Hessian Agency for Nature Conservation,
Environment and Geology
Centre on Climate Change and Adaptation

HESSEN

Urban heat and municipal planning

Climate change in Hesse – focus topic

FACHZENTRUM
KLIMAWANDEL
UND ANPASSUNG

Imprint

Climate change in Hesse – focus topic

Edited by:	Project group KLIMPRAX urban climate Wiesbaden/Mainz, (see page 23) Project management: HLNUG
Development of the guideline:	"Requirements for the consideration of climate-relevant matters in municipal planning processes" (only in German): INFRASTRUKTUR & UMWELT, Professor Böhm und Partner, Darmstadt/Potsdam
Layout:	Christine Zarda

Translation into English with the help of Bruce MacPherson

Publisher, © and distribution: Hessian Agency for Nature Conservation, Environment and Geology
Centre on Climate Change and Adaptation
Rheingaustraße 186
65203 Wiesbaden

Phone: +49 611 6939-111
Fax: +49 611 6939-113
E-Mail: vertrieb@hlnug.hessen.de

www.hlnug.de

Effective: April 2017; English version: June 2018

Picture credits

Cover front page: © darknightsky – fotolia.com

Foreword

Prof. Dr. Thomas Schmid
President of the Hessian Agency for Nature Conservation, Environment and Geology

This brochure supports municipalities in the consideration of inner-city overheating within the scope of municipal planning processes. The adaptation to temperature-related effects of climate change is becoming increasingly important. In particular, a high degree of soil sealing in cities and high building densities increase the effects of rising summer temperatures.

The so-called “heat-island effect” in cities and periods of extreme heat and drought impact the health and well-being of the population, among other things. Green spaces, water areas, plants, unsealed areas, etc. that have an offsetting effect are becoming increasingly important. The development of these structures is managed in (formal and informal) planning procedures, because urban planning and open-space planning have a major impact on the resilience of cities. Those involved in planning processes must be willing to deal with this task.

With the model municipalities Wiesbaden and Mainz, relevant planning processes in the two cities were evaluated in the project KLIMPRAX (climate change in practice) urban climate Wiesbaden/Mainz. Initial findings for better consideration of urban heat stress in planning processes were collected in a wide range of discussions with actors from various municipal bodies. From this, a guideline was developed that you can find on the website of the HLNUG.

This brochure includes essential components of the guideline and thus launches into the topic, showing potential adaptation measures for municipal administrations.

Effects on urban development

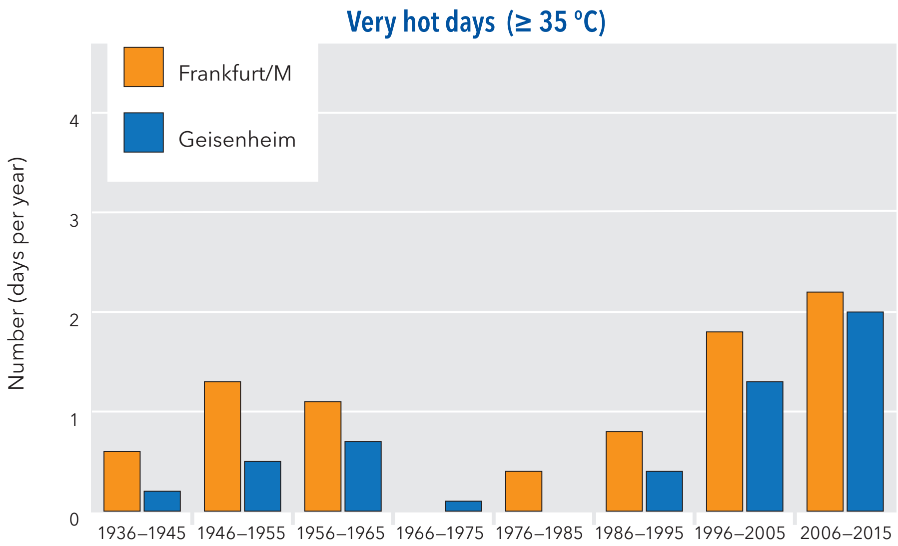
It is getting increasingly warm!

Since the end of the 1980s, there has been an extreme number of years in Hesse with well above average temperatures. In Hesse, nine of the ten hottest years on record have been observed since 1994. The 30-year mean for the period 1986–2015 (9.1 °C) is significantly higher than the mean value for the reference period 1961–1990 (8.2 °C). The warmest years since 1881 occurred in 2014 and 2015.

"The intensity of the heat-island effect increases with a rising number of inhabitants. In cities with about 100,000 inhabitants, the temperature difference between the city and its surrounding areas is up to 6 °C […]" (Umweltbundesamt 2015a, p. 214). The urban centres in Hesse will therefore be more affected than more rural communities.

The rising number of summer days (temperature maximum ≥ 25 °C), hot days (temperature maximum ≥ 30 °C), very hot days (temperature maximum ≥ 35 °C) and tropical nights (temperature minimum ≥ 20 °C) shows the increased heat stress. These thresholds are more often exceeded in major cities than in surrounding areas as a result of the additional urban warming. In the last 20 years, the number of very hot days and tropical nights has increased significantly (figure 1).

Despite their (still) rare incidence, these days represent an increasing health burden and impairment of the well-being of the population, especially when they occur on several days in a row. These climate indices clearly illustrate the increased heat stress which should also be taken into consideration for planning decisions.



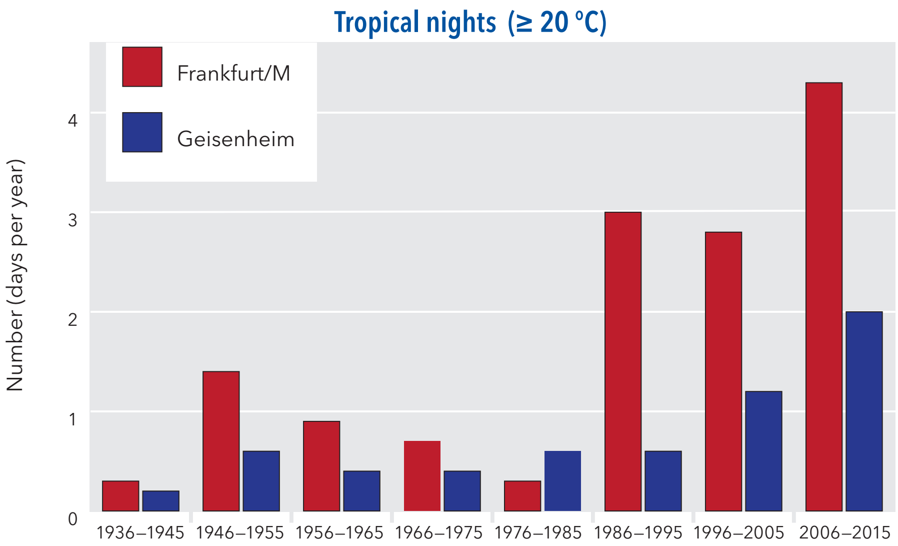


Figure 1: *Mean frequency of days/years with extreme heat from 1936 to 2015 (by decade) using Frankfurt / Main inner-city and Geisenheim as examples*

The observations show that the already ongoing, unavoidable climate change has and will continue to have an impact on economic, ecological and social development. Only through suitable adaptation measures taken in a timely manner can the impact be buffered and potential damage minimised.

Climate protection through the reduction of greenhouse gases remains the precondition for keeping adaptation needs low and manageable in the long term. Climate protection and adaptation to climate change thus belong together (Bundesregierung 2008, p. 5).

Hesse's integrated climate protection plan 2025 has therefore set the objective of reducing greenhouse gas emissions by 30 % by 2020 , by 40 % by 2025 and by 90 % by 2050, as compared to the year 1990 (HMUKLV, 2017).

Climate projections

The regional climate projections for Hesse for the 21st century show a continuation of the temperature increase that has already been observed. Depending on the scope of the increase in greenhouse gas emissions, there are different bandwidths of warming. A "medium emissions scenario" (A1B) projects an increase in the number of hot days of 7 to 33 days (figure 2). This result was reached on the basis of a large number of regional climate projections with various combinations of global as well as regional climate models.

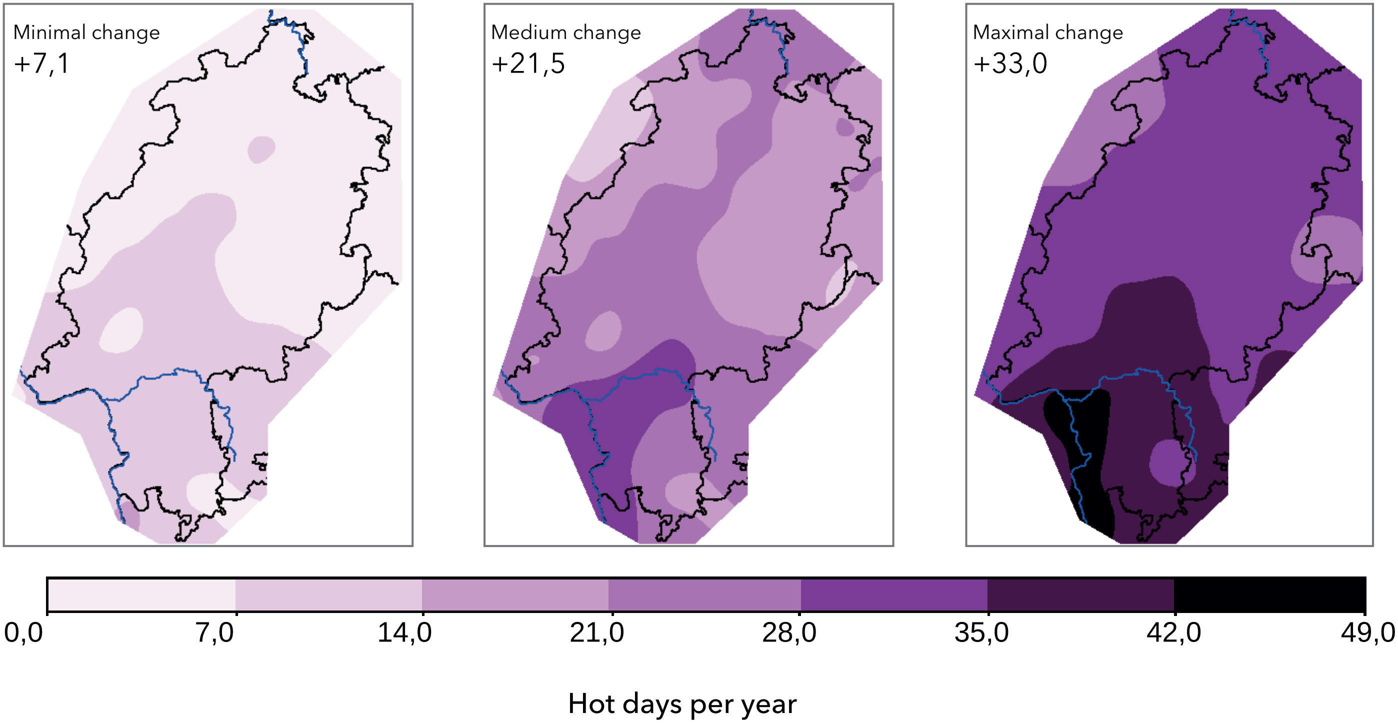
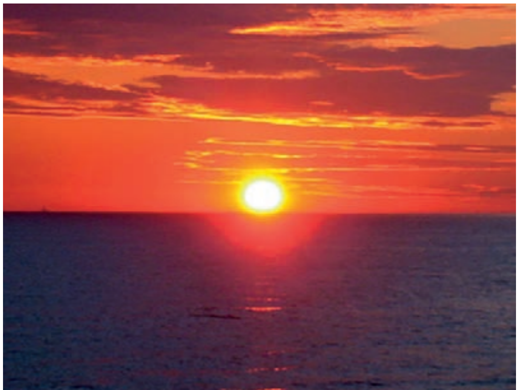


Figure 2: *Projection of the change in the number of hot days in Hesse per year (daily maximum temperature ≥ 30 °C) for the scenario A1B, 21 model combinations, 2071-2100 as compared to 1971-2000 (HLNUG, 2016 b, modified)*



The scenario A1B describes a future world with very fast economic growth and with a global population that increases until the middle of the 21st century and subsequently declines. At the same time, there will be a rapid introduction of new and more efficient technologies (MWKEL, 2013).
The scenario A1B approximately corresponds to the emission reductions agreed to in Paris. These are NOT sufficient to achieve the 2°C target.

Requirements for planning procedures

New climate protection clause pursuant to the German Construction Code (BauGB) from July 2011 (Section 1a Paragraph 5)

"The demands of climate protection will be met through measures that counter the effects of climate change as well as through measures that serve to help us adapt to climate change. The principle in accordance with Sentence 1 is to be taken into account in consideration of Section 1 Paragraph 7."

Climate change must be taken into consideration in municipal action. Municipal planning thus faces new challenges and management tasks. Tackling climate change is a cross-sectional task which is becoming increasingly important, particularly with regard to the safeguarding of public services and equal living conditions (ARL 2016).

With the adaptation to climate change, municipalities are now facing a new challenge. The potential local impacts of climate change (temperature development, changes in precipitation/ water balance, extreme weather events such as heat waves, heavy rains, storms, etc.) must be considered.

This results in new aspects to be assessed in addition to the current content of environmental reviews.

These are the effects of planning on

- climate vulnerability of existing land uses and functions (also of other protected resources in the environmental review process);
- resilience and climate adaptability of the land functions to be newly-determined in the zoning plan;
- reduction of climate change risks in accordance with sustainable land use (City of Regensburg 2013, p. 16).

In addition, the municipalities should take advantage of possibilities to implement measures seen as necessary for adaptation in the form of depictions and arrangements in the urban land-use plans.

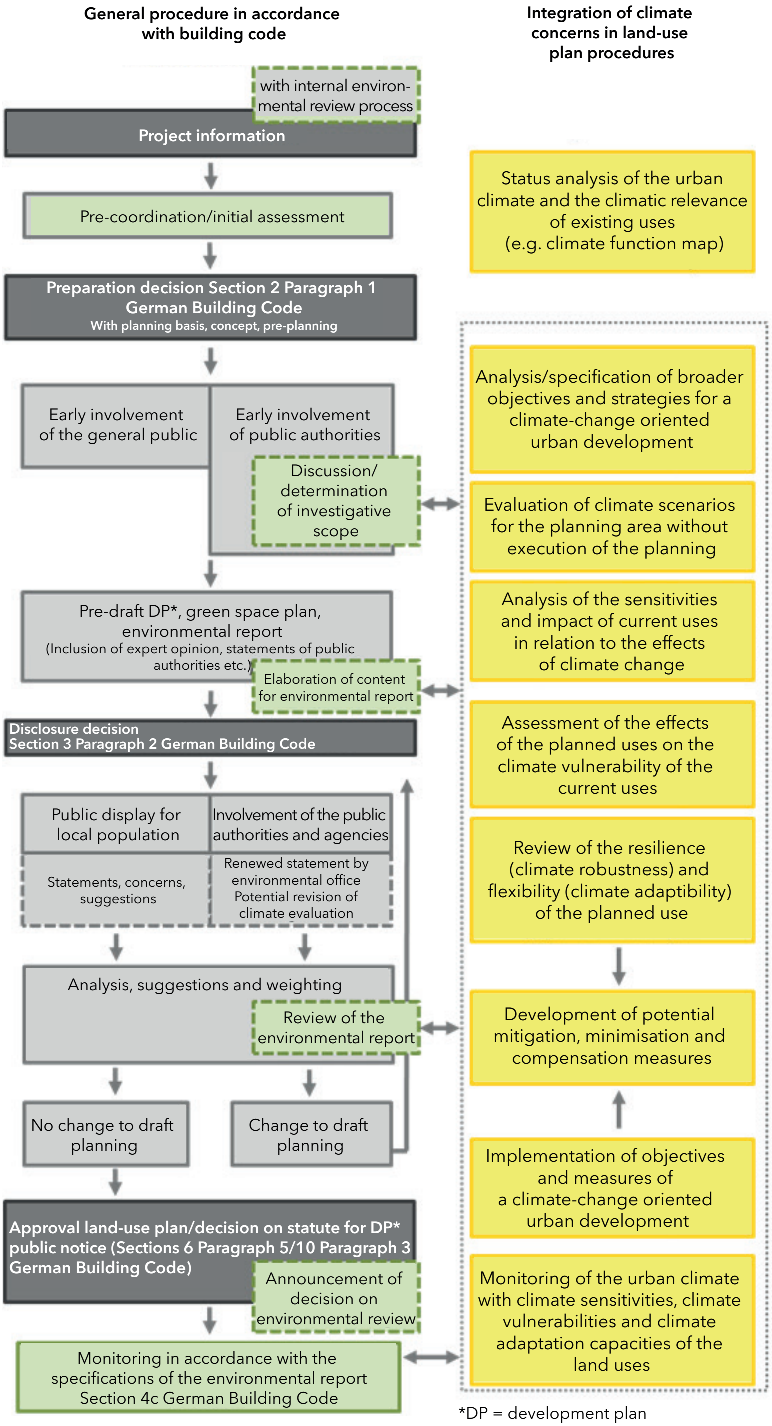
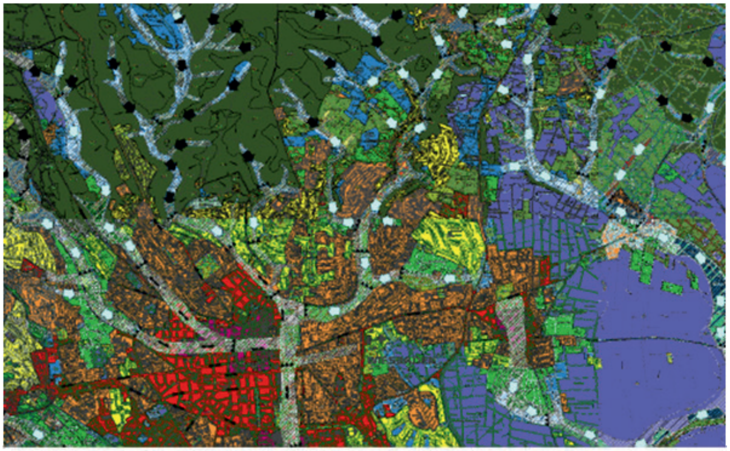


Figure 3 shows a possibility how climate change concerns can be included in the necessary environmental report on urban land-use plan procedures.

On the left, the general process of a development plan process (DPP) including environmental review is shown. The yellow boxes on the right provide information on how and at which point of the procedure the concerns of climate adaptation can be implemented in the process.

Figure 3: *Supplement to the environmental review for consideration of adaptation to climate change (City of Regensburg 2013 – modified by INFRASTRUKTUR & UMWELT)*



Flow parameters of urban climate

Regional circulation corridor (RCC)
Air corridor with differing thermal and/or air quality levels with local and regional importance; active in weather periods with low winds and high winds;

Fresh air corridor
Air corridor with differing thermal levels, without prior air quality burden; particularly active during low winds;

Cold air corridor (CAC)
Air corridor with differing air quality levels over which air masses pass that are always colder than the lower urban atmosphere; particularly active during low winds;

Bio-climatic fresh and cold air corridor (BFC)
Air corridor that is active during low wind periods and brings cold air toward the city; no prior air quality burden

Circulation corridor (CC)
Inner-city air corridor which enables ventilation particularly in periods of high winds.

Air circulation barrier
This barrier function develops when flows in the circulation corridors encounter rail or road embankments or closed building structures as well as thick vegetation whereby the relief energy prevents air overflow to some extent.

Flow direction of cold air by night
Particularly in periods of low winds

Potential air corridor

Spaces with urban climate function

Üxxx **Highly-intensive inner-city overheating area with limited air exchange**
The very high level of soil sealing (approx. > 90 %) with limited vegetation leads to intensive overheating during the day and to delayed and limited cooling at night.

Üxx **Intensive inner-city overheating area with limited air exchange**
The high level of soil sealing (approx. > 70-90 %) with limited vegetation leads to intensive overheating during the day and to delayed and limited cooling at night.

Üx **Overheating area with partially limited air exchange**
The medium level of soil sealing (approx. > 40-70 %) with average vegetation leads to moderate overheating during the day and delayed and moderate cooling at night.

Ü **Limited overheating area, built-up or with sealed soil, with nearly functional air circulation**
The medium to low level of soil sealing (approx. 10-40%) with a high to very high share of vegetation leads to limited overheating and thus indicates bio-climatic comfort zones.

Note:
In the depiction of the overheating areas, the air pollution from car emissions is considered.

Climatic buffer zones

P **Park climates**
Parks, green spaces or cemeteries indicate bio-climatic comfort zones as a result of their extensive wooded areas (shade effect) and their own air circulation development, particularly in summer, which, however, only have a limited external impact.

GZ **Climates of horticulture zones**
The climatic impact of horticulture zones is only sporadically determined by overheating related to soil sealing. These areas, which mai nly consist of small gardens or commercial horticulture, represent a kind of buffer zone between the urban overheating area and areas that produce cool air.

Note:
The additional symbols in the park climates (P) and the garden climates (GC)
*, +,o,- indicate very high, high, moderate and weak relief energy or slope gradient effects.

Figure 4: *Excerpt from the climate function map Wiesbaden (since 2015 pursuant to VDI guideline, VDI 3787 Sheet 1, climate map), source: State Capital Wiesbaden, Environmental Agency (2012): Urban climate Wiesbaden (Environmental Report No. 22), Wiesbaden.*

For an initial assessment of the extent to which a planned project effects urban climate, a fundamental status analysis of the urban climate and the climatic relevance of existing uses is needed. An assessment of this nature can be carried out on the basis of a climate function map (see fig. 4) or a planning information map. The legend provides examples for possible categories that can be used as a basis for more extensive planning decisions. For example, relevant map bases could be prepared as partial surveys for the landscape plan. While a climate function map depicts the spaces with their relevant climate functions (cold and fresh air production, ventilation corridors, etc.), a planning information map also delivers an evaluation of these space-related climate functions. For planning projects, a more detailed climate evaluation is often demanded for planning projects when the initial evaluation indicates that climate-relevant concerns are substantially impacted.

Climate evaluations include detailed information on the climatic conditions in the planning area, an analysis of the climatic and air hygiene effects of a project as well as a final assessment and recommended actions.

Conditions for success

To ensure that a municipality can effectively adapt to climate change, various conditions must be met. Four areas of activity are presented below that are key to a successful integration into the existing structures of municipal planning processes:

✶ Recognition of the concern and motivation to act in politics and administration

How can we create awareness for the need to adapt to climate change and generate motivation to deal with the issue?

Active support through the management levels creates a structural ability to be assertive. Political requirements must be defined to provide orientation to the administration. It is important in this regard to clarify the respective concerns of all relevant municipal bodies on a topic. In terms of the topic "heat in the city", for example, there are references

- to open space planning (green areas, shade, fresh air),
- to building construction (planning and design of public buildings),
- to building management (use/comfort in public buildings),
- to transport (comfort in public transportation) and
- to social aspects and to human health (raising awareness for sensitive population groups).

✶ Knowledge of climate change and its local effects

What technical knowledge do we as municipalities need?

Local climate effects and potential impacts of climate change have to be determined. These must be prepared in a manner relevant for planning and conveyed as approaches and possibilities for action in the municipalities. Availability and awareness of the existing knowledge and tools have to be improved.

Provide information

- Effects and possible technical requirements as well as social and ecological impacts of climate change
- Relevant factors for adaptation to climate change, including legal security for planning decisions
- Specific findings on urban climate (figure 5, page 13)
- Action-oriented approaches and possibilities for the administration
- Relevant affected groups and persons as well as responsible contact persons
- Differences and synergies in the approaches to climate protection and adaptation to climate change

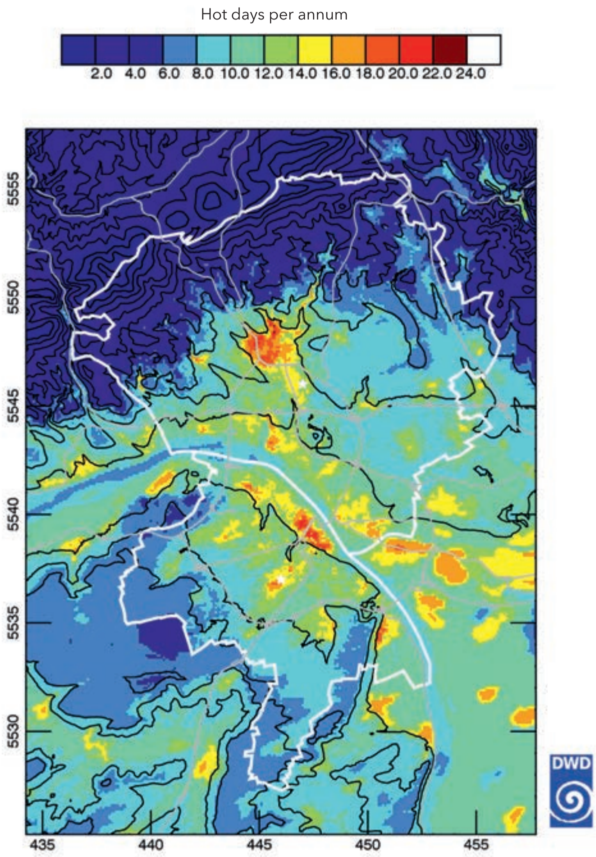


Figure 5: *Various institutions offer simulations with high-resolution urban climate models (for example MUKLIMO_3, FITNAH) for the creation of local climate maps (figure 4). Here the example of a map prepared by the German National Meteorological Service: Median annual number of hot days for the modelling of the present (1971–2000). The gray lines show the main traffic arteries and the white lines the borders of the city. (DWD 2017)*

✶ Embedding the issue in municipal development strategies, evaluating and linking with other relevant issues

How can we take advantage of synergies for work in the administration?

Municipal mission statements and objectives for adaptation to climate change define and specify urban climate concerns of adaptation, among other things, for the planning procedures. They can take up possible conflicts of interest and synergies among areas of action. Strategies that cross levels and departments should be developed. Conflicts, for example in the land-use plan/landscape plan, should be recognised and addressed at an early stage in order to find shared solutions. The personnel and financial resources are to be distributed in such a way that the urban climate concerns can be attended to sufficiently.

✶ Cooperation and coordination within the municipal administration and with other actors within the planning processes

Who should cooperate with whom?

On the one hand, the ability of municipalities to build up their own capacities for adaptation to climate change depends, among other things, on the size of and specialisation within the municipal administration. On the other hand, a very distinct specialisation and differentiation within an administration can often make the necessary interdisciplinary cooperation between municipal bodies more difficult.

In the procedures and the cooperation in planning processes that are clearly organised, the cross-sectional topic "climate change" must be recognised and integrated. The actors in the various municipal bodies must be supported and fostered in their cooperation. The exchange of information and cooperation with third parties (e.g. builders and architects), also across communities, should be actively managed.

Which recommendations for action are appropriate for the situation in your municipality depends, among other things, on the framework conditions for planning processes and the type of concerns the municipality has. Reference points here include the size and the spatial situation of the municipality.

The **size** of the municipality is linked to the degree of differentiation in the distribution of tasks within the administration. Larger cities generally have greater (personnel and knowledge) resources, at the same time, however, also more complex processes and a greater need for internal coordination and regulation. In smaller municipalities, resources are often more scarce but, at the same time, the communication paths are shorter, competences are divided among fewer positions/persons and technical fields are more intensively bundled in the municipal bodies/departments.

The **spatial situation** of a municipality's surrounding also influences the type of possible effects resulting from climate change. Municipalities in urban agglomerations are, as a result of their specific settlement and free space structure, more often and more intensively affected by heat than municipalities in rural areas. In urban centres, for example, nightly heat stress and heat island effects play a major role.

As part of the KLIMPRAX project urban climate, a guideline for municipalities was created. It demonstrates possibilities to optimise planning processes for the benefit of climate change adaptation as presented above.

Among other things, recommendations for action were developed in the form of fact sheets (tab. 1). The recommendations are prepared according to size categories, spatial situation and the derived relevance for the respective type of municipality. You can find the fact sheets in the guideline "*Requirements for the consideration of climate-relevant matters in municipal planning processes*" (only in German) which is available for download on the website of the Hessian Agency for Nature Conservation, Environment and Geology.

www.hlnug.de/fileadmin/dokumente/klima/klimprax/Leitfaden_klimprax.pdf

The structure of the 23 fact sheets is outlined below.

__Table 1:__ Structure of the fact sheets on recommendations for action

Headline in the fact sheet	Explanations
Measure no.	Consecutive number
Area of action	Allocation to one of the four areas of action: ✶**Awareness and motivation** ✶**Technical knowledge** ✶**Overall strategy/synergies** ✶**Cooperation and Coordination**
Timeline	General evaluation of a timeline for implementation: • **Short term:** Measure can generally start immediately. • **Medium term:** Preparations are generally needed for the measure, e.g. technical preparations. • **Long term:** Longer preparations are generally necessary or the measure is relatively complex in terms of implementation so that, initially, relevant resources must first be made available.
Acceptance	Open field for your evaluation of the acceptance of such a measure. Can help with the prioritisation of selected measures.
Measure	Name of the measure
Goal	What goal is to be achieved with the measure?
Brief description	Describe measure with information about implementation possibilities.
Leadership/ contact persons	Recommendation: Who is generally in charge of such a measure?
Further actors	Recommendation: Who is generally involved in the implementation of such a measure?
Relevance by type of municipality	General assessment, for municipalities of which size (small, middle, large) and spatial situation the measure is relevant: ✶✶✶✶✶ ▶ very high relevance ✶✶✶ ▶ moderate relevance ✶ ▶ limited relevance
Good examples/ literature	Here, cities and districts are mentioned which have implemented such a measure within the scope of research/model projects and/ or information on reports in which further information related to the measure can be found.

Self assessment

You can use the following checklist for a quick introduction and to evaluate the situation in your municipality. Links to the respective fact sheets are provided in the municipal guideline (they are not included in the brochure on hand). This chart offers a full overview of relevant questions.

In which department is the topic of adaptation to climate change located?	
☐ Environment	☐ Nature and landscape protection
☐ Urban development	☐ Urban planning
☐ Green space management	☐ Other department
☐ Not at all	

Which departments contribute to adaptation to climate change within the scope of planning procedures?	
☐ Environment	☐ Building
☐ Urban development	☐ Health
☐ Urban planning	☐ Transport
☐ Nature and landscape protection	☐ Property administration
☐ None	

Do policy makers and administration support the consideration of adaptation to climate change in planning procedures in the form of ...?		
... political decisions	☺	☹
... provision of resources, for example:		
• Official contact person	☺	☹
• Expert exchange	☺	☹
• Acquisition of funds	☺	☹

What technical knowledge is available for adaptation to climate change?		
Projections and scenarios for urban climate with regard to climate change	☺	☹
Maps of future urban climate	☺	☹
Data/models on urban climate	☺	☹
Climate function maps	☺	☹
Planning information maps	☺	☹
Monitoring data	☺	☹
I am aware of technical knowledge	is accurate	not accurate
Our municipality is "big enough" for the preparation and processing of data	is accurate	not accurate
Which process-oriented means are available for planning procedures?		
Text modules for the environmental report on climate adaptation	☺	☹
Checklists for planning procedures for consideration of the requirements arising from adaptation to climate change	☺	☹
How is the topic "adaptation to climate change" integrated into strategies and concepts?		
There are climate policy objectives and mission statements	☺	☹
Only climate protection is dealt with	is accurate	not accurate
There is an adaptation strategy	☺	☹
Adaptation to climate change is considered in urban development (concepts, development strategies)	☺	☹
Adaptation to climate change is considered in land-use plans/landscape plans; is considered in the revision of the land-use plans/landscape plans	☺	☹

In the guideline “Requirements for the consideration of climate-relevant matters in municipal planning processes” (only in German), you will find further information on the topic of heat in the city. It includes a list of best practice examples from other cities as well as an overview of urban development planning possibilities for adaptation to climate change pursuant to the building code and land utilisation ordinance.

Further processing steps will follow as part of the project KLIMPRAX urban climate Wiesbaden/ Mainz. They will subsequently lead to an **overall guideline** (the above-mentioned guideline is a first partial result) with the following topics:

- Improvement of meteorological knowledge
- Improvement of the transfer of meteorological results into planning practice
- Improvement of the weighting basis for climate impact evaluation and assessment of the sector “human health”

Reasons for the KLIMPRAX urban climate Wiesbaden/Mainz project

Climate change is already taking place, and future climatic changes are partially already inevitable. The implementation of specific measures for climate protection and, in particular, for climate adaptation can only be carried out locally. This is the challenge that municipalities are currently facing.

On April 16, 2013, the European Commission presented the EU strategy for adaptation to climate change. Climate change adaptation in European cities is mentioned here as a focus point. The Commission wants to promote adaptation for vulnerable areas and in this regard mentions the integration of adaptation issues in the urban space planning, design of buildings and the management of natural resources (Europäische Kommission 2013).

In its position paper “Adaptation to climate change – recommendations and measures for cities” (only in German), the German Association of Cities also recommends that urban overheating tendencies should be considered in urban planning and that ventilation of inner-cities should be maintained, developed and improved (Deutscher Städtetag 2012).

The HLNUG has taken up this topic in the KLIMPRAX project.

Literature and sources

ARL (2016) – Akademie für Raumordnung und Landesplanung: Positionspapier zur Anpassung an den Klimawandel. http://arl-net.de/content/positionspapier-zur-anpassung-den-klimawandel. Abgerufen am 20.03.2016

Bundesregierung (2008) – Deutsche Anpassungsstrategie an den Klimawandel, vom Bundeskabinett am 17. Dezember 2008 beschlossen, Berlin

Deutscher Städtetag (2012) – Positionspapier Anpassung an den Klimawandel – Empfehlungen und Maßnahmen der Städte, Köln, S. 5

DWD (2017) Modellbasierte Analyse des Stadtklimas als Grundlage für die Klimaanpassung am Beispiel von Wiesbaden und Mainz, H. Noppel, Berichte des Deutschen Wetterdienstes Band 250, erscheint in Kürze.

Europäische Kommission (2013) – „Eine EU-Strategie zur Anpassung an den Klimawandel“, Brüssel, S. 16f

HLUG (2013) – Hessisches Landesamt für Naturschutz, Umwelt und Geologie: Klimawandel in der Zukunft, Reihe Klimawandel in Hessen, Wiesbaden

HLNUG (2016 a) – Hessisches Landesamt für Naturschutz, Umwelt und Geologie: Anforderung an die Berücksichtigung klimarelevanter Belange in kommunalen Planungsprozessen. http://www.hlnug.de/fileadmin/dokumente/klima/klimprax/Leitfaden_klimprax.pdf

HLNUG (2016 b) – Hessisches Landesamt für Naturschutz, Umwelt und Geologie: Umweltatlas Hessen. http://atlas.umwelt.hessen.de/atlas/. Abgerufen am 28.6.2016

HMUKLV (2017) – Hessisches Ministerium für Umwelt, Klimaschutz, Landwirtschaft und Verbraucherschutz: Integrierter Klimaschutzplan Hessen 2025. https://umweltministerium.hessen.de/sites/default/files/media/hmuelv/integrierter_klimaschutzplan_web_barrierefrei.pdf. Abgerufen am 24.3.2017

Stadt Regensburg (2013) – Integration einer Klimafolgenabschätzung in die Umweltprüfung zum Flächennutzungsplan – am Beispiel der Flächennutzungsplanung mit integrierter Landschaftsplanung der Stadt Regensburg. München

MWKEL (2013) – Ministerium für Wirtschaft, Klimaschutz, Energie und Landesplanung Rheinland-Pfalz: Klimawandelbericht – Grundlagen und Empfehlungen für Naturschutz und Biodiversität, Boden, Wasser, Landwirtschaft, Weinbau und Wald. Mainz

Umweltbundesamt (2015) – Monitoringbericht 2015 zur deutschen Anpassungsstrategie an den Klimawandel – Bericht der interministeriellen Arbeitsgruppe Anpassungsstrategie der Bundesregierung. Dessau-Roßlau

Cooperating partners in the project **KLIMAPRAX urban climate Wiesbaden/Mainz** each with representatives of the project group:

- German National Meteorological Service
- State Capital Wiesbaden (model municipality)
- State Capital Mainz (model municipality)
- State Agency for the Environment, Rhineland Palatinate
- Rhineland-Palatinate Centre of Excellence for Climate Change Impacts
- Hessian Agency for Nature Conservation, Environment and Geology
- Centre on Climate Change and Adaptation (project management)

Hessisches Landesamt für
Naturschutz, Umwelt und Geologie
Für eine lebenswerte Zukunft