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Enabling heat-stress-resilient mobility with the HEAL navigation app in Germany

Participatory, data-driven navigation supports inclusive pedestrian mobility in Heidelberg and beyond

A heat-stress-avoidant navigation application (App) supports citizens in finding paths which are less exposed to extreme heat. The application especially targets at-risk groups and tourists. Combining near-real-time sensor data, modelling, and participatory methods maintains pedestrian mobility, raises awareness of heat risks, and serves as a scalable model for other cities.

Key Learnings

- **A Participatory Approach helps overcome real-life challenges:** Engaging at-risk groups through interactive walks and workshops provided critical insights into real-life mobility challenges, such as the absence of shaded resting areas, exposed public transport stops, and long waits at poorly timed traffic lights, and paved the way for overcoming them.
- **Accessibility Considerations:** When designing heat-stress-resilient navigation Apps that account for diverse user needs, ensure broad usability and inclusivity.
- **Scalability supports broad application:** Ensuring adaptability to other circumstances with similar challenges enables other cities to apply the navigation App, as it provides a model for integrating heat adaptation strategies into urban mobility. Data provided by the navigation App can support informed decision-making and the implementation of tailored urban planning measures.

About the region

Heidelberg is located in southwestern Germany, within the densely populated Rhine-Neckar metropolitan region, and is part of the state of Baden-Württemberg. The city has a population of approximately 160,000 and is renowned for its historic landmarks, as well as its strong academic and research institutions. Located at the exit of the Neckar Valley where it opens into the Rhine Plain, and at the transition from the Odenwald low mountain range to the Upper Rhine Valley, Heidelberg has a temperate climate with warm summers and cold winters. The average annual temperature is around 11°C, with moderate rainfall throughout the year. The heat island effect causes the city to be often significantly warmer than the surrounding area, especially in summer.

Climate Hazards

Extreme Heat

Sector

Urban, Health

Key system

Health and Wellbeing



Climate Threats

Heidelberg experiences warm summers, with temperatures rising in recent years and heatwaves becoming more frequent. The city's dense infrastructure with large areas of sealed surfaces and limited green spaces providing shade, contributes to significantly higher temperatures within the city than in the surrounding rural area (Urban Heat Island Effect). This effect intensifies during prolonged heat events, exacerbating health risks and reducing the overall comfort of the city's inhabitants. Figure 1 shows that surface temperatures reached almost 53°C during July 2022.



Figure 1: Infrared image of the surface radiation temperature on a hot day in July 2022 on the 'Promenade' in Heidelberg's 'Bahnhof' district. Image Credit: [Foshag et al. \(2024\)](#).

From sensors to citizens: heat-adapted mobility in Heidelberg

Monitoring climate change and implementing appropriate heat adaptation measures in Heidelberg relies on climate assessments, sensors, and models.

In response to the emerging challenges associated with extreme heat, Heidelberg developed a [Heat Action Plan](#) (in German) as an adaptation framework. It includes heat-stress prevention and adaptation measures, such as greening and de-sealing surfaces, providing drinking water points and shaded areas, and targeted information and protection for particularly at-risk groups. Innovative urban climate analyses and tools, such as the [Climate Scanner](#) (Klimascanner, in German), can support planning climate-friendly construction projects and maintain the quality of life for Heidelberg's inhabitants. Other adaptation measures include promoting greening of facades and roofs, climate-smart urban development, and involving the public in preventive measures and self-help initiatives.

In line with these efforts, the [HEAL](#) (Heat Adaptation for Vulnerable Populations) project responds to the growing risks of urban heat stress. The measures within this project ensure safe mobility and support daily activities during heat events, primarily focusing on pedestrians, but also accommodating cyclists. The project complements the broader Heat Action Plan by providing innovative solutions.

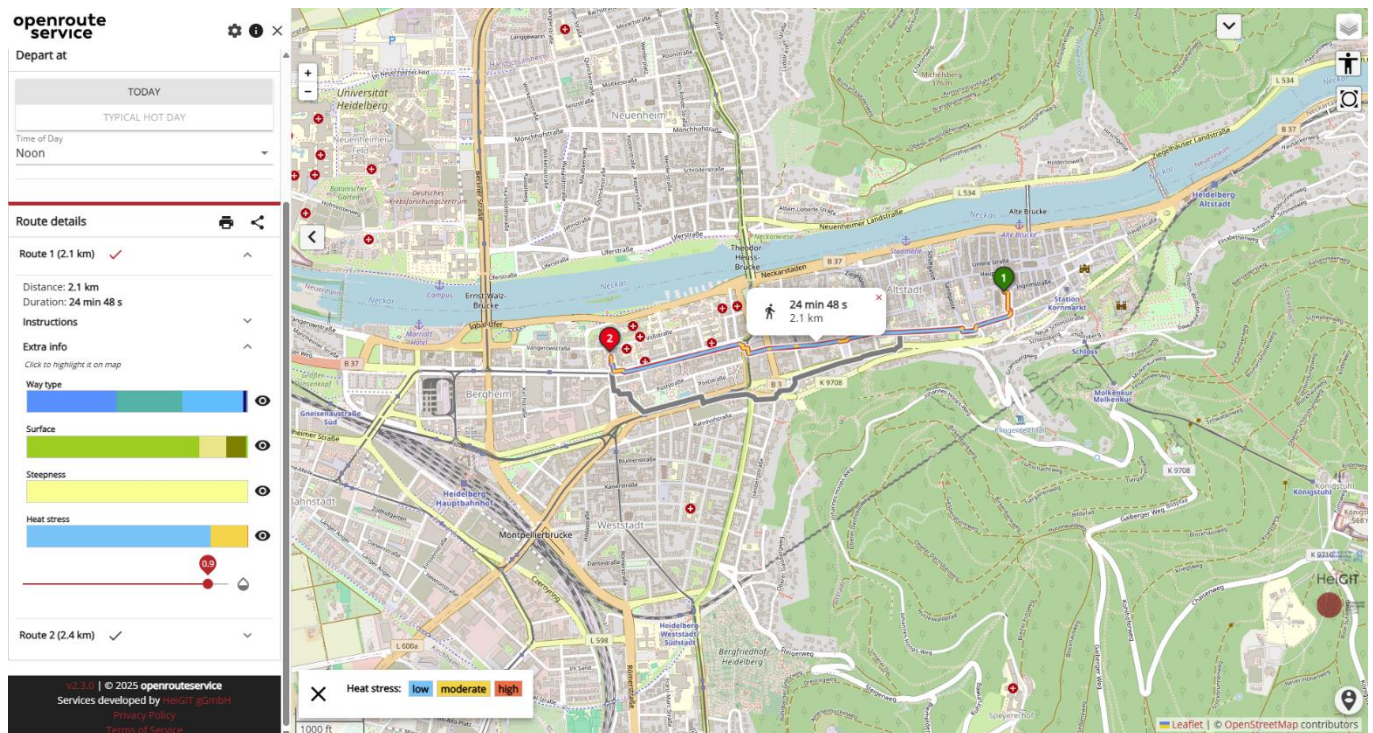


Figure 2: A HEAL route in Heidelberg from the old town to the city library with two different options showing the heat stress along both paths. Image Credit: HEAL project.

Central to the project is a heat-stress-avoidant navigation App to help at-risk groups and others navigate the city more safely during periods of extreme heat. Using near-real-time sensor data, shadow modelling and input from at-risk groups collected in surveys, expert interviews, city walks, and informal exchanges, the navigation App calculates alternative routes that steer users away from heat-exposed main roads and instead guide them through shaded areas and parks. Additionally, it provides detailed information on path characteristics, including surface type, gradient, and overall walkability, ensuring accessibility for different user groups. To further refine the routing approach, the project team simulated 10,000 pedestrian trips in Heidelberg at different times of the day to analyse variations in route selection based on heat exposure. These simulations helped optimise the algorithm.



Figure 3: Together with the target groups researchers developed individual adaptation strategies and protective measures to enable everyday life and mobility even during hot days. Photo: Kathrin Foshag.

Beyond aiding mobility, the project measures include raising awareness about climate change and the impact of heat stress in urban environments. A key component of HEAL is its transdisciplinary approach, which actively involves local stakeholders such as the Office for Environmental Protection, the Academy for Older People and senior and family community/network members. To ensure the navigation App addresses real-life challenges and is easy to use, the project team organised five interactive city walks, surveys, interviews (mobile and static), participatory and mental mapping. Those engagement activities allowed at-risk groups to highlight specific mobility challenges, share their heat-avoidance strategies, and identify critical problem areas. A heat workshop at the Bahnstadt district engaged pupils from a secondary school in discussions on heat-related health risks and potential solutions. These methods provided insights beyond numerical data, revealing how different groups experience heat stress, which areas in Heidelberg are perceived as heat hotspots and how a routing application can be designed to be more accessible, particularly for the elderly population.

“Interdisciplinarity connects experts across fields like geography, computer science, medicine, and the social sciences; transdisciplinarity goes a step further, bridging science with society and practice. To develop practical and effective solutions, it is essential to engage directly with the target groups.”

Dr. Kathrin Foshag, Senior Researcher at TdLab Geography, Heidelberg University.

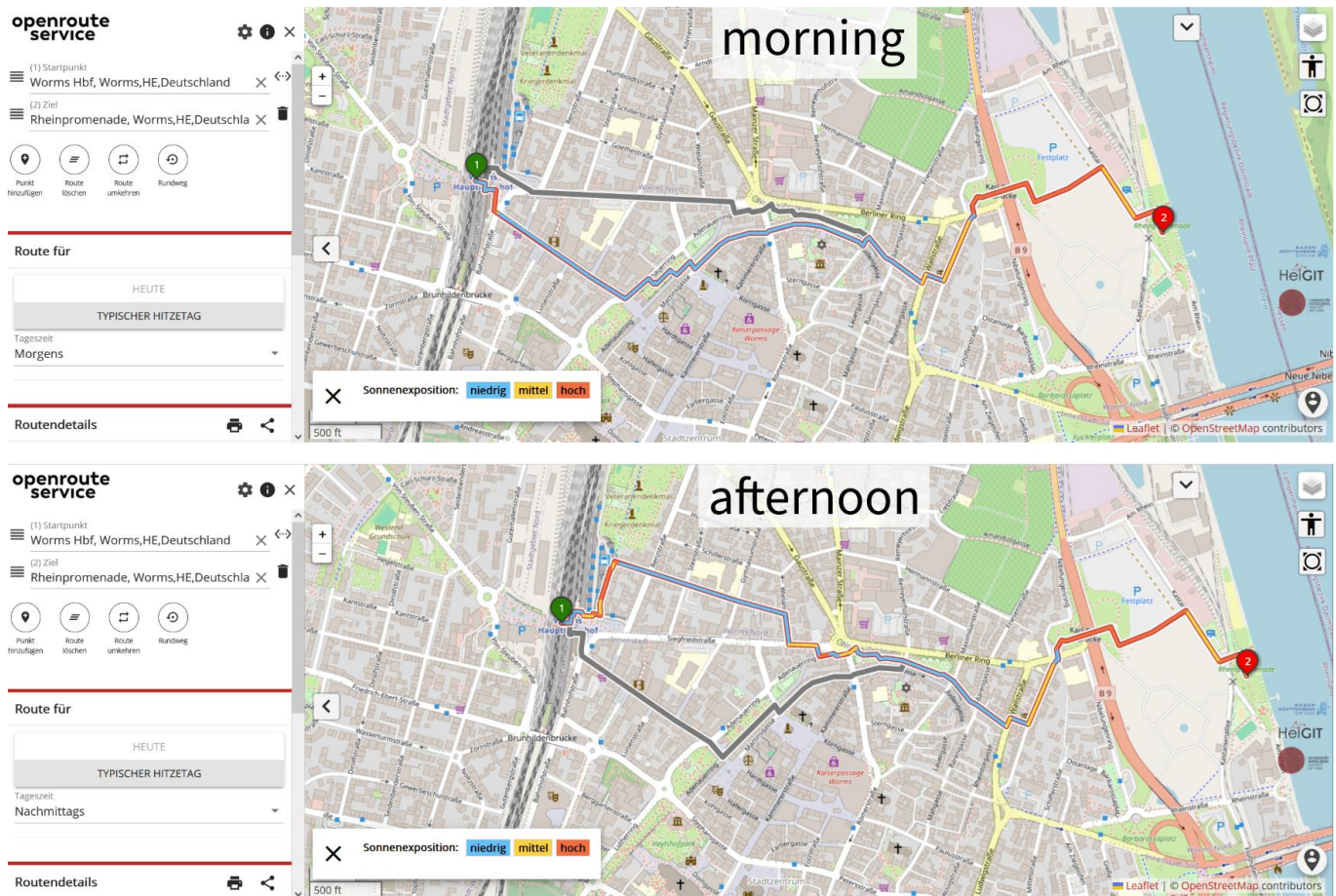


Figure 4: A HEAL route in Worms from the main train station to the Rhine promenade: slightly different routes are suggested in the morning and afternoon to avoid heat stress. Image Credit: HEAL project.

The HEAL team has successfully launched the navigation App in Heidelberg during the summer of 2024. The project design allows for transferring the overall approach and the App to other German cities, extending the benefits beyond Heidelberg. Thanks to close collaboration with the municipality of Worms and Walldorf, the app is now also available for these urban areas. Looking ahead, the HEAL team aims to further expand the app's availability to embed climate adaptation strategies into urban infrastructure across Europe.

“HEAL aligns closely with our heat network approach in Worms. It is a tool that can be used by multipliers and decision-makers as well as directly by affected groups. Our next aim is to explore how HEAL can support the planning of future heat adaptation measures”.

Marco Elischer, Climate Protection Manager for the City of Worms.



Figure 5: Marco Elischer, Climate Protection Manager for the City of Worms, presenting the HEAL app as part of the Ready4Heat project and Cities Refresh Campaign. Image Credit: Alicia Göpner / Climate Alliance.

Summary

Interdisciplinary research paired with community engagement can enhance urban resilience to heat stress. By developing a heat-stress-avoidant navigation application (App), the HEAL project supports vulnerable groups in navigating the city more safely during extreme heat. Through interactive walks and workshops, researchers gained valuable insights into real-life mobility challenges, ensuring the App is both practical and accessible. As HEAL expands beyond Heidelberg, it provides a transferable model for integrating climate adaptation into daily urban mobility across European cities.

Further information

The work presented in this adaptation story is part of the [HEAL](#) project.

The HEAL project was funded by the Baden-Württemberg Foundation in 2021-2024 as part of the research program “Innovations for adaptation to climate change”.

The project was developed by researchers at Heidelberg University’s Institute of Geography (Department of Geoinformatics and the TdLab Geography) and HeiGIT (Heidelberg Institute for Geoinformation Technology), in cooperation with city partners such as the Heidelberg Digital Agency and the Office for Environmental Protection. Additionally, the project actively engaged with civil society organisations, such as the Academy for Older People and various senior and family networks.

- [HEAL-Heat avoidance routing application based on OpenRouteService](#)
- [GitHub - GIScience/heal-routing-analysis: This repository includes the code used for the routing-based network analysis of the HEAL project](#)
- [Auf sicherem Weg durch die Hitze: Neue Wege zur Hitzeanpassung in Heidelberg](#)

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