

13:30 – 13:40	Introduction and Statement BMBF	Birkmann (ireus) and Mr. Frank (BMBF)
13:40 – 13:52	Urban climate and vulnerability: innovative assessment and scenario approaches – the ZURES project	Birkmann, Puntub, Burmeister, Garschagen
13:53 – 14:05	Bridging science, policy and planning: Bonn and Ludwigsburg – the ZURES project	Löffler, Helbig, Burkhardt, Sandholz, Göttsche, Laranjeira
14:06 – 14:18	Innovative measuring and microscale modelling – the iSCAPE project	Fuchs, Christian
14:19 – 14:31	Air quality, heat stress and human vulnerability in cities: an international perspective	Martayan (Global Urban Air Pollution Observatory GUAPO)
14:32 – 14:45	Discussion	All

# Research for Sustainable Cities



## Wie der Klimawandel die Hitze anheizt

### Tagesthema

**Wetter** Die aktuell hohen Temperaturen kommen nicht von ungefähr: Die Erwärmung der Erde führt auch zu Veränderungen in hohen Luftströmungen. *Von Klaus Zintz*

### HITZE BIS IN GROSSE HÖHE



lage“ aus einigen regnerischen Tagen Fluten werden. Im vergangenen Sommer waren dies einerseits die Rekordhitzen und Dürren in Nordamerika und Westeuropa, andererseits die Starkregen und Überschwemmungen in Südosteuropa und Japan.

Diese ungewöhnlichen Wetterphänomene traten damals nahezu gleichzeitig im Juni und Juli auf. Auch in diesem Jahr könnte es wieder so ähnlich kommen: „Während wir in dieser Woche in Europa Temperaturen von möglicherweise bis zu 40 Grad Celsius befürchten, verzeichnete Indien kürzlich Temperaturrekordre von über 50 Grad“, ergänzt Rahmstorf.

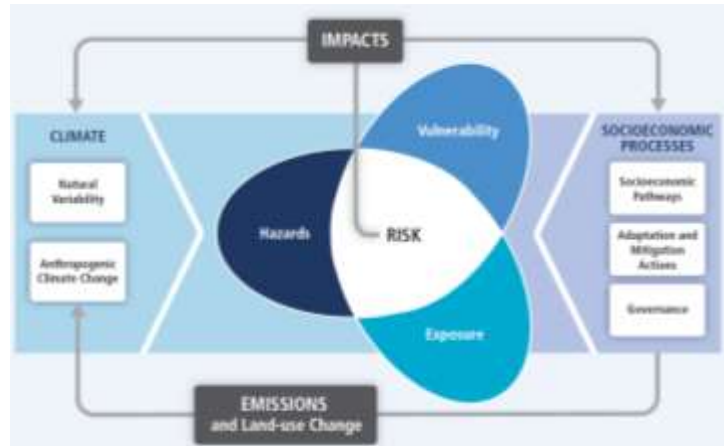
Die Klimaforscher erwarten, dass diese Wellenmuster in den oberen Schichten der Atmosphäre durch den Klimawandel künftig häufiger auftreten werden – und zwar im Sommer wie auch im Winter. Dafür verantwortlich seien grundlegende physikalische Tatsachen. Landmassen neigen nun einmal dazu, sich schneller zu erwärmen als Ozeane – wodurch sich



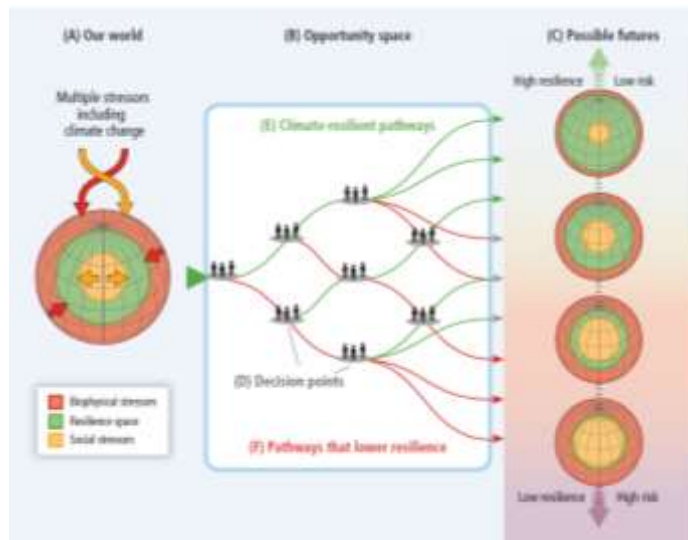
## Vulnerability and risk analysis as a tool for enhancing the resilience of cities and urban infrastructures

### Key questions

- How to assess present and future heat stress in growing medium-sized cities?
- How do future climate change and urbanization interact?
- How do different population groups perceive heat stress?
- What methods and indicators can be used to develop scenarios for human vulnerability at the local scale?
- How to link local scenarios of human vulnerability and climate?
- What is the added value of the information for decision making?



Source: IPCC 2014



Source: IPCC 2014

- Growing medium-sized cities have to conserve open green space, but also provide new space for housing
- Challenges: present climate and vulnerability scenarios often focus on national and international scales
- Urban growth and/or densification are inherent characteristics of growing medium-sized cities – is that an entry point for local scenarios?
- Which data is available at the local level for assessing climatic and societal change?

# Urban Climate and Human Vulnerability

## Presenters:

Ms. C. Burmeister (Geo-Net)

Prof. Garschagen (UNU; now: LMU)

Ms. W. Puntub (IRPUD, Technical University Dortmund)

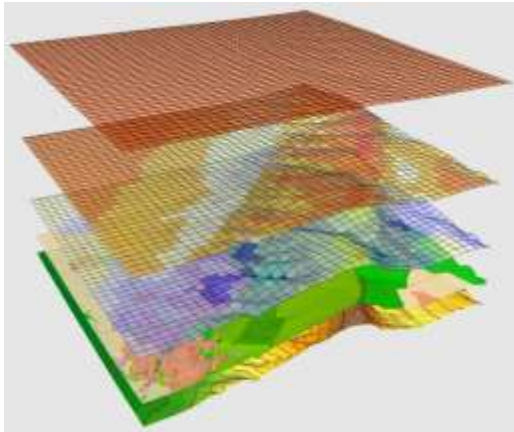
Prof. Birkmann (IREUS; University Stuttgart)

# Urban Climate: Today and tomorrow

To quantify the heat exposure model simulations are conducted of the present and future situation. As initialisation a dry and hot weather situation with no cloud cover is used to present the „worst case“

## FITNAH – 3D model

Flow over Irregular Terrain with  
Natural and Anthropogenic Heat  
Sources = **FITNAH**



Source: Gross 1989, 1993, 2002

## Resolution:

Bonn - 10m □ Ludwigsburg – 25m

## Climate Change

Ludwigsburg: RCP2,6  $\Delta +0.7$  | RCP8,5  $\Delta +2.2$

Bonn: RCP2,6  $\Delta +0.5$  | RCP8,5  $\Delta +2.0$

## Input data

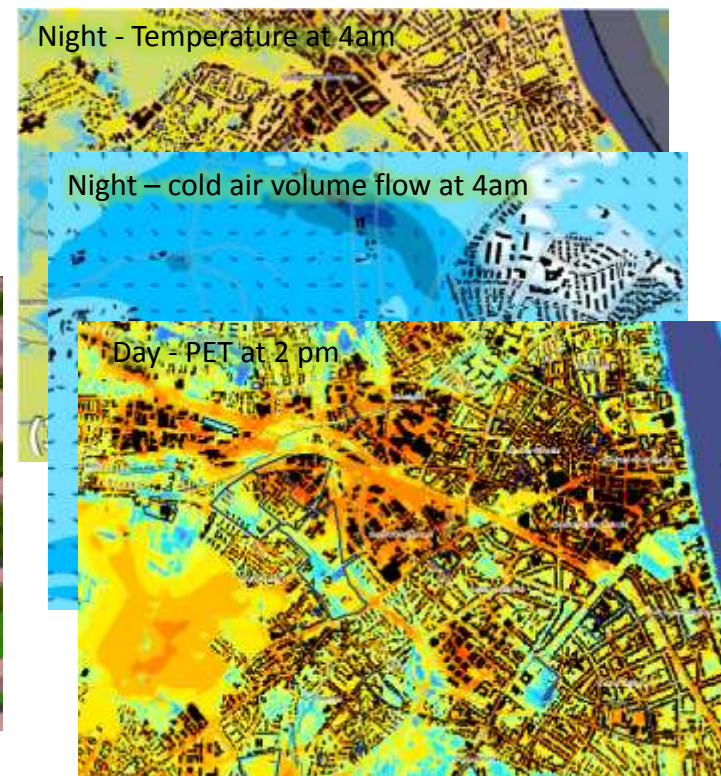
### Present and Future



+ sealing degree

## Results of climatic parameters

### Present and Future

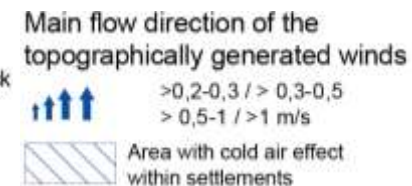
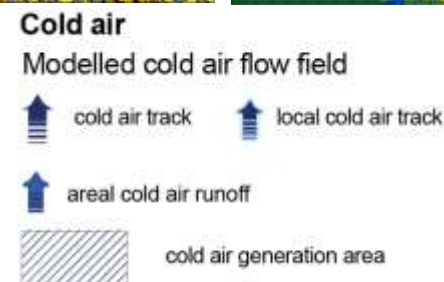
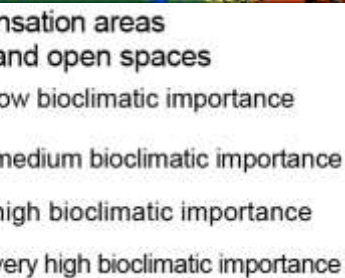
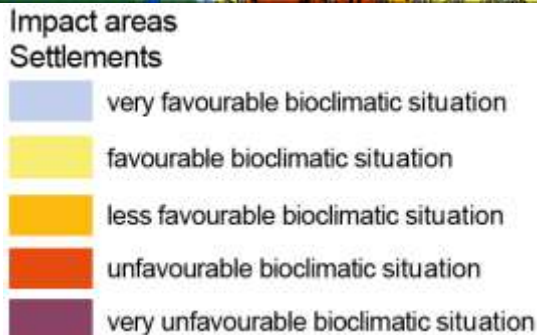




# Urban Climate: results for the City of Bonn

Guidance Map – night situation 4 am (Zoom Gustav-Stresemann-Institute)  
Spatial Base = real land use layer

Today  Future 2030 with climatic change and growing settlement development



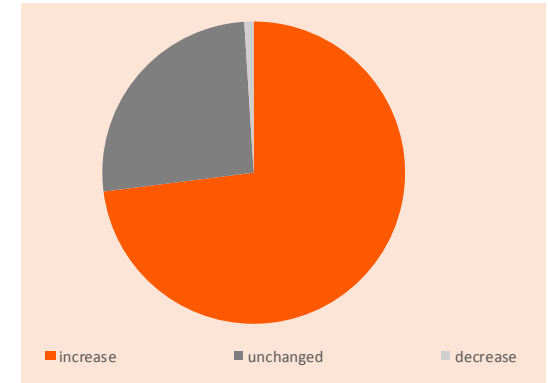
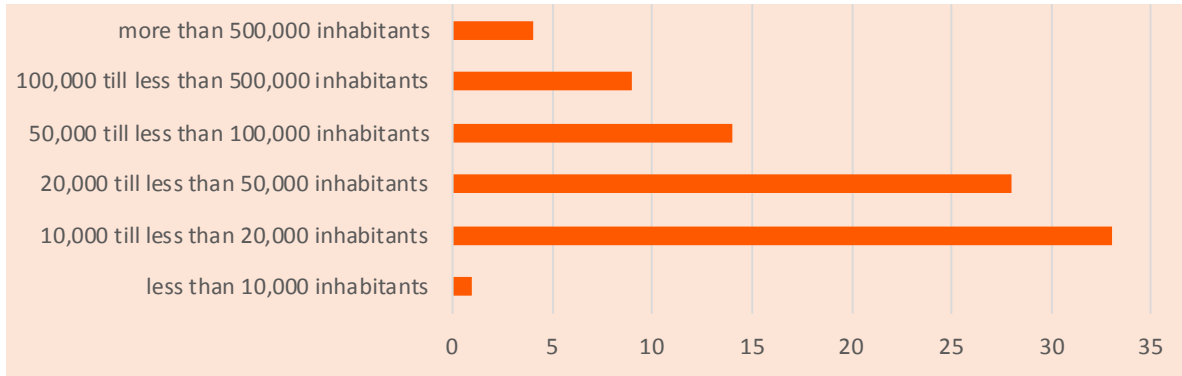
- bioclimatic conditions will become severe under climate change and under compaction and sealing
- the importance of green and open spaces will grow
- present cold air tracks are the same in the future



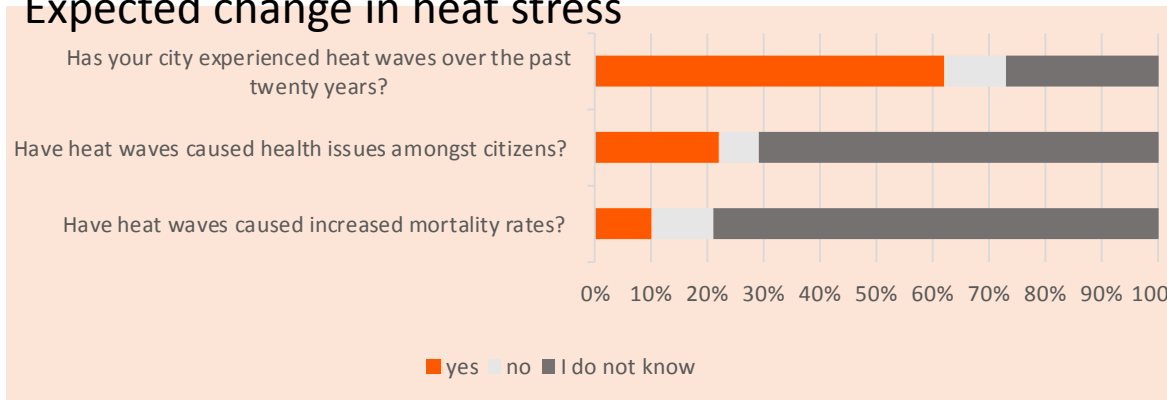
# Heat & vulnerability: Importance vs. current practice

Respondents: 89 city administrations in Germany

Expected change in vulnerability towards heat stress

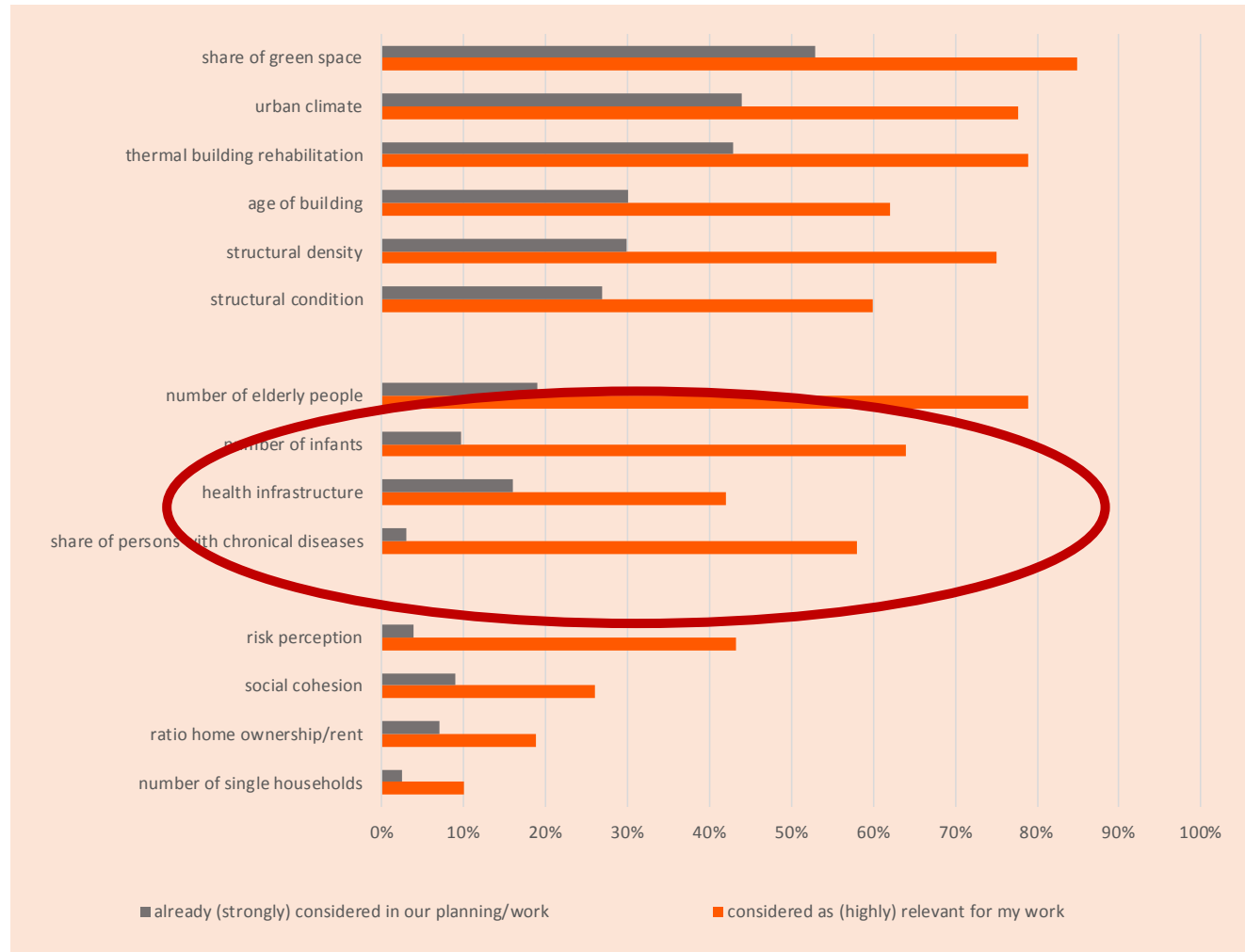


## Expected change in heat stress



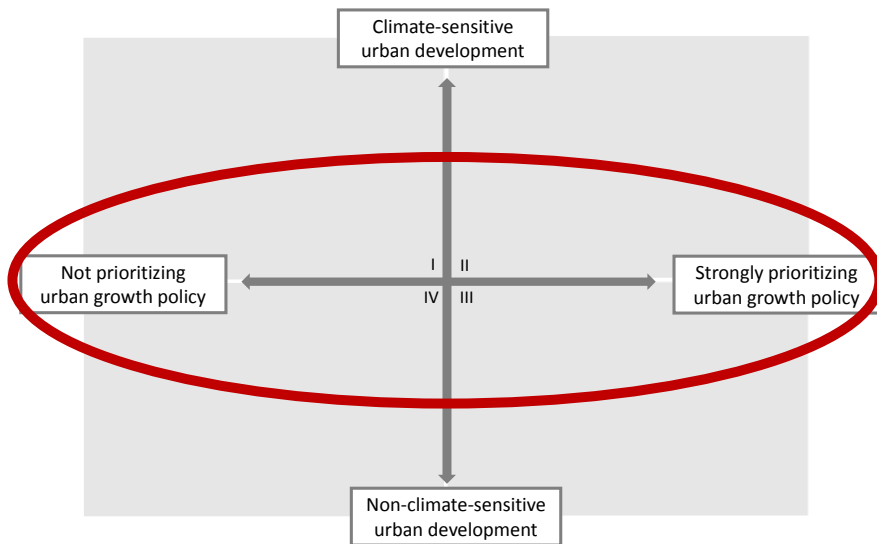
*Most cities expect both: an increase in heat stress (hazard) as well as in vulnerability!*

Important aspects: theoretical appraisal vs. application in planning

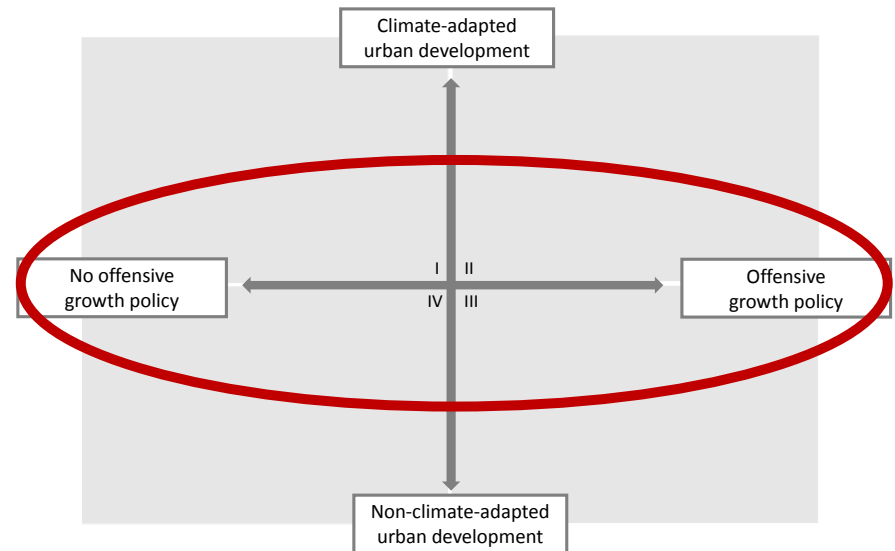


The gap between perceived importance and actual consideration in planning practices is widest with regards to aspects of social vulnerability!

## Ludwigsburg



## Bonn





## Core Indicators



Ratio of inhabitants in residential areas (person/ha)



Ratio of population age 65-year-old and above (%)



Number of SGB2 recipients per 1,000 employable residents

## Population



New Living Units



Future population

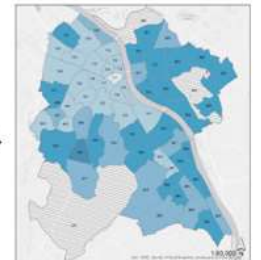
## Elderly



Number of people who lives in 2016 and expected to be still alive in the future



Future total population



## Poverty

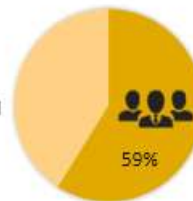


Scenario 2

Scenario 3a-2

Scenario 3b-1

Scenario 3d



Ratio of employable residents in 2035

SGBII recipients per 1,000 employable residents in 2035

Scenario 2

Scenario 3a-2

Scenario 3b-1

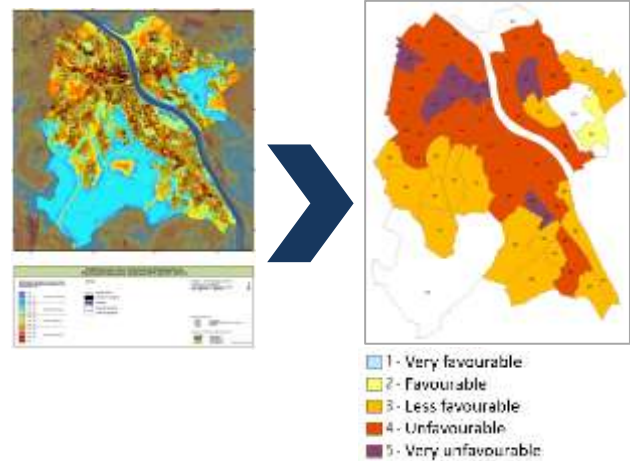
Scenario 3d



# Coupling scenarios: core indicators - Bonn

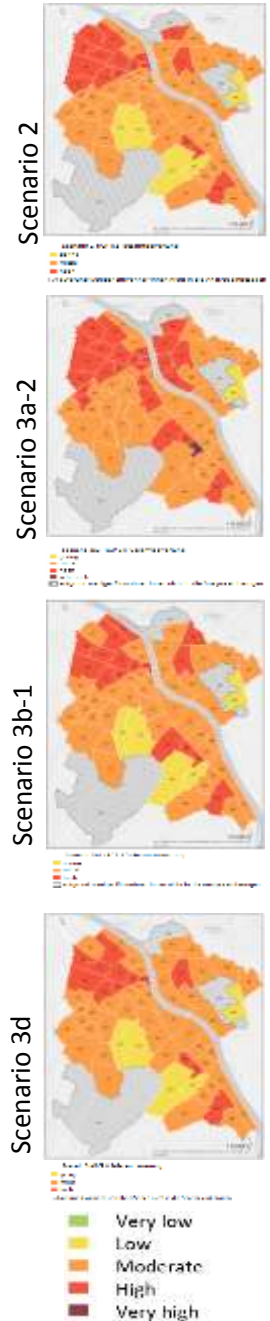
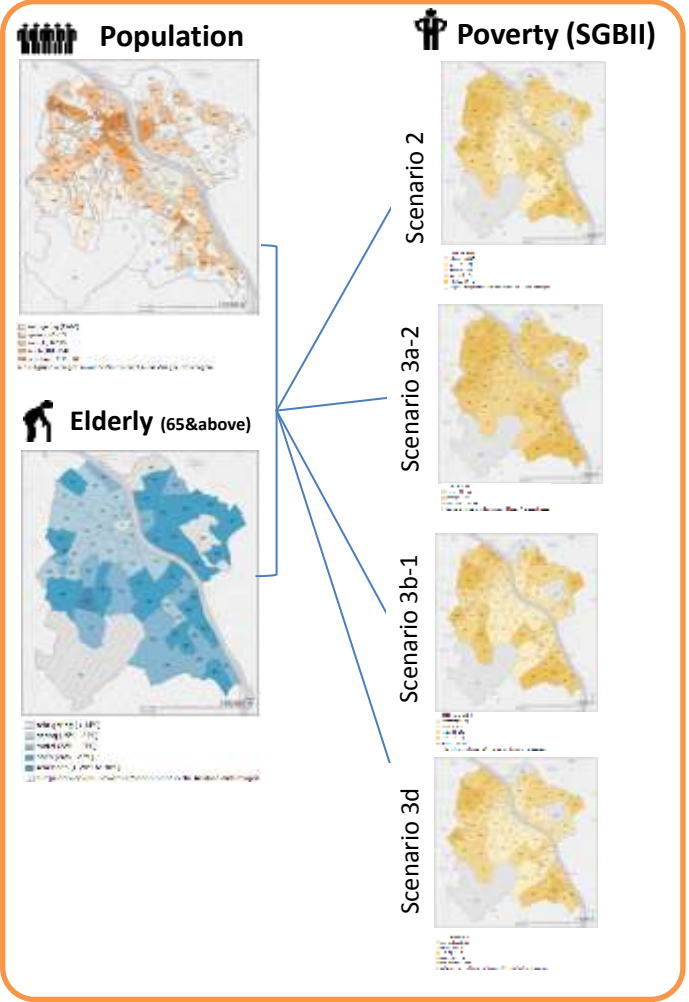
## Future climate (RCP 8.5)

RCP 8.5



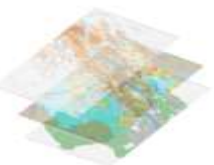
- e.g.
- Overall
  - Day-time
  - Night-time

## Future socio-economic scenario

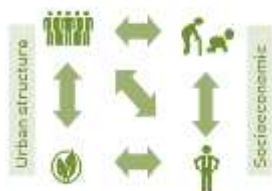


# Lessons learned - Bonn

## Good practices



**Double analytical models through integrated future climate and socio-economic scenarios**



**Multifaceted consideration of the problem with spatio-temporal illustration**



**Tool for supporting urban development policy debate and promoting risk informed planing**

- Initial hotspots' identification of possible vulnerable area in the future
- Support long-term investment and mitigation measures



**Simple technique & dataset and transferable**

## Challenges

### Scale does matter



VS



- *Personal perception VS Sub-district socioeconomic VS Global climate downscaling and development pathways*
- *Limited access of socio-economic data in household or building block level (privacy confidentiality and disclosure)*

### Uncertainty is certain



Source: Adapted from google map 2019

- *Social development dynamic in the future (e.g. young people mobility, immigrants, aging society)*
- *Interaction with neighboring cities or nodes*

### Day-time & night-time social activities

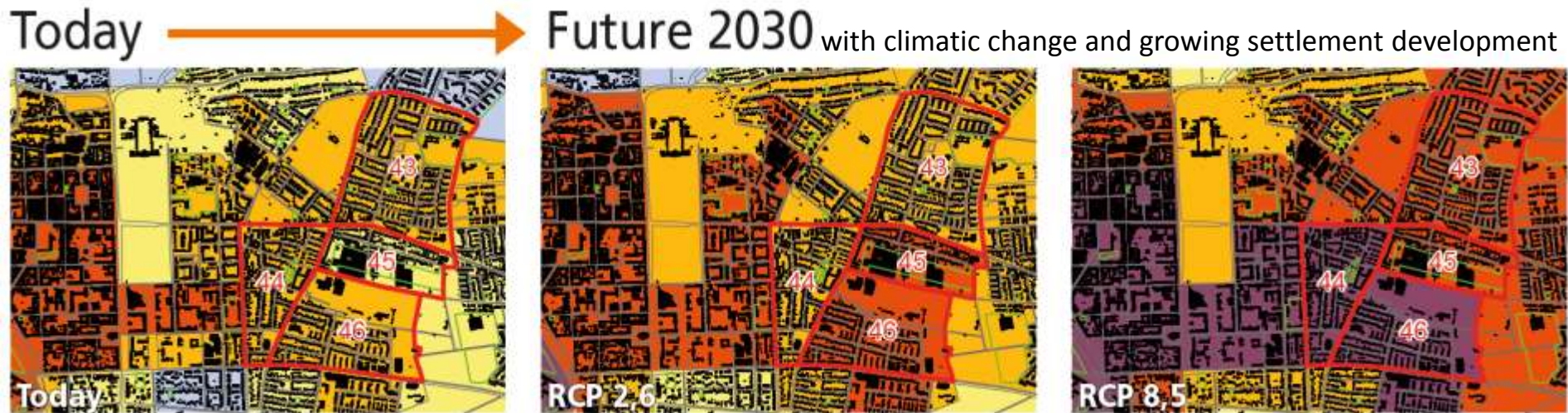


Source: [https://www.freepik.com/premium-vector/day-night-sky\\_2589626.htm](https://www.freepik.com/premium-vector/day-night-sky_2589626.htm)

- *Social vulnerable groups and social sensitive infrastructure*
- *Pollutions (Noise & Air)*



## Guidance Map Zoom to the City Center – Spatial Base = statistical ward layer

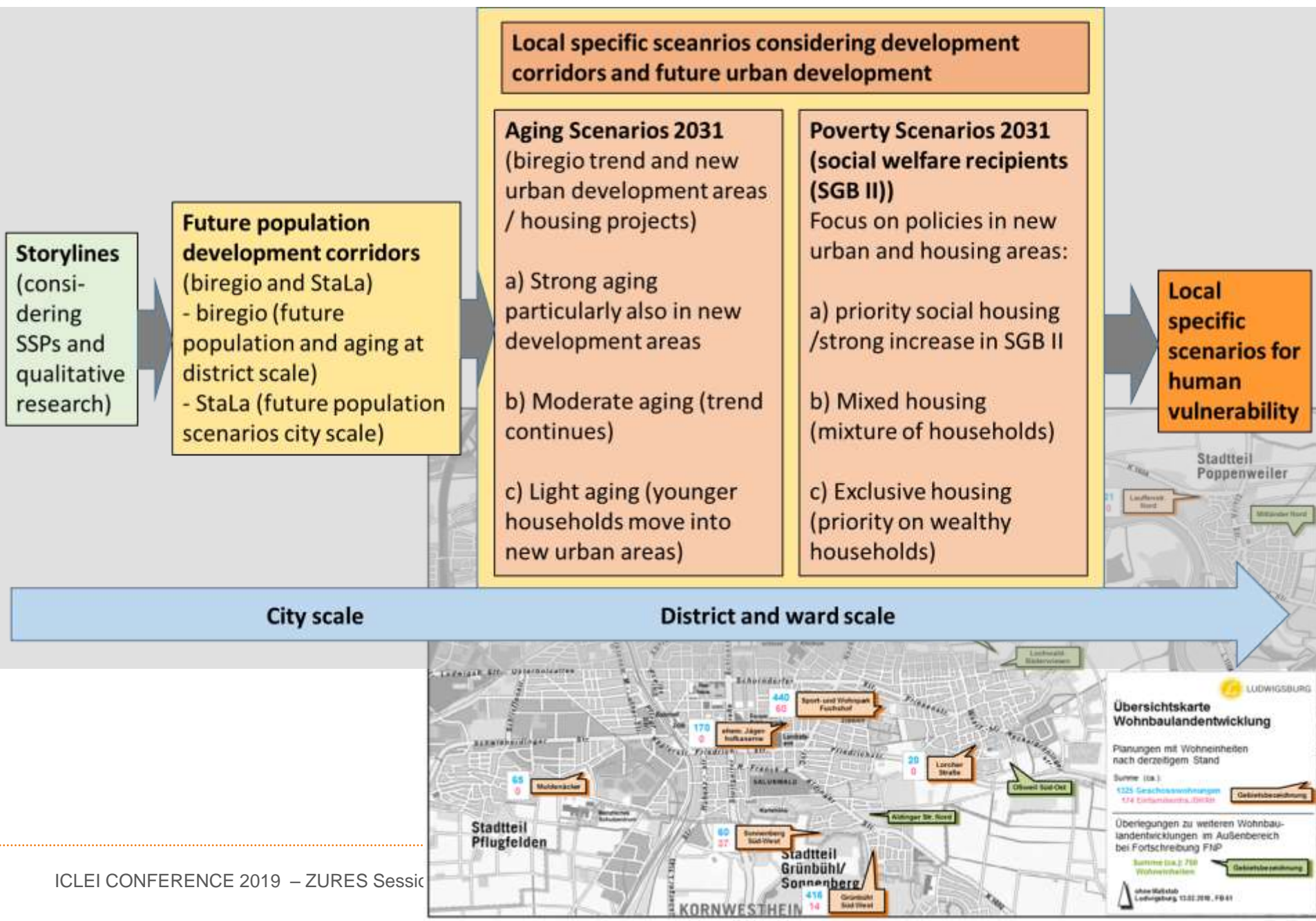


### Heat Stress Assessment Classes

- very favourable bioclimatic situation
- favourable bioclimatic situation
- less favourable bioclimatic situation
- unfavourable bioclimatic situation
- very unfavourable bioclimatic situation
- future settlement areas

- bioclimatic conditions will become severe under climate change
- this process will be intensified by more compaction and sealing
- some structures are more robust (resilient) against climate change

# Methodology: assessing future vulnerability





# Climate and vulnerability at ward scale 2031

## Present conditions (2017)



moderate  
vulnerability  
2031 & RCP  
8,5

- Trend continuation
- New housing areas contain mixed HH.

## Same Climatic Change RCP 8,5



## 2. Scenarios

high  
vulnerability  
2031 & RCP  
8,5

- Strong aging
- Increased SGB II in new urban areas





## Bridging science, policy and planning

### Presenters:

Ms. J. Löffler and Mr. J. Helbig (City of Bonn)

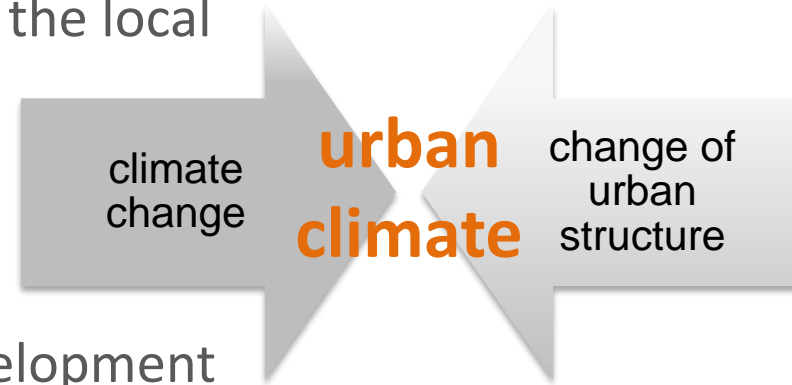
Mr. A. Burkhardt (City of Ludwigsburg)

Dr. S. Sandholz (UNU) - Expertenbefragung

Ms. F. Götsche (IREUS) – HH Befragung

Mr. K. Laranjeira (IREUS) – HH Befragung

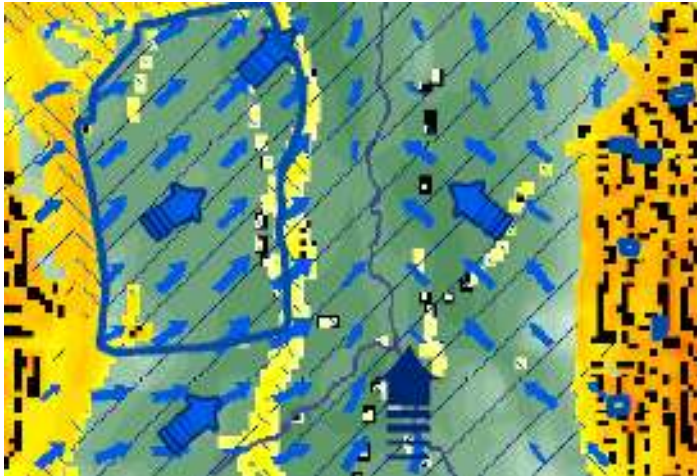
- urban heat stress is already a problem in both cities
- significant and measurable change of the local climate
- growing municipality
  - e.g. need for new housing areas
- political resolution regarding the development (activation) of new urban areas
- goal conflict: structural development vs. preservation/optimisation of important compensation functions / areas
- necessity to develop valid information for political decision-making for urban development and land-use planning



- Further development of the assessment – integration of suggestions from various departments
- intensive dialogue between practice and science moderated by ZURES project partners



Translation of the climate analysis into specific recommendations for urban development and decision making (e.g. guidance map for planning)



- Evaluation of potential new urban areas in terms of the urban climatic situation / function (e.g. cold air generation, etc.)
- Analysis of the impact of selected measures
- Advice regarding the best implementation of measures (e.g. roof / facade greening, opening of sealed surfaces to reduce urban heat island effect)





Climate Analysis map Workshop, 11.6.2018; Picture: agl



Integrated planning advice map Workshop, 9.4.2019; Picture: City of Ludwigsburg

- Three science-practice workshops in the City of Ludwigsburg
- Climate analysis map, planning guidance map, integrated planning advice map
- Discussion and further development of the maps with representatives from different departments (urban planning, green areas, district commissioners, etc.)

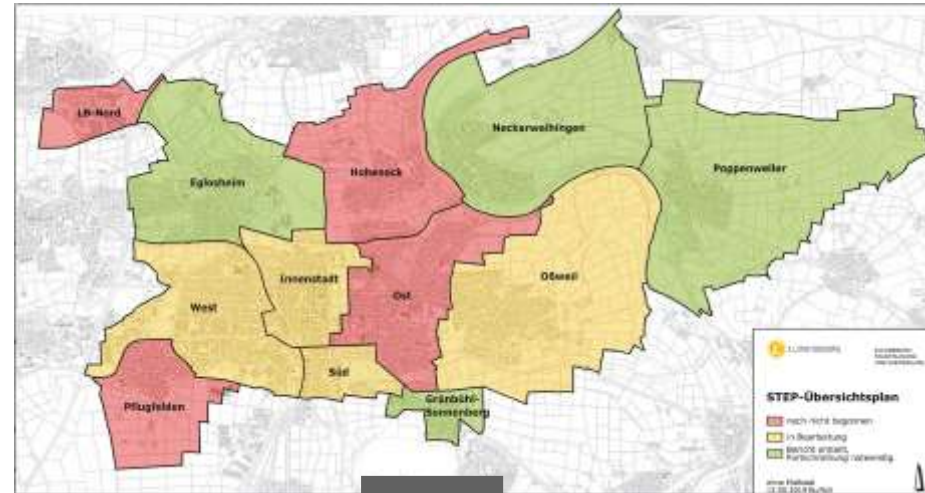
## *Potential application for integrated planning*

- Land use plan and development plans at district scale

## *Outlook*

- In the next 2 years further development of the STEPs (District Development Plans)
- Integration of climate and socio-economic indicators and scenarios - district level

## City Development Concept



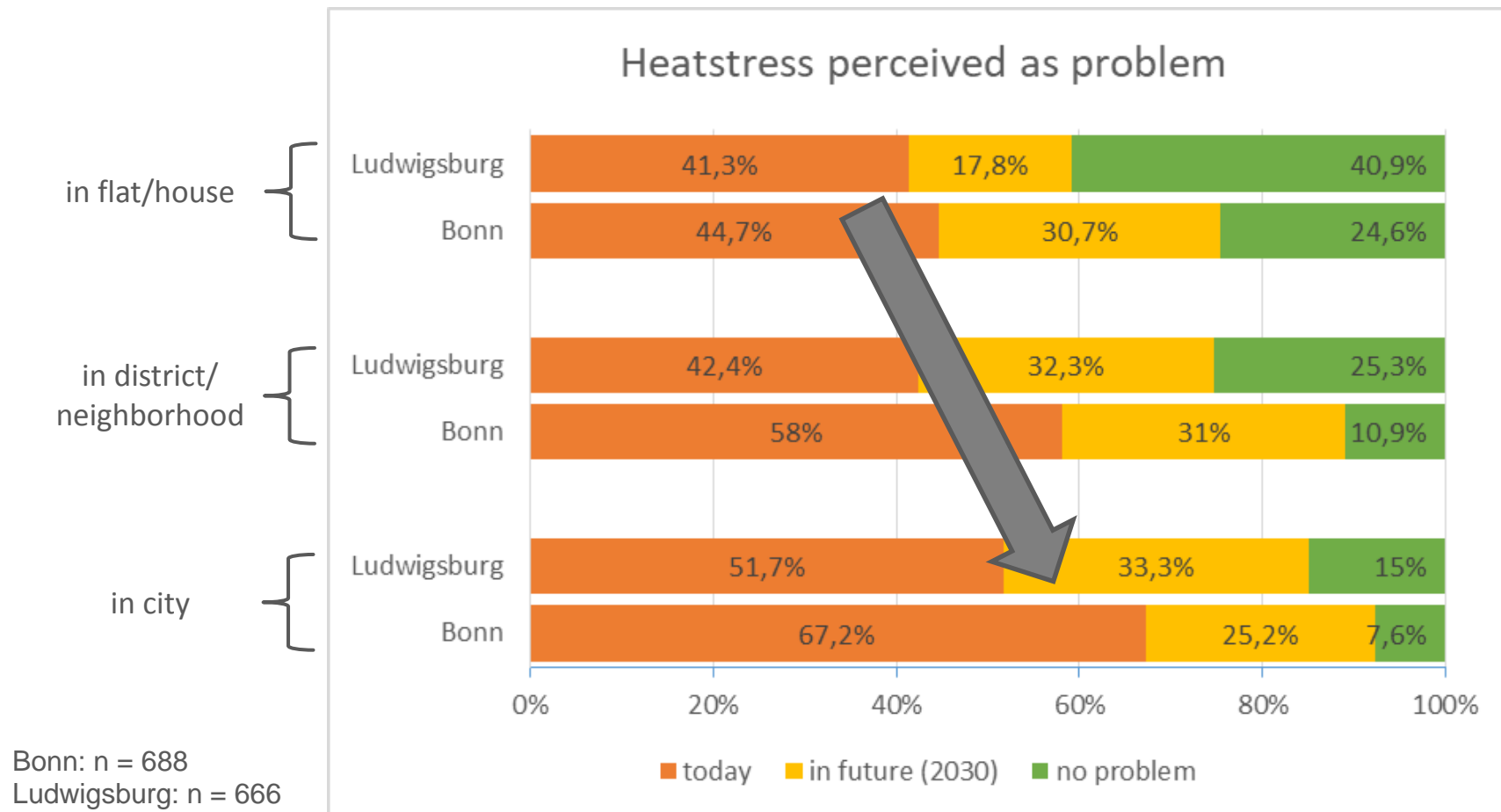
## District Development Plan



Map from the District Development Plan Grünbühl-Sonnenberg, 2009; City of Ludwigsburg

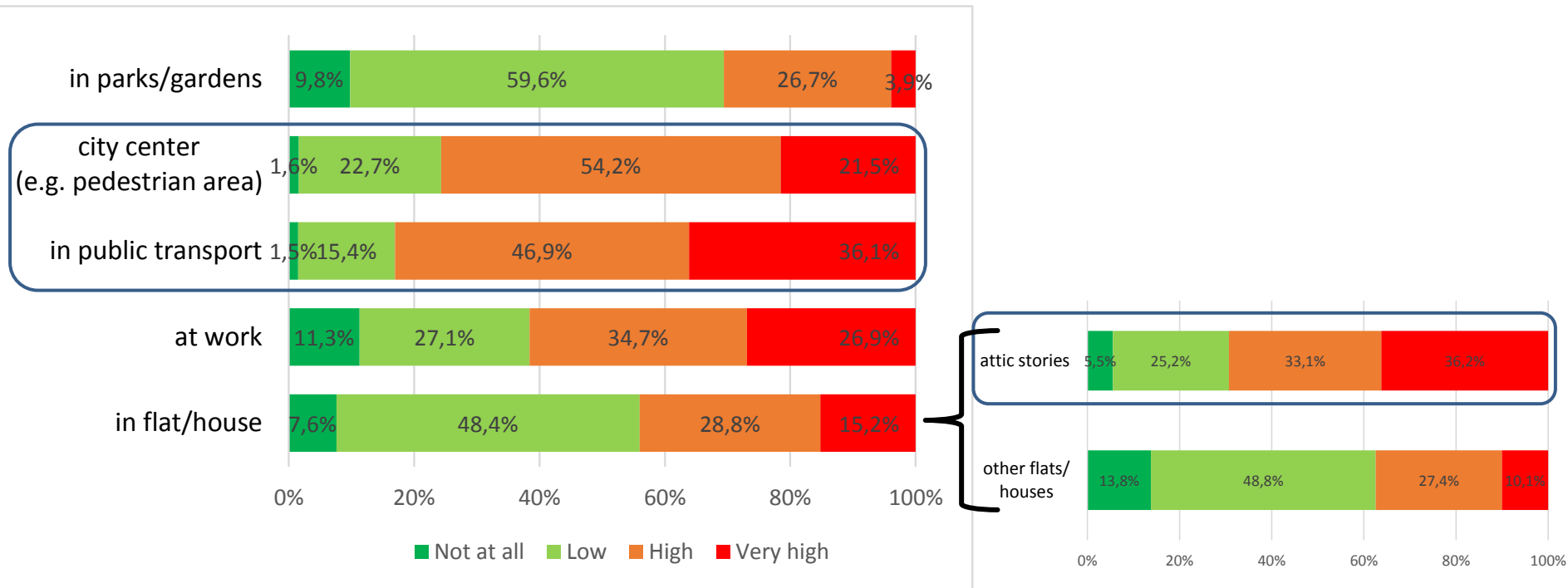
# Relevance of urban heatwaves

– results from household surveys in Bonn and Ludwigsburg



# Hotspots of urban heat stress

## – results from HH surveys





# Social groups at risk to urban heat stress

– results from HH surveys



Elderly



Why affected?

- Infrequent use of **parks** & public recreation areas; **restricted adaptation** options: low coping & adaptive capacity

How affected?

- 15% of all above 65y indicated frequent impacts on **cardiovascular** system: high potential health risk

- Mix of “soft” and “hard” measures
  - Heat-sensitive large-scale **urban planning**
  - **Small-scale** measures, e.g. drinking fountains, trees, rooftop greening
  - **Incentives** for private adaptation while avoiding **maladaptation** -> **awareness** building through information transfer
- Challenges
  - Achieve one thing without abandoning the other
  - Leave no one behind



- I. ZURES results provide better information on how to balance the need for new space for housing areas and the need to preserve open green spaces in the context of heat stress
- II. ZURES can help to identify relevant and local specific measures to optimise the thermic comfort in hotspots of urban heat
- III. Challenge: there is a need to improve the data-basis of socio-economic indicators as requirement for an equal and integrated assessment of climate and vulnerability – Bonn
- IV. Planning tools are needed (e.g. STEPs) that allow to represent and integrate a more comprehensive understanding of climate risks – capturing future climate and societal change



## Verbundkoordination

Universität Stuttgart, Institut für Raumordnung und Entwicklungsplanung (IREUS) unter der Leitung von Prof. Dr.-Ing. Jörn Birkmann

## Projektpartner



Technische Universität Dortmund, Institut für Raumplanung (IRPUD)



agl Hartz • Saad • Wendt  
Landschafts-, Stadt- und Raumplanung,  
Saarbrücken

GEO-NET Umweltconsulting GmbH,  
Hannover



United Nations University – Institute for  
Environment &  
Human Security, Bonn

## Projektlaufzeit

September 2016 – August 2019



## Modellstädte

Bundesstadt Bonn, Amt für Umwelt,  
Verbraucherschutz und Lokale Agenda,  
Abt. Umweltvorsorge und -planung, Leitstelle  
Klimaschutz



Stadt Ludwigsburg, Referat Nachhaltige  
Stadtentwicklung, Europa und Energie

## Projektförderung

Bundesministerium für Bildung  
und Forschung (BMBF)

Eingereicht im Rahmen der Bekanntmachung  
Sozial-ökologische Forschung im thematischen  
Schwerpunkt Nachhaltige Transformation urbaner  
Räume



Bundesministerium  
für Bildung  
und Forschung

