UCaHS - Urban Climate and Heat Stress in mid-latitude cities in view of climate change

Research questions

The severe impact of climatic effects on human health has been proven in several studies and particularly urban heat stress has been linked to reduced well-being, higher morbidity and mortality. However, up to now little is known about the spatial patterns and processes of heat stress risk on a city-wide scale linking socio-economic and biophysical dimensions of vulnerability. An improved knowledge about the distribution of different population groups with a varying degree of vulnerability and resilience has to be gained to identify and adequately develop options for those at risk.

(1) What are spatio-temporal and multi-scale patterns and underlying processes of vulnerability of the population to urban heat stress?

(2) What is the multidimensional risk to urban heat stress for different groups?

(3) Which scenarios can be developed of likely future vulnerability and risk under different alternatives of options?

Research approach

To answer these three questions a spatio-temporal modelling approach is selected to identify influencing factors of vulnerability and risk to urban heat stress and moreover, to generate future scenarios of risk. Our research approach uses well-grounded dimensions of vulnerability, hazard and risk of existing studies. We explicitly focus on an integrated research approach to reflect upon the multidimensional nature of urban vulnerability and risk to urban heat stress.

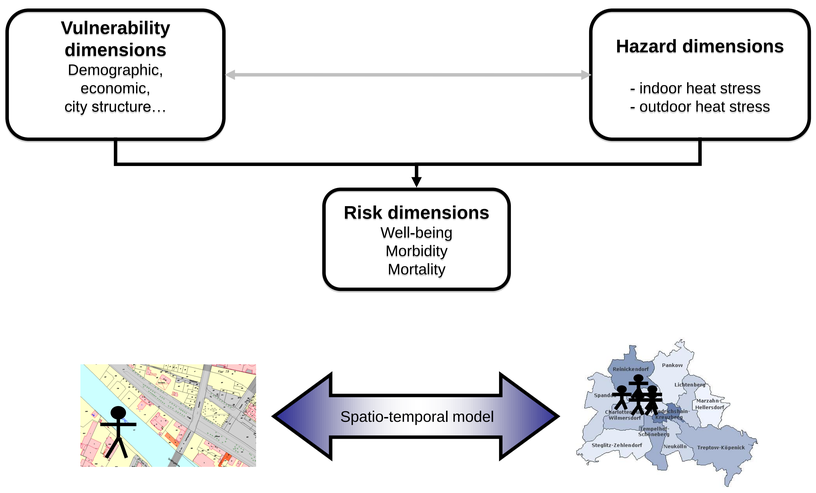
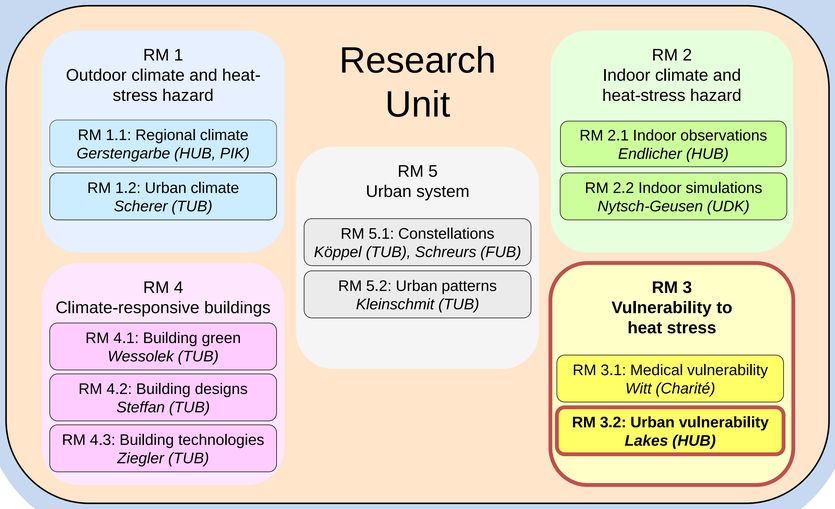


Fig.1: Multi-scale and multi-dimensional risk model of urban heat stress.

Sub-project 3.2
Urban vulnerability



Methodology

In a first step a conceptual model is generated based on the development of indicator sets to characterise the key elements vulnerability and heat stress hazard which define risk to urban heat stress. Interlinkages and likely indicators of the envisaged multi-scale and multi-dimensional risk model (Figure 1 and table 1). From the conceptual model a Bayesian network is then developed for the study area of Berlin. Thanks to earlier work we build upon a-priori knowledge and availability of relevant datasets (Figure 2).

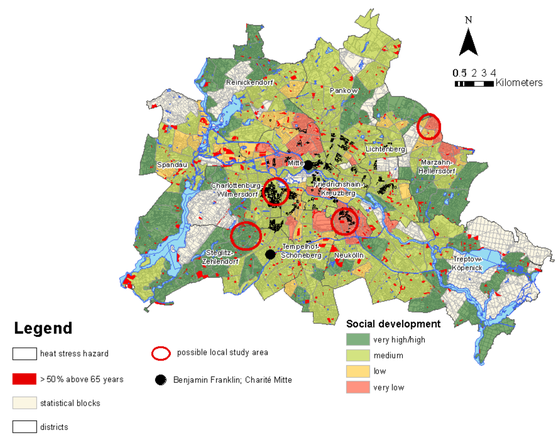


Fig.2: Study Area Berlin – preliminary insights on heat stress in Berlin

The spatio-temporal modeling approach using Bayesian networks is seleceted based on earlier findings:

• Representation of findings as probabilities -> inherent in risk analyses of climate change impact on health
•Iterative modification with new data and knowledge
• Causal relationships can be limited to parts of the network where observations are available

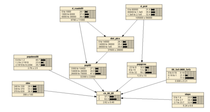


Fig.3: BBN example to model risk

Tab. 1: Indicators and Data

	Dimensions	Indicators	Berlin-wide Data	Individual data
Vulne-rability	Demography	Age, health condition, socio-cultural, social capital…	Monitoring Soziale Stadtentwicklung, Census	Questionnaires
	Economy	Socio-economic, economic resources…	Monitoring Soziale Stadtentwicklung, Census	Questionnaires
	Planning	Programmes, plans, strategies, public health programs…	SenStadt, SenGUV; borough administration	Questionnaires
Hazard	Urban outdoor heat stress	Outdoor bioclimatic indicators, magnitude and frequency of heat stress…	Umweltatlas, climate models (PIK), meteorological data	Field data
	Urban indoor heat stress	Indoor bioclimatic indicators, magnitude and frequency of heat stress…	-	Indoor measurements
Heat stress risk	Well-being/Morbidity	Impact of urban heat stress	-	Questionnaires
	Mortality	Mortality data	Statistical office Berlin/Brandenburg	Questionnaires

Work schedule

Tab. 2: Work packages (WP) and associated work schedule (in half-yearly intervals)

WP	Description	Work schedule
100	**Project management**	
110	Reporting	
120	Logistics and organisation	
200	**Individual research**	
210	**Development of a conceptual model of vulnerability to heat stress in urban areas**	
211	Identification of categories to characterize vulnerability and risk	
212	Generation and visualization of the interrelationships between the categories	
213	Identification of political and societal influences on vulnerability to heat stress	
214	Exchange with experts from different scientific fields on the conceptual model	
215	Scenario and storyline-development	
220	**Data acquisition and preprocessing**	
221	Data collection and preprocessing	
222	Remote sensing data and digital surface model analysis	
230	**Individual level questionnaires**	
231	Development and realization of questionnaires	
232	Analysis of questionnaire results	
233	Revise the conceptual risk and vulnerability model	
240	**Development of an urban heat stress risk model**	
241	Development and calibration of a BBN model on a local scale	
242	Development and calibration of a BBN model on a city-wide scale	
243	Integration into a multi-scale and nested BBN model	
250	**Vulnerability analysis**	
251	Vulnerability analysis of different groups to urban heat stress using the multi-scale BBN	
260	**Analysis of risk arising from urban heat stress**	
261	Risk analysis of outdoor and indoor heat stress	
262	Risk analysis of urban heat stress for selected groups	
270	**Development of scenarios of future vulnerability and risk under different options and changes in driving factors**	
271	Quantification of storylines for scenario-building for future vulnerability and risk	
272	Scenario-modelling using the calibrated BBN risk models	
273	Visualization and interpretation of vulnerability and risk for the different scenarios	
280	**Final report and synthesis**	
300	**Collaboration within the Research Module**	
310	Vulnerability analysis of hospital patients	
320	Risk analysis of hospital patients	
400	**Collaboration within Research Links**	
410	Identification of political and societal influences on vulnerability to heat stress	
420	Development and realization of questionnaires	
500	**Collaboration within Research Clusters**	
510	Present-day heat stress hazards, vulnerabilities and risk	
520	Testing actions for reducing heat stress risk	
600	**Collaboration within Research Unit**	
610	Exchange with experts from different scientific fields on the conceptual vulnerability and risk model	
620	Projected heat-stress hazards, vulnerabilities and risks	
630	Transferability of the methodology to other mid-latitude cities	
640	Identification of future research and development activities	
650	Preparation of the follow-up proposal	

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