west (Benkelberg) of the district were mentioned. Furthermore, risks from wildfires during harvesting were named and discussed in general.

The points on the map show that the entire district is affected by different climate risks. The participants claimed that risks regarding heavy rain, storm, heat, wildfires and droughts can affect the whole district and are not limited to specific areas. It was pointed out that risks to critical infrastructure are particularly relevant for the electricity system, which is crucial for nursing and retirement homes, for example with regard to patients requiring ventilation.

Conclusion – risk screening

Based on the experiences and climate risk perceptions shared by stakeholders, as well as the results from the Copernicus Atlas and klimafolgenonline.de, heavy rainfall, heat, and storms were identified as the primary risks for the district, given their past impacts. However, since climate change is expected to intensify emerging risks in the district—such as wildfires and droughts—and local experience in managing these hazards remains limited, they will also be incorporated into the subsequent phases of the project.

At present, knowledge on hazards and risks is based on past extreme events such as storms, heavy rainfall, and heatwaves. Standard datasets from the German Weather Service (DWD), including precipitation amounts, average and maximum temperatures, are available as a foundation for the assessment. In addition, municipal heavy rainfall hazard maps provide further spatial information on local exposure.

In addition to these datasets, several previous projects and initiatives have already addressed individual climate risks in the region. The Klima SAAR project for the federal state of Saarland examined impacts related to heat and heavy rainfall, while the Geoportal Saar provides accessible information regarding river floods. At the municipal level, the KAN-T *project* in Tholey focused specifically on heavy rain events.

What is still lacking are systematic insights into how the frequency and intensity of such events will change under climate change conditions, as well as integrated analyses that combine hazard information with local vulnerabilities in order to better understand potential impacts. For this purpose, the workflows of the CLIMAAX Handbook have been applied. More detailed results will be developed in the second phase.

More details are described in supporting documentation.

2.2.2 Workflow selection

As outlined in the previous chapter, heavy precipitation, heat, and wind are regarded as the primary hazards forming the basis of the main risks in the district of St. Wendel. Accordingly, the corresponding workflows were selected and are presented in the subsequent chapters. The “River Flooding” workflow was also tested. However, since there are no major rivers in the district, the hazard assessment did not yield meaningful results. For this reason, the focus was placed on the “Heavy Precipitation” workflow.

The assessment of climate change impacts further considers different aspects of society and stakeholders. Particular attention is given to vulnerable groups, as 26% of the population is over 65 years old and 28% of them are in need of care (Bertelsmann Stiftung 2025). Other groups at risk include children, pregnant women, and people with disabilities, some of whom rely on support in social institutions. Critical infrastructure such as energy, water, and waste supply and disposal systems, as well as hospitals, day-care centres, and nursing homes, are also of central importance. In addition, the relatively old building stock, which is only partially adapted to climate change, represents another vulnerability. The agriculture and forestry sector is expected to be highly exposed to climate impacts.

2.2.2.1 Windstorm

The workflow “Wind Storm” addresses the risks related to storm events in the district of St. Wendel. Past events have already demonstrated the significance of this hazard: in 2022, a tornado struck the municipality of Urexweiler, and in 2023 a severe downburst in Asweiler caused major damage to several buildings. In addition, higher-lying municipalities such as Nohfelden and Nonnweiler are particularly exposed to winter storms due to their geographic location. The main exposures include the population, buildings, and critical infrastructure, especially in the northern municipalities, that may be directly affected by high wind speeds. Vulnerabilities arise especially for elderly people, children, and persons with disabilities, as well as from inadequately adapted buildings (e.g. old roofs) and inadequately adapted critical infrastructure. Furthermore, there are considerable risks for the forestry sector, as past storm events have already caused severe damage to forest stands. These impacts are expected to intensify since trees are increasingly stressed by drought conditions, making them more vulnerable to storm damage (severely damaged/dead trees > 7 % in 2023).

2.2.2.2 Workflow Heavy Precipitation

The workflow “Heavy Precipitation” addresses the risks related to intense rainfall and associated flooding in the district of St. Wendel. Due to its location in south-western Germany and the neighbouring low mountain range “Hunsrück,” the region records some of the highest annual precipitation levels in the country (DWD measuring station Nohfelden – multi-year average 1981–2010: 1143 mm - (Deutscher Wetterdienst (DWD) 2025b)). The district is already affected several times per year by heavy rainfall and flooding events that cause major damage. Between 2001 and 2021, 46 heavy rainfall events were recorded, 32 of which exceeded 46 mm/h of precipitation (Deutscher Wetterdienst (DWD) 2021). Past events such as the “*Pfingsthochwasser* 2024” and recurring problems in valley locations, for example in the villages such as Sotzweiler and Hasborn, highlight the severity of the hazard. The main exposures include the population, buildings, and critical infrastructure located in areas particularly prone to flooding due to geographic conditions. Vulnerabilities are especially pronounced for elderly people, children, and persons with disabilities, as well as for buildings and infrastructure that are not adequately adapted to such events. In addition, landslides triggered by heavy rainfall represent an additional risk.

2.2.2.3 Workflow Heat Wave

The workflow “Heat Wave” addresses the risks related to extreme heat in the district of St. Wendel. Heat waves particularly affect the town of St. Wendel and surrounding areas, where high temperatures can create significant stress for the population and the environment. Exposures include residents living in heat-prone areas and buildings that are not adapted to rising temperatures. Vulnerabilities are especially pronounced among elderly people, children, and persons with illnesses.

In comparison to southern Europe, average temperatures are lower; however, heat waves still occur, and the main challenge is that the region is poorly adapted. Challenges include a very limited availability of air conditioning, building structures that are not designed for high temperatures, and tourist sites with insufficient shading (e.g. Bostalsee).

2.2.2.4 Workflow River Flooding

The workflow on river flooding was tested for the district of St. Wendel. However, as only smaller rivers are present in the district, no meaningful results were produced. Therefore, the assessment focused on the heavy precipitation workflow.

2.2.3 Choose Scenario

In Phase 1, the workflows primarily applied the RCP 8.5 scenario, focusing on the period towards the end of the 21st century. This scenario was selected in order to reflect a high-emission pathway and to capture the potential worst-case developments of climate change. In the second phase, based on the insights gained from the first analysis, additional scenarios (e.g., RCP 4.5) and time horizons will be included.

2.3 Risk Analysis

2.3.1 Workflow Windstorm

Table 2: Data overview workflow windstorm

Hazard data	***Vulnerability data***	***Exposure data***	***Risk output***
Prepared historical storm footprints Storm: Lothar 26.12.1999 Copernicus Climate Change Service, Climate Data Store, (2022): Winter windstorm indicators for Europe from 1979 to 2021 derived from reanalysis. Copernicus Climate Change Service (C3S) Climate Data Store (CDS). DOI: 10.24381/cds.9b4ea013	Vulnerability curves (LUISA damage curves, Curves Feuerstein- for building construction types)	LUISA land cover 2018	Structural damages (€/m2)

2.3.1.1 Hazard assessment

The windstorm workflow was conducted according to the CLIMAAX Handbook, using *Option A by downloading prepared historical storm footprints from the Copernicus Climate Change Service (2022)* (see CLIMAAX Handbook: Hazard Assessment STORMS (CLIMAAX 2025)). For this assessment, the winter storm Lothar (26 December 1999) was selected. The storm moved across Europe from west to east and severely affected south-western Germany, causing major damages. In Saarland and specifically in the district of St. Wendel, wind speeds between 100 and 130 km/h were recorded.

In the first step, the hazard footprint of windstorm *Lothar* across Europe was mapped, showing the maximum monthly wind gusts [m/s] during the event (Figure 5). The map illustrates the widespread impact area, with particularly high gust values across parts of Central Europe, also affecting the federal state of Saarland. In the second step, the maximum wind speeds were extracted for the district of St. Wendel (Figure 6), revealing that the strongest gusts, exceeding 36 m/s, occurred in the southern part of the district. In the final step, the storm footprint was localized to the district of St. Wendel in order to provide the hazard data input for the subsequent risk assessment.

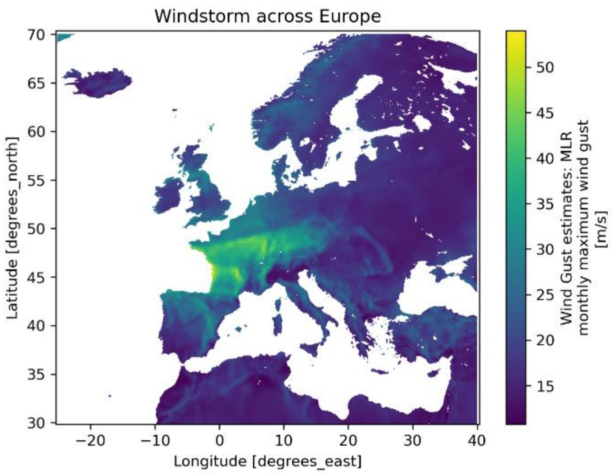

Figure 5: Winter storm Lothar across Europe (26.12.1999)

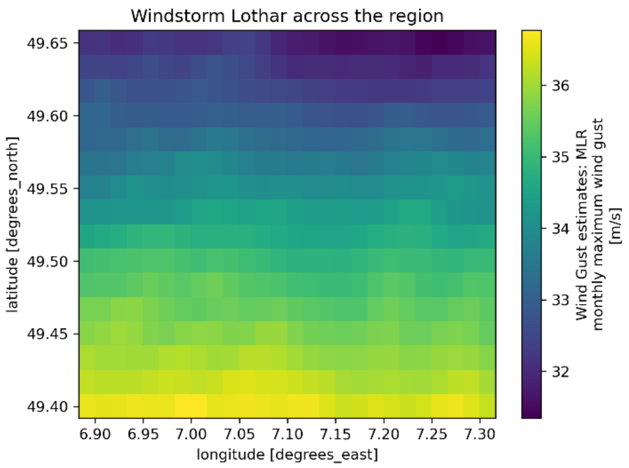

Figure 6: Maximum wind gusts of windstorm Lothar in the district of St. Wendel

2.3.1.2 Risk assessment

In the first step the exposure data were prepared for the further assessment by using the LUISA land cover data (LUISA Base Map 2018 2021) for the district of St. Wendel. Figure 7 shows that the district is largely covered by agricultural and forestry areas. Furthermore the city of St. Wendel and the smaller villages of the different municipalities with urban areas (different densities) can be seen.

In the next step, the GDP per capita was adjusted to the German reference value from the “LUISA_damage” Excel file in order to ensure more realistic calculations for the subsequent steps. A value of 55,800 USD per capita was applied (World Bank 2025). Based on this adjustment, Figure 8 shows the damage potential of structures in the district of St. Wendel, calculated on the basis of land use and maximum damage values. Areas with higher building density and critical infrastructure exhibit higher potential damages, while rural areas generally show lower values.

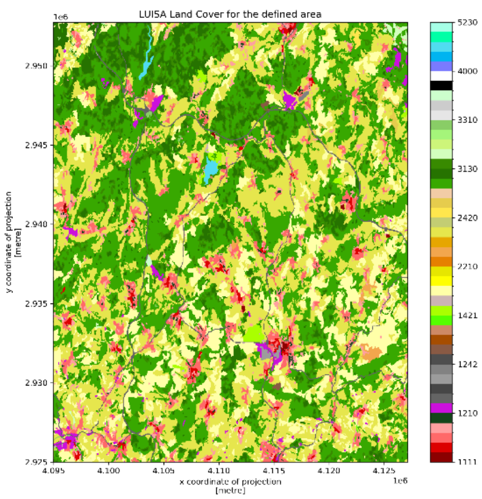

Figure 7: LUISA land cover data for the district

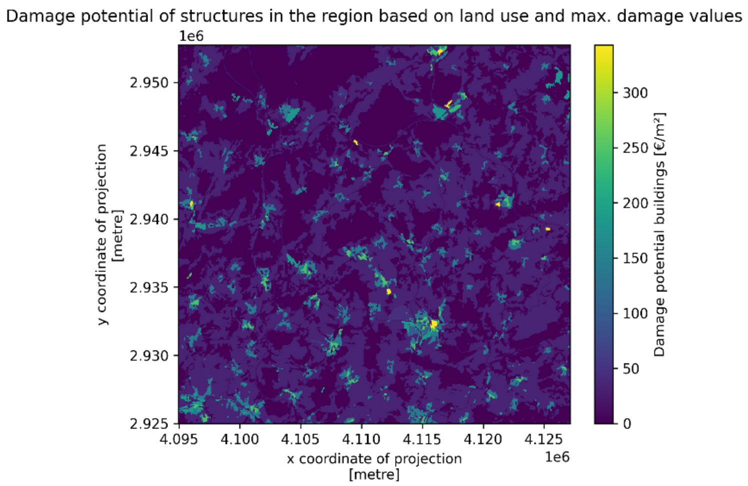

Figure 8: Damage potential of structures in the district of St. Wendel

In the following the vulnerability curves for building construction types and for wind building damage for the LUISA land cover types were created and illustrated in Figure 9 and Figure 10 , using the damage curves of (Feuerstein et al. 2011).

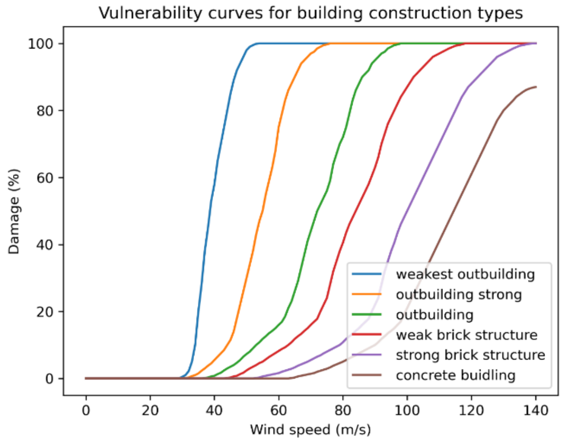

Figure 9: Vulnerability curves for buildings

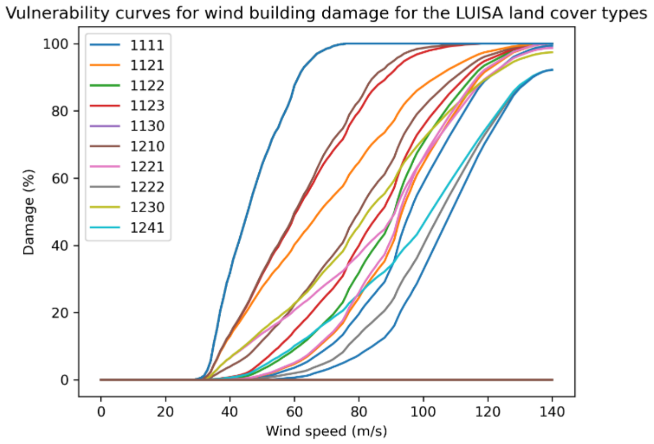

Figure 10: Vulnerability curves for wind building damage for the LUISA land cover types

In the next step of the risk assessment, the LUISA land cover data were combined with the storm wind gust data to illustrate the hazard intensity across different land cover types in the district of St. Wendel. As highlighted in the hazard assessment, the strongest wind gusts occurred in the southern part of the district, where the town of St. Wendel as well as agricultural and forested areas are located (Figure 11).

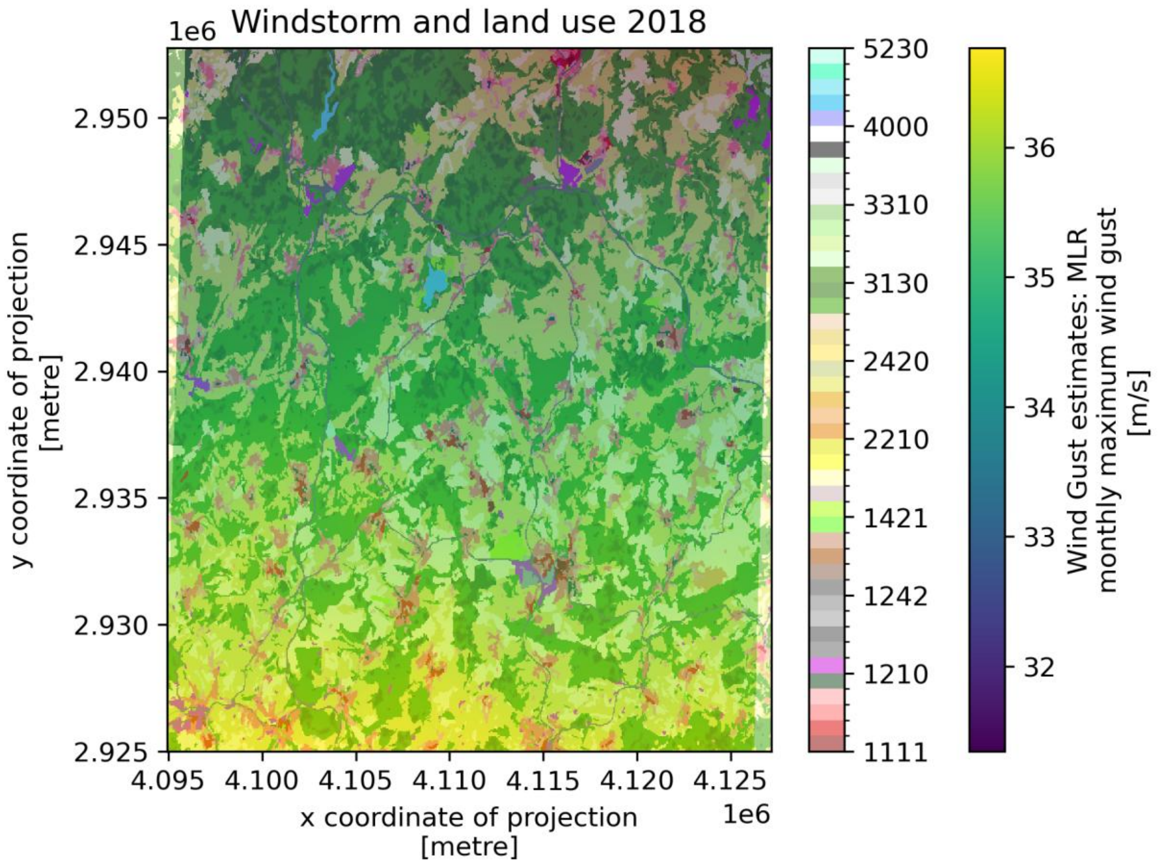

Figure 11: Land cover data and wind gust for the district of St. Wendel

By conducting the damage calculation, the structural damages per land cover class were analysed and are illustrated in Figure 12. Pastures and non-irrigated arable land show the highest damage values in euros, followed by industrial and commercial areas as well as fruit tree and berry plantations. However, this result does not fully correspond with the experiences from past storm events in the region, where the main damages occurred to buildings (e.g. damaged roofs) and to forest areas.

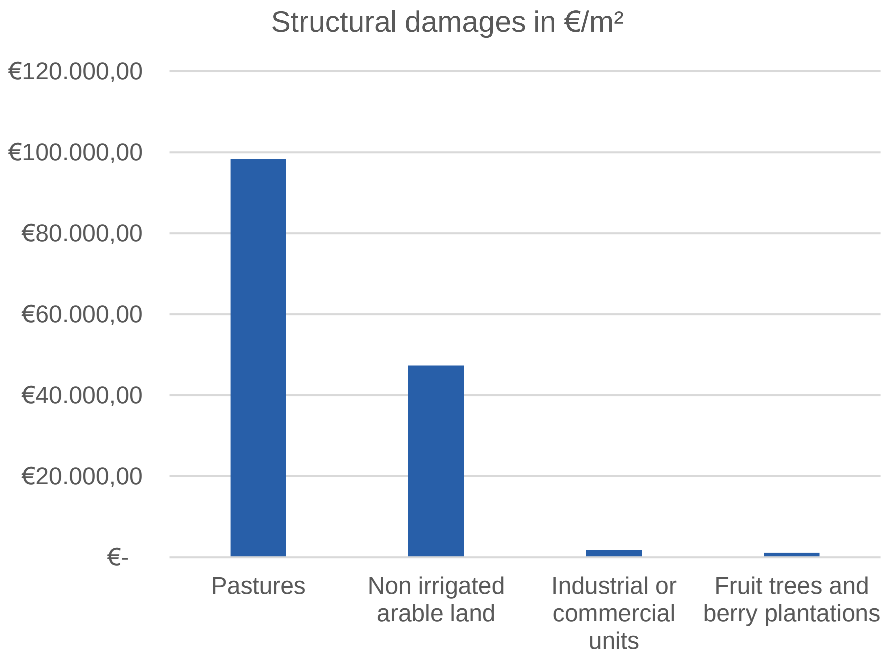

Figure 12: Damages in € for the four land cover classes with the highest amount of Damages (own illustration)

Finally the structural damage in €/m² for the region regarding the selected storm event based on winter storm “Lothar” was shown on a map (Figure 13). It can be seen that the highest damages occur in the south, due to the higher wind gust.

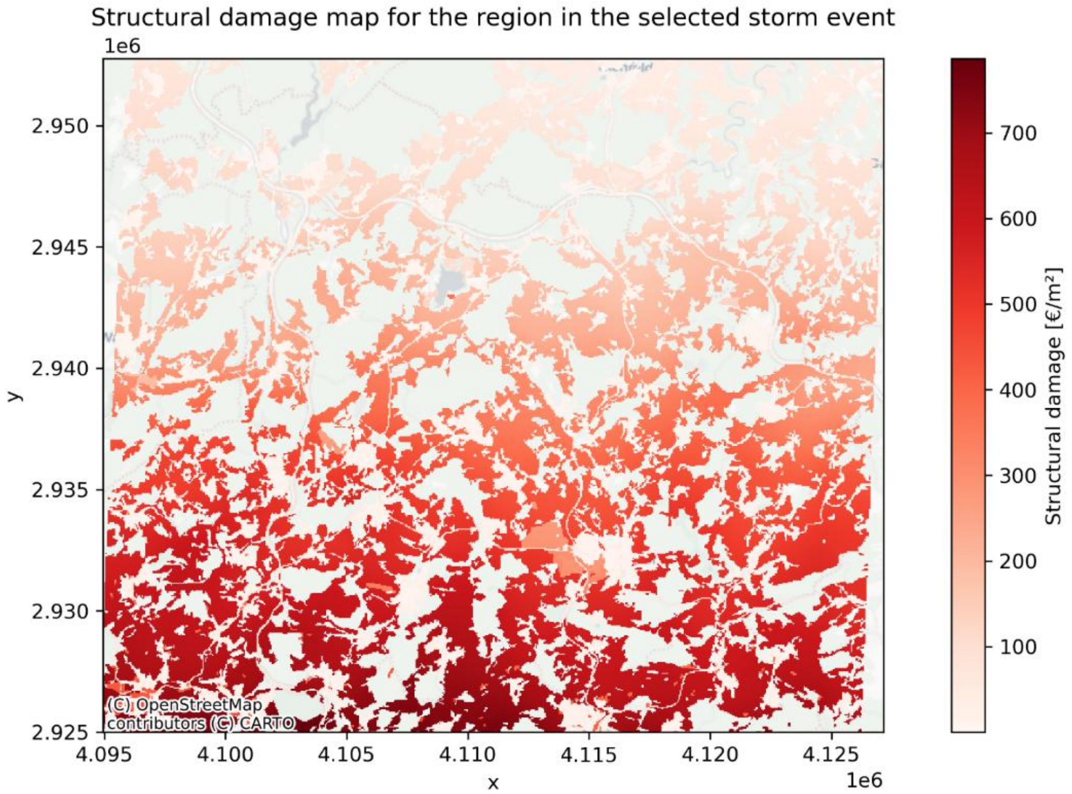

Figure 13: Structural damage map for the district of St. Wendel

2.3.2 Workflow Extreme Precipitation

Table 3: Data overview workflow heavy precipitation

Hazard data	***Vulnerability data***	***Exposure data***	***Risk output***
EURO –Cordex Data: Projected increase of heavy rainfall events KOSTRA-DWD-2010R gridded data on precipitation magnitude and intensities depending on the rainfall duration and the return period (historical 1951 – 2010) (Deutscher Wetterdienst (DWD) 2025c)	Infrastructure vulnerability: Schools and hospitals based on data from open street map	Schools and hospitals in areas with increasing heavy rain events	Expected return periods Expected future magnitudes Critical infrastructure and expected return periods

2.3.2.1 Hazard assessment

Before the workflow was conducted, different threshold values were analysed. The Heavy Precipitation Index (SRI) is a dimensionless scale from 1 to 12 that classifies heavy rainfall events and facilitates risk communication compared to using raw return periods. Originally proposed by Schmitt, the index links rainfall intensities and durations to ordinal index classes rather than relying solely on statistical recurrence intervals (e.g. a 1-in-100-year event). While the DWA concept provides general reference thresholds that are location-independent, it explicitly recommends using local precipitation statistics to establish more accurate thresholds. The advantage of the SRI lies in its intuitive and categorical form, making it easier to communicate risks to stakeholders and the public (Schmitt 2016).

For the present analysis, the SRI was applied specifically to the city of St. Wendel regarding one six heavy precipitation events in the district of St. Wendel, based on freely available KOSTRA DWD raster data provided by the German Weather Service (DWD).

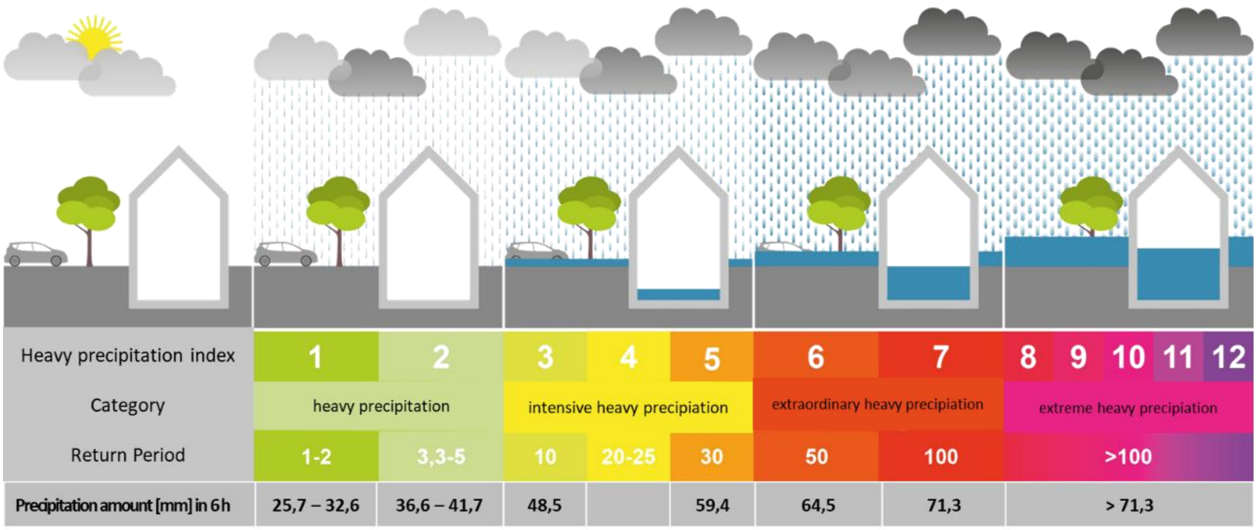

Figure 14: Heavy precipitation index for the city of St. Wendel (6-h rain event) (own illustration according to Schmitt).

In addition to the Heavy Precipitation Index, the warning thresholds of the German Weather Service (DWD) were applied for the further assessment. These thresholds differentiate between three levels of warnings (Deutscher Wetterdienst (DWD) 2025d):

- Significant weather warning: 15–25 l/m² within 1 hour or 20–35 l/m² within 6 hours
- Severe weather warning: >25–40 l/m² within 1 hour or >35–60 l/m² within 6 hours
- Extreme weather warning: >40 l/m² within 1 hour or >60 l/m² within 6 hours

As the available workflow data referred to a 6-hour duration, the analysis focused on the threshold for extreme heavy rainfall events exceeding 60 l/m² in 6 hours.

The heavy rainfall workflow was conducted according to the CLIMAAX Handbook (see CLIMAAX Handbook: Hazard Assessment HEAVY RAINFALL). For this assessment, the historical baseline period 1976–2005 and the future period 2041–2070 under the RCP8.5 scenario were analyzed using EURO-CORDEX data (ICHEC-EC-EARTH GCM, KNMI-RACMO22E RCM). Non-bias corrected datasets with 3-hour temporal resolution were downloaded and aggregated to 3h, 6h, and 24h event durations. The results for 6-hour events are shown in the following figures. Due to the low spatial resolution of the data, the analysis was carried out for the entire federal state of Saarland.

In the first step, the annual maximum precipitation values for 6-hour events were extracted for the city of St. Wendel for the future period 2041–2070 (Figure 15).The bar chart displays the maximum annual precipitation per year in millimeters. The figure shows considerable interannual variability, with some years recording peaks of more than 40 mm, while other years remain below 20 mm.

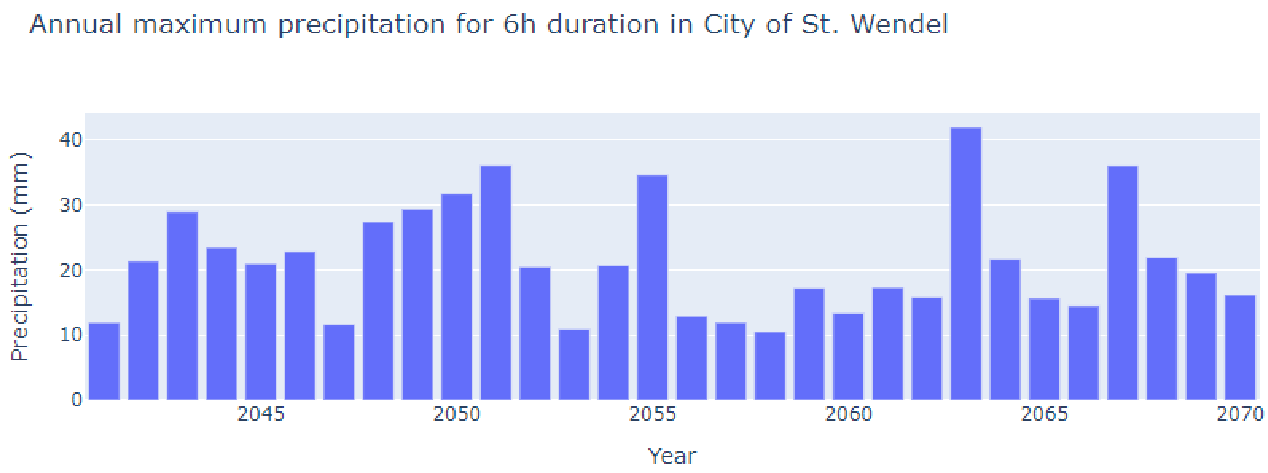

Figure 15: Annual maximum precipitation for 6h duration in the City of St. Wendel

In the second step, the expected precipitation intensities for different return periods were calculated for the city of St. Wendel (Figure 16). The graph illustrates the ensemble mean values as well as the range between minimum and maximum model results, showing that precipitation amounts increase strongly for rare events such as the 50- or 100-year return period.

It can be observed that the values of the middle graph, for example for a 100-year event based on the projection, are lower than the values that have already occurred in the past according to the DWD data (100-year event with >71.3 l/m² in 1 h – see Figure 14).

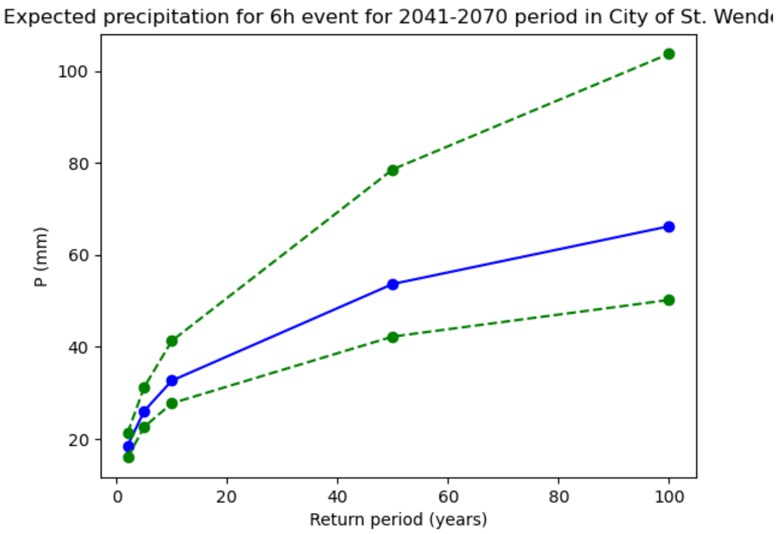

Figure 16: Expected precipitation for 6h event for 2041-2070 in the City of St. Wendel

In the third step, the 6-hour precipitation return levels were aggregated to the Saarland region (Figure 17). Historical values for 1976–2005 were compared with the future projection for 2041–2070 under RCP8.5. The figure shows a clear upward shift of the precipitation curves, indicating that heavy rainfall events of all return periods are expected to become more intense in the future, with the difference being particularly large for extreme events such as the 200- or 500-year return period. As already described before, the precipitation magnitude for the different return periods appear to be too low in comparison to the historical DWD-rainfall data.

Figure 17: Mean precipitation for 6h duration events over Saarland

In the final step, the spatial distribution of extreme precipitation was mapped for Saarland (Figure 18). The left panel presents the absolute precipitation intensities of a 6-hour event with a 100-year return period for the mid-century period 2041–2070. The right panel displays the relative change compared to the baseline 1976–2005. The maps reveal clear spatial differences: while some parts of western Saarland show only minor changes, central and south eastern areas are projected to experience increases of more than 50% in 100-year precipitation intensity.

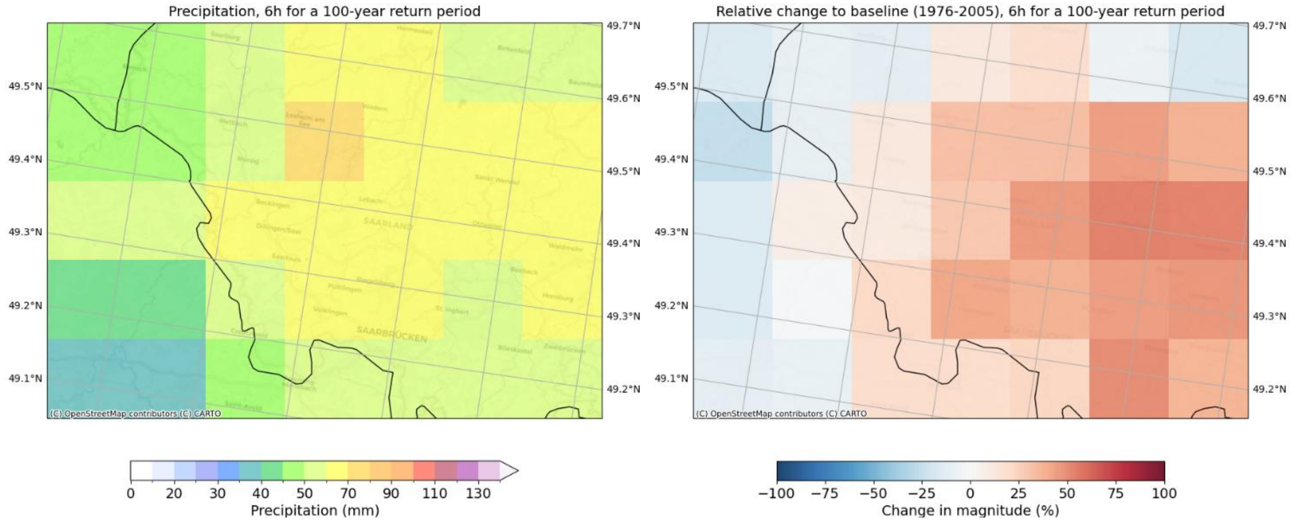

Figure 18: Extreme precipitation for 2041-2070 under RCP 8.5 climate projections

2.3.2.2 Risk assessment

To conduct the risk assessment, the 6-hour data generated by the hazard assessment workflow were used. As a critical threshold, the >60 mm in 6 h value defined by the German Weather Service (DWD) was applied. The underlying scenario was RCP 8.5, and the assessment focused on the period 2041 to 2070. For the further processing of the workflow and the creation of the regional figures, GIS was used to generate TIFF files for 6-hour rainfall values with return periods of 2, 5, 10, 20, 50 and 100 years for the entire study area. These data are based on the historical KOSTRA-DWD-2010R dataset. On this basis, the following figures were produced. Due to the low spatial resolution of the data, the analysis was carried out for the entire federal state of Saarland.

Figure 19 illustrates the current return periods for the 60 mm/6 h threshold in comparison with the projected future return periods. It can be seen that while such events currently have return periods of around 50 to 100 years, they are expected to occur significantly more often under future climate conditions (5 to 10 years). The district of St. Wendel in the north east of the federal state of Saarland shows the shortest current and future return periods.

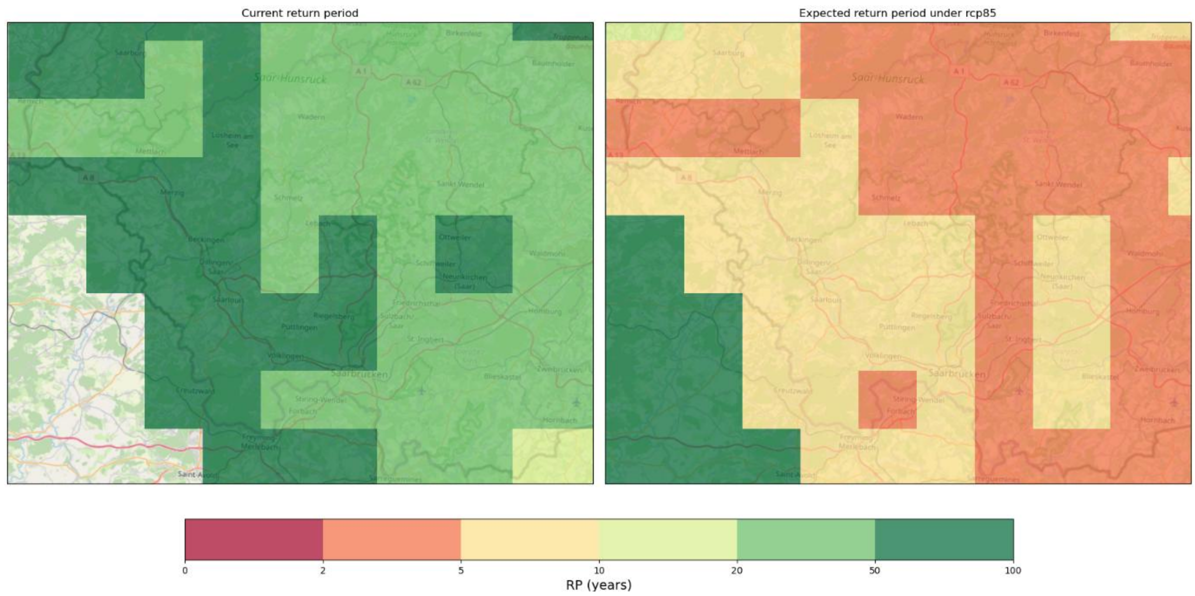

Figure 19: Current and future return periods for a 60 mm and 6 h event in the federal state of Saarland under RCP 8.5 for 2041–2070

In the next step, schools and hospitals for the entire federal state of Saarland were added to the map (based on OSM data). The analysis reveals that most schools and hospitals are concentrated in the urban region of the city of Saarbrücken in the south of Saarland. Specifically, in the district of St. Wendel, the majority of the schools and the only hospital are located within the city of St. Wendel itself. It is important to note that all schools and hospitals in the district will be affected by a short return period for a 60 mm – 1 hour event. This prediction is based on the RCP 8.5 scenario for the period between 2041 and 2070.

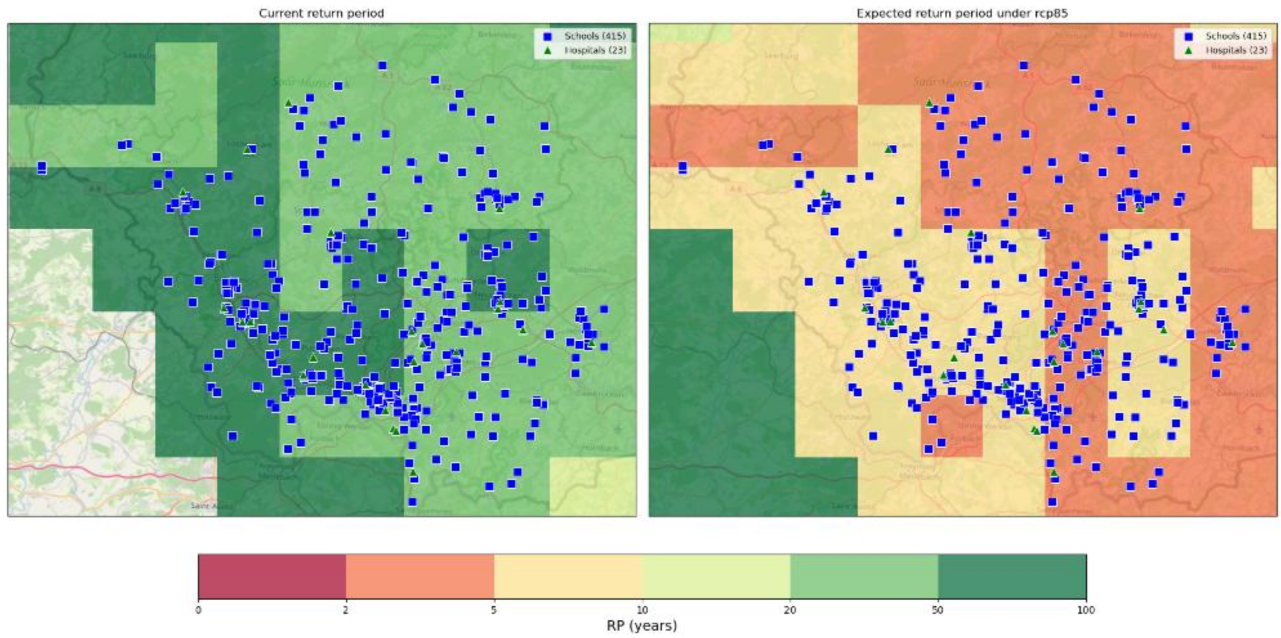

Figure 20: Critical infrastructure - Current and future return periods for a 60 mm and 6 h event in the federal state of Saarland under RCP 8.5 for 2041–2070

Additional assessments based on the example risk assessment workflow were also carried out, but the results proved to be incorrect. The following plots were generated:

- Relative change in precipitation magnitude under RCP 8.5 for 2041–2070
- Shift in return periods for 60 mm/6 h events, RCP 8.5, 2041–2070 vs. 1976–2005
- Projected differences in return periods for 60 mm/6 h events in St. Wendel, including critical infrastructure (schools, hospitals)

Unfortunately, these outputs resulted in faulty representations and are therefore omitted here. In the second project phase, these analyses will be revisited and produced in a corrected form.

2.3.3 Workflow Urban Heatwaves

Table 4: Data overview workflow urban heatwaves

Hazard data	***Vulnerability data***	***Exposure data***	***Risk output***
EURO-Heat dataset (Climate Data Store)	Vulnerable population (Worldpop Hub] (https://dx.doi.org/10.5258/SOTON/WP00646	Landsat 8 satellite data for temperatures	Risk maps based on hot areas with vulnerable population Expected change of heat waves

2.3.3.1 Hazard assessment

The heatwave workflow was conducted according to the CLIMAAX Handbook, following the EURO-HEAT methodology. For this assessment, the location of the district of St. Wendel (lat 49.47°, lon 7.17°) was selected. The analysis was carried out for the scenario RCP 8.5 for the period until 2100, using the EU-wide health-related definition of a heatwave.

In the first step, the occurrence of annual heatwave days was calculated over the full time period. The time series illustrates both the historical development and the projected increase under future climate conditions. In the second step, the results for the district of St. Wendel were extracted and displayed (Figure 21). The graphic shows the number of heatwave days per year under RCP 4.5 and RCP 8.5.

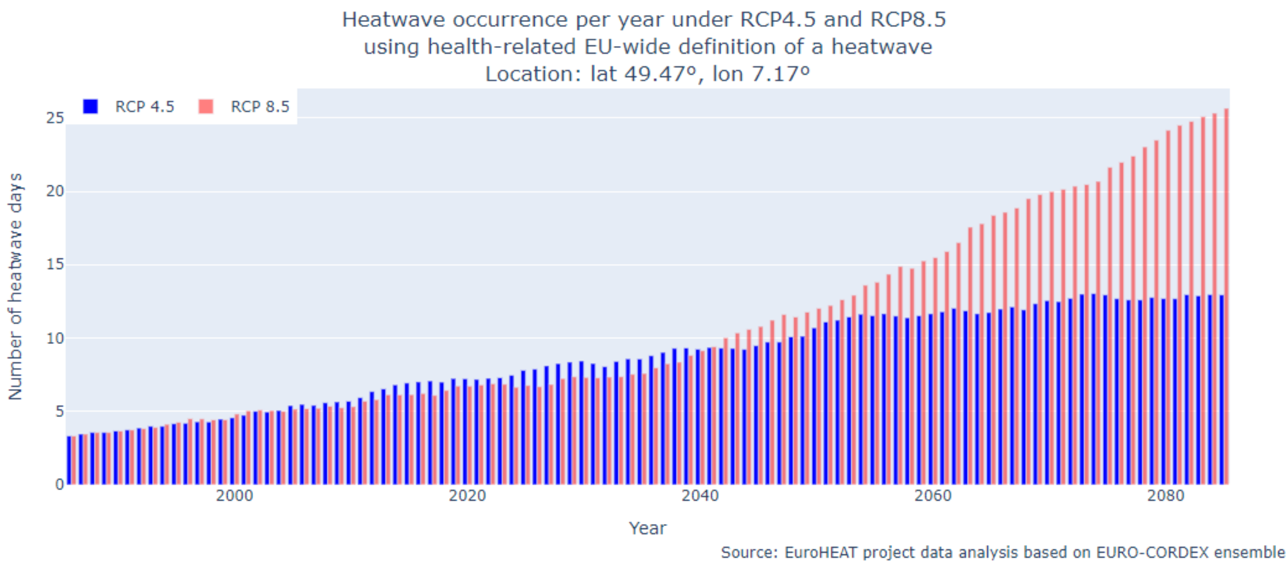

Figure 21: Heatwave occurrence per year under RCP 4.5 and RCP 8.5 for the city of St. Wendel

The results highlight that historically, only a few heatwave days per year were observed in the city of St. Wendel (around five days). Towards the mid-century (around 2040), the number of annual heatwave days increases to values between 5 and 10 days. By the second half of the century, a strong rise in frequency is projected, with annual values regularly exceeding 10 days for the RCP 4.5 scenario and more than 20 days for the RCP 8.5 scenario.

2.3.3.2 Risk assessment for the city of St. Wendel

The heatwave risk assessment was conducted according to the CLIMAAX Handbook, following the workflow for urban heatwaves based on satellite-derived data (see CLIMAAX Handbook: Risk Assessment HEATWAVES). For this assessment, the city of St. Wendel was selected as the area of interest.

In the first step, the exposure data were prepared by mapping overheated areas in the district, derived from satellite information. Figure 22 shows the spatial distribution of overheated zones, highlighting areas with medium to high exposure levels. These hotspots represent parts of the district where urban density, surface sealing and land cover contribute to higher local heat stress compared to surrounding areas.

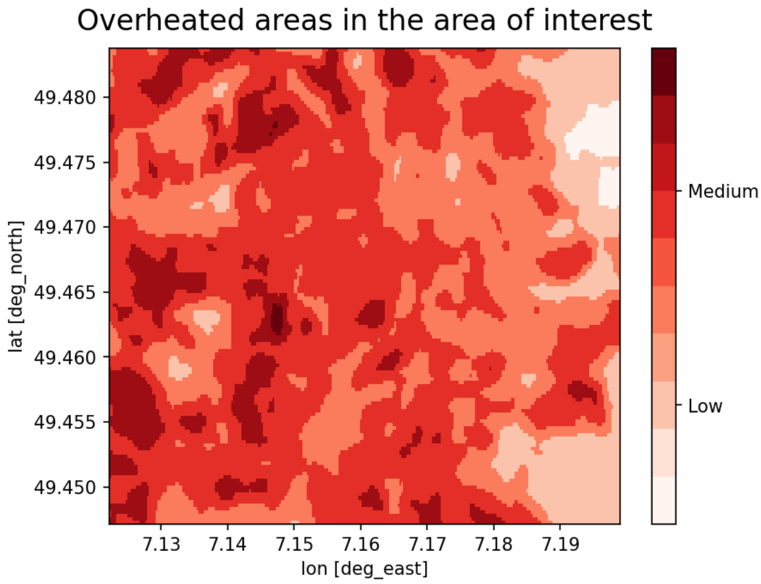

Figure 22: Overheated for the city of St. Wendel

In the next step, the distribution of vulnerable population groups was analysed using WorldPop data for the year 2020. The dataset includes age classes from 1 to 5 years as well as 65, 70, 75, and 80 years and above, representing groups that are particularly sensitive to heat stress. The results illustrate the density of these vulnerable populations within the district of St. Wendel. Very high values are concentrated in the central urban area of the city of St. Wendel, while lower values dominate in the surrounding rural areas (Figure 23).

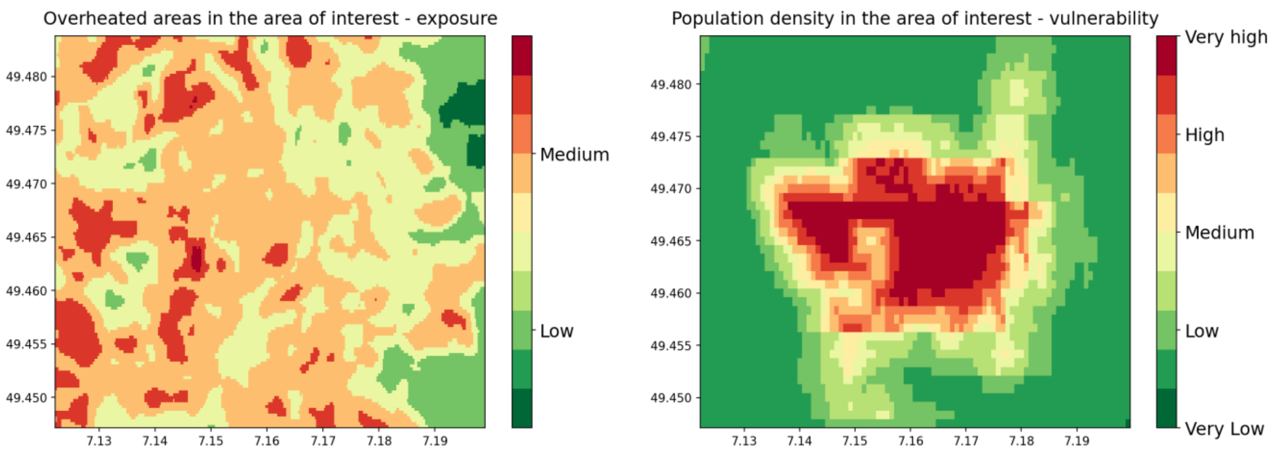

Figure 23: Overheated areas and population density for - city of St. Wendel

In the final step, the possible heat risk level for the vulnerable population was calculated by combining the exposure and vulnerable population (Figure 24). The results indicate that the highest risk levels occur in the city centre of St. Wendel, where overheated areas and a high density of vulnerable groups coincide. By contrast, the rural parts around the city, although also affected by elevated heat, show lower risk levels due to their lower population density.

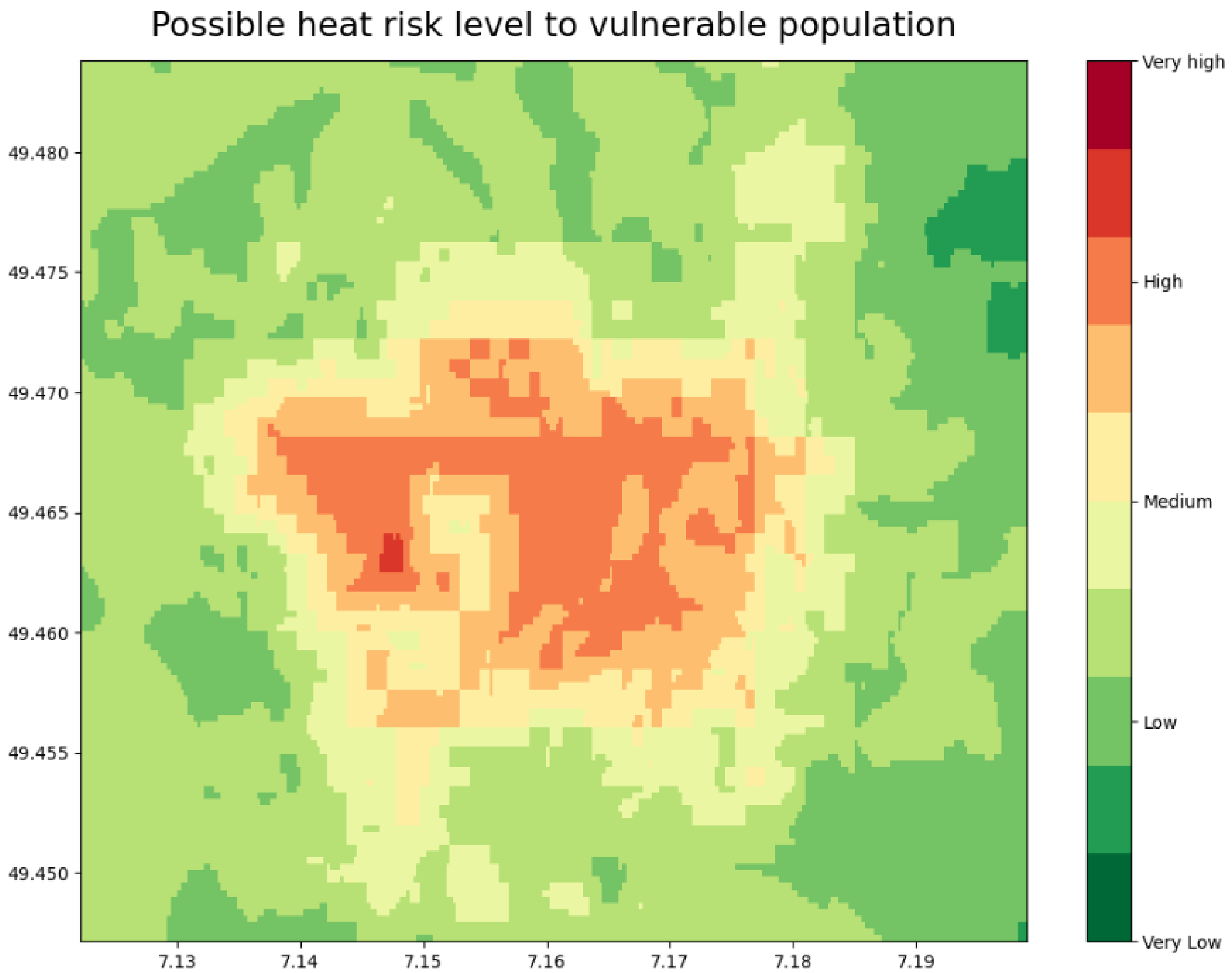

Figure 24: Heat risk level to vulnerable population - city of St. Wendel

2.3.3.3 Risk assessment Heat projections

The assessment of projected changes in heatwave risk was conducted according to the CLIMAAX Handbook, using the workflow on heatwave risk projections (see CLIMAAX Handbook: Heatwave Risk Projected Change). For this analysis, climate projections under RCP 4.5 and RCP 8.5 were considered for the federal state of Saarland.

In the first step, the relative change of heatwave occurrence compared to the historical reference period (1986–2015) was analyzed (Figure 25). The results show that under both RCP 4.5 and RCP 8.5 a clear increase in the frequency of heatwaves is projected for Saarland, with particularly strong increases in the second half of the century under RCP 8.5. The southern and eastern parts of Saarland, including the district of St. Wendel, are most affected.

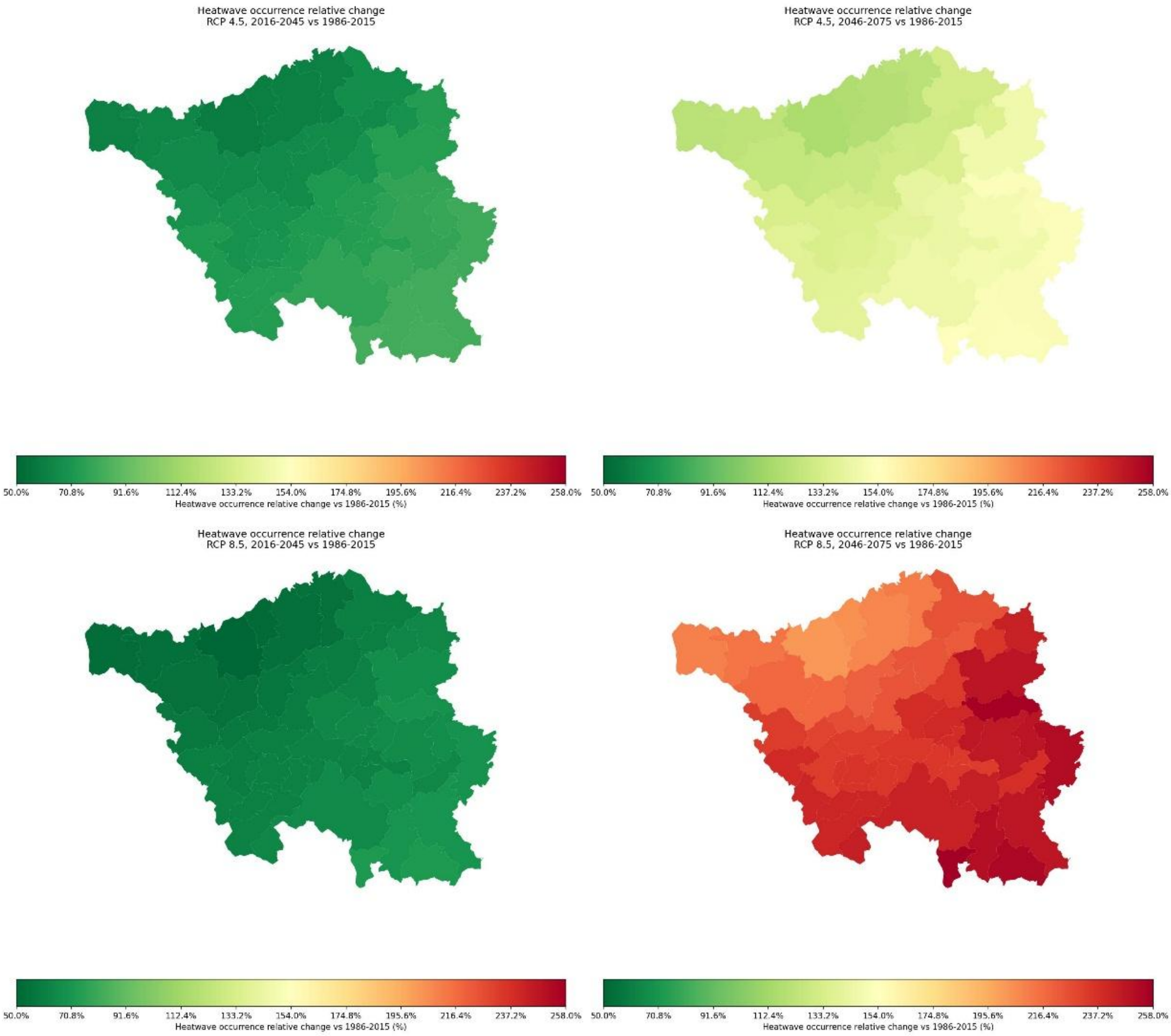

Figure 25: Relative change of heatwave occurrence for Saarland under RCP 4.5 and RCP 8.5 compared to the reference period (1986–2015).

In the next step, the relative change in heatwave risk for vulnerable population groups was assessed (Figure 26). The maps highlight that, while the risk is projected to rise across all regions, the most pronounced increases occur in the southern Saarland municipalities where both exposure and vulnerable population density are higher. By contrast, the district of St. Wendel shows a comparatively lower increase in projected heatwave risk, reflecting both fewer heatwave days and a lower concentration of vulnerable groups compared to the south.

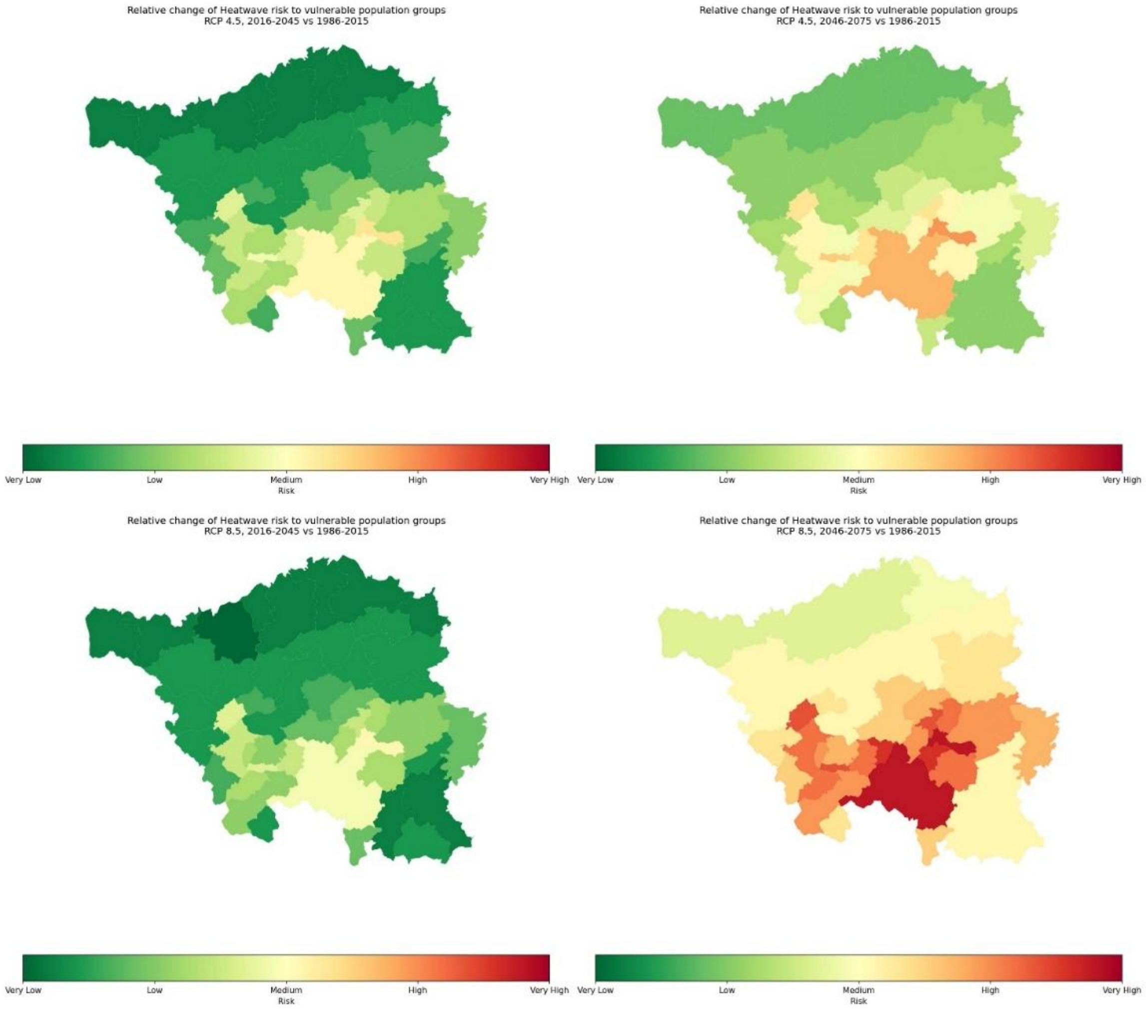

Figure 26: Relative change of heatwave risk to vulnerable population groups for Saarland under RCP 4.5 and RCP 8.5 compared to the reference period (1986–2015).

2.4 Preliminary Key Risk Assessment Findings

Based on the stakeholder workshop, the available datasets, and the CLIMAAX workflows conducted in Phase 1, a first structured assessment of climate-related risks for the district of St. Wendel was carried out. The results show that the district is exposed to multiple climate hazards, including heavy precipitation, windstorms, heatwaves, and, to a lesser extent, wildfires and droughts. The findings of the stakeholder workshop were directly incorporated into this assessment, complementing the quantitative workflow results with local experiences and perceptions.

The prioritisation of risks, as illustrated in the multi-criteria risk matrix (Figure 27), highlights heavy precipitation and windstorm as the most urgent and severe risks for the district. Heat is identified as a moderate but rising risk, with hotspots in the urban core of St. Wendel and tourist areas such as the Bostalsee. Compared to heavy rainfall and windstorms, however, the current severity and urgency of heat risks are assessed as lower. Wildfire and drought are ranked lowest at present, as they were considered less severe and urgent by both the stakeholders and the initial assessment.

More detailed information regarding severity, urgency and capacity are described in the following subchapters.

Risk Workflow	Severity C	Severity F	Urgency	Capacity (Resilience/ CRM)	Risk Priority
River flooding	x	x	x	x	x
Coastal flooding	x	x	x	x	x
Heavy rainfall	3	4	3	3	Very high
Heatwaves	2	3	3	2	Moderate/High
Drought (Assessment Phase 2)	1	3	2	2	x
Fire (Assessment Phase 2)	1	2	2	2	x
Snow	x	x	x	x	x
Wind	3	4	3	3	High

Severity	Urgency	Resilience Capacity	Risk Ranking
Critical	Immediate action needed	High	Very high
Substantial	More action needed	Substantial	High
Moderate	Watching brief	Medium	Moderate
Limited	No action needed	Low	Low

Figure 27: Key risk assessment

2.4.1 Severity

According to the results of the conducted assessment of phase 1 the severity (Current – C and Future – F) for the different hazards is described in the following:

- **Heavy precipitation (C: Substantial / F: Critical):**
  Heavy rainfall is already one of the most pressing climate risks for the district, with all municipalities repeatedly affected in recent years. Events such as flash floods and landslides triggered by intense rainfall have highlighted the severity of this hazard. The workflows confirm that heavy precipitation will become even more frequent and intense in the future, meaning that a risk currently classified as *substantial* is expected to rise to *critical* severity under climate change conditions. In extreme cases, heavy precipitation can lead to loss of human life and cause severe damage to buildings and critical infrastructure.
- **Windstorm (C: Substantial / F: Critical):**
  Storms have already caused major damage in the district, particularly in higher-lying municipalities. Forests, which are increasingly weakened by drought, are especially at risk. Current severity is assessed as *substantial*, but the combination of past experience and projected increases in storm intensity means that severity will become *critical* in the future. Severe windstorms can result in loss of human life and substantial damage to buildings and critical infrastructure. In addition, the impact on forests can be significant, as seen in past events.
- **Heatwave (C: Moderate / F: Substantial):**
  Heat risks are currently less severe compared to heavy precipitation and windstorms, but they are rising. Vulnerable groups such as elderly residents and children are particularly exposed, especially in urban areas like the city of St. Wendel and at touristic hotspots such as the Bostalsee, where shading is insufficient. While current severity is classified as *moderate*, future projections from the workflows show a significant increase in heatwave days, raising the severity level to *substantial*.
- **Wildfire (C: Limited / F: Moderate) – Detailed Assessment in Phase 2:**

At present, wildfire risk is relatively low and classified as *limited*. Nevertheless, stakeholders pointed to fire outbreaks during harvest periods and to increasing dryness in forests. With projected climate change leading to more frequent and prolonged drought conditions, wildfire severity is expected to rise to *moderate* in the future, particularly for agriculture and forestry.

- **Drought (C: Limited / F: Moderate) - Detailed Assessment in Phase 2:**
  Drought currently poses a comparatively minor risk, but it is beginning to affect forestry and agriculture, such as the spruce stands at the Peterberg and farmland in the western part of the district. Severity is therefore rated *limited* at present. In the future, longer and more intense dry periods are likely, which will increase the severity to *moderate*, especially in combination with other stressors such as storm vulnerability of forests.

2.4.2 Urgency

According to the results of Phase 1, the urgency of action for the different hazards is described in the following:

- **Heavy precipitation:**
  Heavy rainfall is already causing frequent damage across the district, and return periods for extreme events are projected to decrease significantly in the future. Adaptation measures should therefore be implemented in order to reduce risks from flash floods and impacts on buildings and critical infrastructure.
- **Windstorm:**
  Storms have already produced severe damage in recent years, including tornado and downburst events. With forests increasingly vulnerable due to drought stress and buildings only partly adapted, there is an urgent need for timely adaptation. Early implementation of protective and preventive measures is essential to address both current and projected risks.
- **Heatwave:**
  Heat-related risks currently require targeted measures, especially in urban centres and touristic hotspots. However, with a strong increase in heatwave days projected, adaptation should be initiated in the short term to protect vulnerable groups and improve resilience.
- **Wildfire:**
  At present, wildfire risk requires only limited immediate attention, although stakeholders highlighted risks during harvest periods and in increasingly dry forests. Urgency is expected to grow in the future, but it remains lower compared to heavy precipitation, windstorms, and heatwaves.
- **Drought:**
  Drought currently has limited urgency but is beginning to stress agriculture and forestry. In the future, longer and more intense dry periods will likely increase the need for adaptation. At present, however, other hazards demand higher priority.

2.4.3 Capacity

The district administration and political bodies are highly motivated to raise awareness and implement measures. However, they need to develop their knowledge and skills. Climate adaptation is already a key issue for various departments. Individual activities have already been carried out and are currently being planned. At district level, for example, there is the cultivation of cup plant (cf. Landkreis St. Wendel n.d.a) and at municipal level, there are heavy rain hazard maps (cf. e.g. Planungsbüro Hömme GbR n.d.) and individual adaptation measures. However, there is no holistic strategy. Since 2023, the first district-owned disaster control centre in Saarland has existed, and its remit is expanding with the help of CliRAs-WND to include comprehensive risk analysis and the development of adaptation measures. Although emergency management is well established, the district's and its municipalities' financial capacities are limited. In the 2025 district budget, expenditure on youth welfare, care assistance, and personnel costs increased significantly (cf. Landkreis St. Wendel 2024b). The budget shows a significant surplus in investment activities (cf. Landkreis St. Wendel 2024a). The district levy, which is paid by the district municipalities, increased from 54 to 59 per cent, representing a significant additional burden for the municipalities (cf. Landkreis St. Wendel 2024b). Financing preventive climate adaptation will mainly depend on external support. Indicators of the social situation of the district's population show better values than the German national average (cf. Bertelsmann Stiftung 2025). It is therefore important to encourage the population to prepare themselves (through awareness-raising, information, knowledge-building and skills development). In this context, it is also crucial to increase social capacities to avoid creating social injustices when implementing adaptation measures. Physical capacities have been expanded for some time with the help of other research projects. For example, various measuring devices have been and are being installed at selected locations to record floods (cf. Landkreis St. Wendel 2022) and heat (in the project ADAPT; cf. IZES gGmbH 2024). The aim is to pool the data collected, evaluate it collectively, and make it accessible to all aid organisations. Natural capacities, such as areas that allow rainwater to infiltrate the ground, are sometimes in competition with economic interests in individual municipalities. These capacities must be protected and expanded by raising risk awareness further.

2.5 Preliminary Monitoring and Evaluation

The first phase of the climate risk assessment demonstrated that the application of the CLIMAAX workflows provides an important basis for evaluating current and future risks in a structured way. The workflows proved particularly useful in highlighting how risks are expected to intensify under climate change conditions and therefore supported a more robust prioritisation of hazards. This was especially evident for heavy precipitation, where the assessment clearly showed a significant worsening of risk in the future. At the same time, the process also revealed challenges, including the limited spatial resolution of available datasets and the need to better integrate local-scale information to capture small-scale impacts. These insights underline the importance of continuous monitoring and evaluation in the next project phases.

Feedback from stakeholders showed that there is a desire for a network platform where different groups can easily exchange information with each other. Knowledge and understanding of responsibility already exist for some climate hazards, while for others there is a need for information and the allocation of responsibility. It was interesting to learn which interest groups have already developed climate adaptation activities and where gaps exist. For the further work process, it was important to see which actors can and want to actively participate in the project.

In general, it was noted that the population must be integrated into the further participation process. The interest groups emphasized that the population's personal responsibility must be strengthened and individual approaches supported. For this reason, it is important to present the risks in a way that is generally understandable and make them available to the population in an accessible manner. Young people/schoolchildren and their teachers in particular should be involved so that those who will have to deal with the future risks are already included today.

Detailed results of the stakeholder workshop:

The participants requested information/workshops on the following topics for the further development of CliRAs-WND:

- Heavy rain hazard map for the entire district
  → Possibly in paper form, combination of analog and digital
- Citizen information
  → Various media, playful concept (competitions in the localities), presentations
- Make endangered rivers and streams recognizable for residents
- Workshop on concrete solutions
- Heat concept for schools, daycare centers and retirement homes
- Regular sensitization of the population
  → Concrete examples also for unaffected citizens, greater personal responsibility of citizens desired
- Better accessibility of information material for everyone
- Maps showing e.g. shared respiratory care homes
- Information on civil protection contacts in the municipality
- Information on subsidies, e.g. sustainable building
- Information on nutritional adaptation in the event of crop failures

According to the participants, the following additional stakeholders should be involved in the CliRAs-WND process:

- Citizens
- Ministry (state and federal)
- Pupils, young generation
- Teachers
- Companies, gardeners and landscapers, architects/planners
- Care services e.g. day care

Figure 28: Impressions from the stakeholder workshop on July 30, 2025(Photos: IZES gGmbH)

2.6 Work plan

In Phase 2, the results of Phase 1 will be further processed and expanded. This phase will include:

- **Application of workflows for additional risks** such as wildfires and droughts, which were identified as emerging hazards during the stakeholder process.
- **Addressing contradictory findings**, for example regarding return periods of heavy precipitation (see Chapter “Workflow Heavy Precipitation”).
- **Refinement of hazard and vulnerability assessments** at a higher spatial resolution using GIS, including the preparation of additional scenarios for the already assessed risks (heat, windstorms, and heavy precipitation). This also includes the creation of more specific maps for critical infrastructures and tailored outputs for stakeholder groups to support thematic workshops.
- **Organisation of thematic workshops** with stakeholders to validate and expand the findings.
- **Integration of existing local datasets** (e.g. municipal heavy rainfall hazard maps) and linking them with the Phase 1 results, as well as compiling and analysing existing studies and data.
- **Implementation of citizen information activities** to strengthen public awareness and engagement, for example by publishing articles in regional media.
- **Expansion of regional networking activities**, including collaboration with the federal state of Saarland and other relevant actors.
- The **river flooding workflow** will not be pursued further, as no major rivers are present in the district and the heavy precipitation workflow already provides sufficient results.

Phase 2 will thus create the foundation for Phase 3, which will focus on the development of the adaptation strategy, the climate risk management plan, and the definition of concrete adaptation measures.

3 Conclusions Phase 1- Climate risk assessment

Phase 1 of the CliRAs-WND project has laid the groundwork for a systematic approach to climate risk management in the district of St. Wendel. By applying the CLIMAAX methodology, combining quantitative workflows with qualitative stakeholder input, and embedding results into the regional context, a first structured risk profile for the district has been produced. This profile provides decision-makers and stakeholders with a comprehensive overview of current and projected climate risks and serves as the analytical basis for subsequent phases of the project.

The assessment clearly demonstrates that the district faces multiple climate-related hazards. **Heavy precipitation** emerged as the most urgent and severe risk, with return periods for extreme rainfall events projected to shorten drastically. This implies that events which are currently classified as 50- or 100-year occurrences may happen every 5 to 10 years in the future. Such developments underline the need for immediate adaptation measures to reduce risks of flash floods, landslides, and impacts on critical infrastructure. These results also highlight the discrepancy between model-based projections and local reference data (KOSTRA), underlining the importance of integrating high-resolution municipal datasets in Phase 2. **Windstorms** represent another major risk: they have already caused significant building damages and severe losses in forest areas, and future projections indicate intensification, particularly because drought-stressed forests are more vulnerable to storm impacts. **Heatwaves** currently represent a moderate but growing risk, especially in the city of St. Wendel and tourist areas such as the Bostalsee. Vulnerable groups such as elderly people, children, and individuals with health conditions are especially exposed. In addition, **wildfire and drought risks**, though less urgent at present, were emphasised by stakeholders and are expected to increase in the coming decades, particularly in agriculture and forestry.

The stakeholder process proved to be a key strength of Phase 1. Local authorities, emergency organisations, operators of critical infrastructure, and representatives of social institutions contributed valuable insights, which complemented the quantitative model results. This allowed the identification of local risk hotspots, improved understanding of vulnerabilities, and clarification of roles and responsibilities through the RACI framework. The workshop also highlighted strong local motivation to engage with climate adaptation, while pointing to gaps in awareness, data accessibility, and practical guidance.

Phase 1 also revealed several important challenges that need to be addressed. One limitation concerns the **data basis**: available climate model outputs are only of medium resolution and cannot capture localised impacts with sufficient precision. Linking these datasets with municipal-scale hazard maps and observational data will therefore be a priority in Phase 2. Another challenge is the **limited adaptive capacity** of the district and its municipalities. Financial and human resources are constrained, and adaptation tasks are not yet legally binding, making systematic implementation difficult. At the same time, the analysis showed that there is strong political commitment at the district level and a willingness among stakeholders to take ownership of adaptation measures if suitable support and guidance are provided.

Overall, Phase 1 has achieved its objectives by producing a transparent and holistic picture of climate risks in St. Wendel. The main conclusions are:

- Heavy precipitation is the most critical risk and requires immediate action.
- Windstorm and heat are also priority risks, with a clear need for preventive strategies.
- Drought and wildfire are emerging risks that must be systematically monitored and integrated into future analyses.

- Adaptation capacities are limited and must be strengthened through awareness-raising, stakeholder engagement, and external financial support.
- The CLIMAAX workflows proved useful for identifying relative changes and prioritising hazards, but further refinement with local data will be necessary.

This first phase therefore provides a crucial foundation for Phase 2, where refined risk assessments with higher-resolution data and thematic workshops will be conducted. Phase 2 will also address identified contradictions, for example concerning rainfall return periods, and will prepare targeted outputs for specific stakeholder groups. Ultimately, these refined results will enable Phase 3, which will focus on the development of a climate risk management plan, a local adaptation strategy, and the design of concrete adaptation measures.

4 Progress evaluation and contribution to future phases

All milestones and key performance indicators (KPIs) of Phase 1 have been achieved, and the work in Phase 2 can proceed as planned.

Table 5: Overview key performance indicators

Key performance indicators	***Progress***
1 Kick-off event for main stakeholders conducted	Completed: The event was originally scheduled for the first week of June. Due to the need to enable several people with tight schedules to participate and to offer a sufficiently prepared group of stakeholders the opportunity to participate, the workshop could not be held until July 30.
1 Scoping process (identification of main risks) conducted	Completed: Even before the workshop with the main stakeholders, there was an intensive exchange between disaster control and IZES regarding which risks should be considered. To this end, past events were reviewed and the latest data analyzed. The workshop provided us with final confirmation of the relevant risks.
1 CLIMAAX methodology for multi risk assessment applied	Completed: The CLIMAAX methodology for multi-risk assessment was successfully applied. The heavy precipitation workflow required considerable time, as several difficulties arose during its implementation. As a result, the final deadline at the end of September was fully utilised.
Comprehensive climate risk report including multi-hazard risk assessment for the district of St. Wendel	Phase 2 + 3
Stakeholder workshop conducted to validate climate risk findings	Phase 2 + 3
Existing studies for the region compiled and analysed	Phase 2 + 3
Local datasets integrated into the climate risk analysis for higher resolution	Phase 2 + 3
Stakeholder workshops conducted (e.g. for critical infrastructures)	Phase 2 + 3
Climate risk management plan developed and adopted	Phase 2 + 3
Local climate adaptation strategy formulated based on risk assessment	Phase 2 + 3
Specific adaptation measures identified and evaluated for feasibility	Phase 2 + 3
Municipal administrations engaged in integrating climate risks into planning processes	Phase 2 + 3
Technical meetings with urban and regional planners conducted	Phase 2 + 3
Planning guideline created for municipalities to incorporate climate risks	Phase 2 + 3

Key performance indicators	Progress
Updated emergency response plan incorporating climate risk data	Phase 2 + 3
Training session conducted for emergency responders and civil protection agencies	Phase 2 + 3
Citizens reached through awareness campaign and information sessions	Phase 2 + 3
Articles in regional media published on climate risks and adaptation	Phase 2 + 3

Table 6: Review milestones

Milestones	Progress
M1 - Kick-off meeting with subcontractor	Completed: The online kick-off meeting took place on May 26.
M2 - Kick-off event for information and involvement of stakeholders	Completed: Due to scheduling conflicts and the summer holiday period, the workshop was held slightly later than originally planned, on 30 July 2025, but was successfully conducted.
M3 - Completed implementation of the CLIMAAX common methodology for multi-risk assessment and analysis of the results	Completed: The CLIMAAX methodology for multi-risk assessment was successfully applied. The heavy precipitation workflow required considerable time, as several difficulties arose during its implementation. As a result, the final deadline at the end of September was fully utilised.
M4 - Completed refined regional/local high-resolution analysis and risk assessment and comparison of results	Deliverable 2
M5 - Workshop for presenting results of phase 1 and 2 to stakeholders	Deliverable 2
M6 - Local adaptation strategy and risk management plans have been developed	Deliverable 3
M7- Final dissemination and presentation of results + adaptation strategy to stakeholders	Deliverable 3
M8 - Subcontracting completed	Deliverable 3

5 Supporting documentation

For deliverable one the following documents were created:

- Main Report Deliverable 1
- Report “Summary Stakeholder Workshop 30 July 2025”
- Report “Risk Screening_Additional Climate Data”
- Document “Scoping_Guiding Questions”
- Communication Outputs (Press release, media)
- Workflow results (Visual Outputs (infographics, maps, charts and datasets collected)
    - Storms
        - Hazard assessment storm
        - Risk assessment storms
    - Extreme precipitation
        - Extreme precipitation hazard assessment
        - Extreme precipitation risk assessment
    - Heat
        - Heatwaves hazard assessment euroheat
        - Heatwaves risk assessment
        - Heatwaves risk projected change

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