



# Climate Change Impacts and Adaptation Strategies in Bavarian Cities

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Project „Stadt.Klima.Natur“ (= City.Climate.Nature),  
an Initiative of the Bavarian Environment Ministry

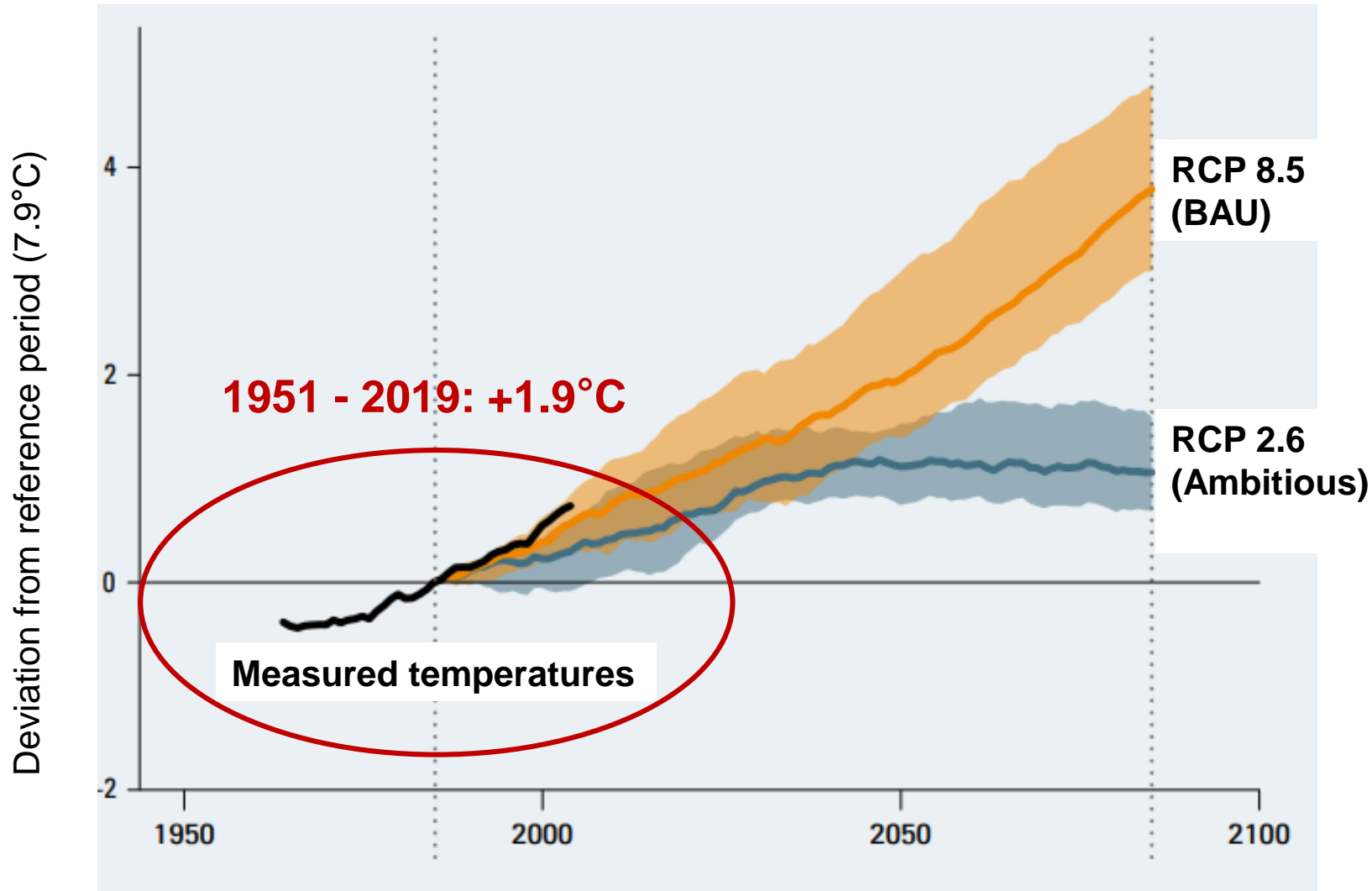
[stadtklimanatur.bayern.de](https://stadtklimanatur.bayern.de)





# Climate change in Bavaria

## Average annual temperature



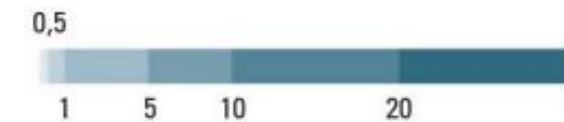


## Climate change in Bavaria

## Heavy rain days/year (>30 mm/day)

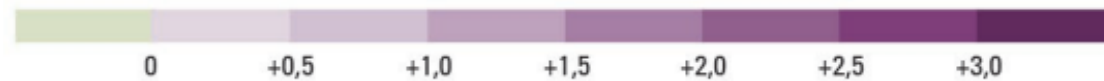
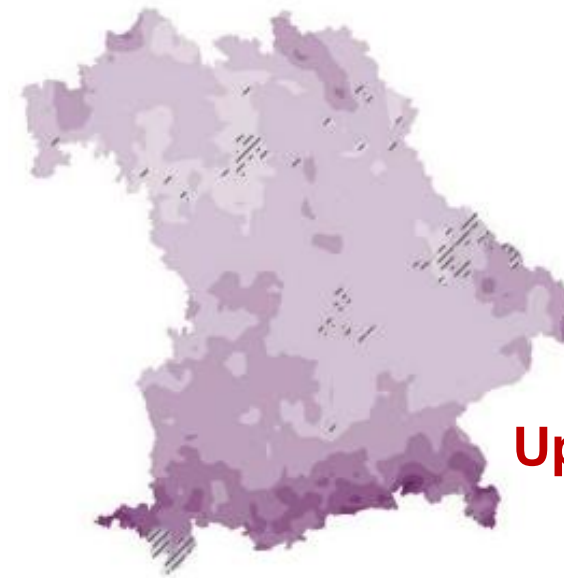


**Average: 4 days**



Reference period (1971-2000)

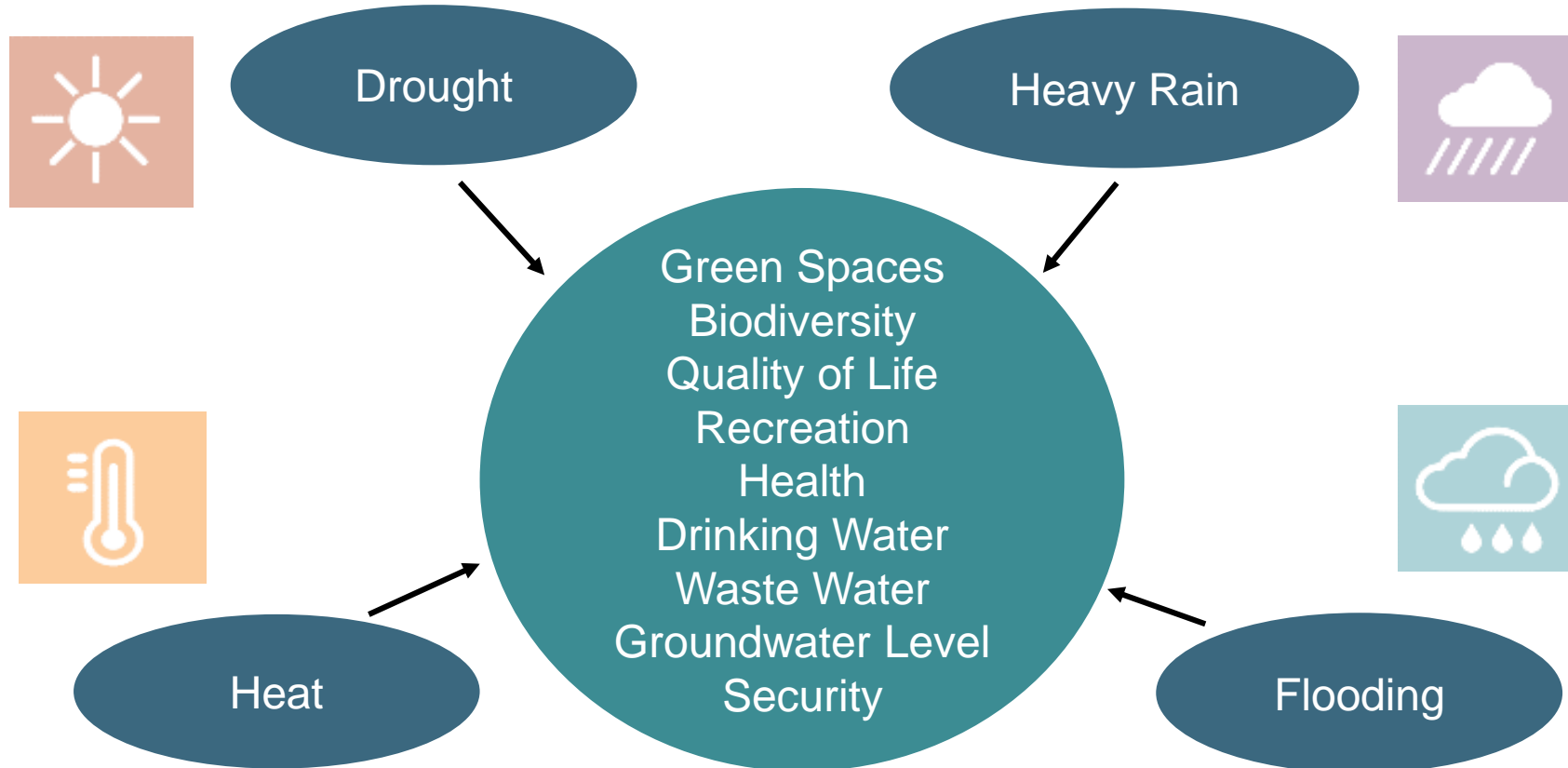
**Up to + 4 days**



Heavy rain days by end of the century



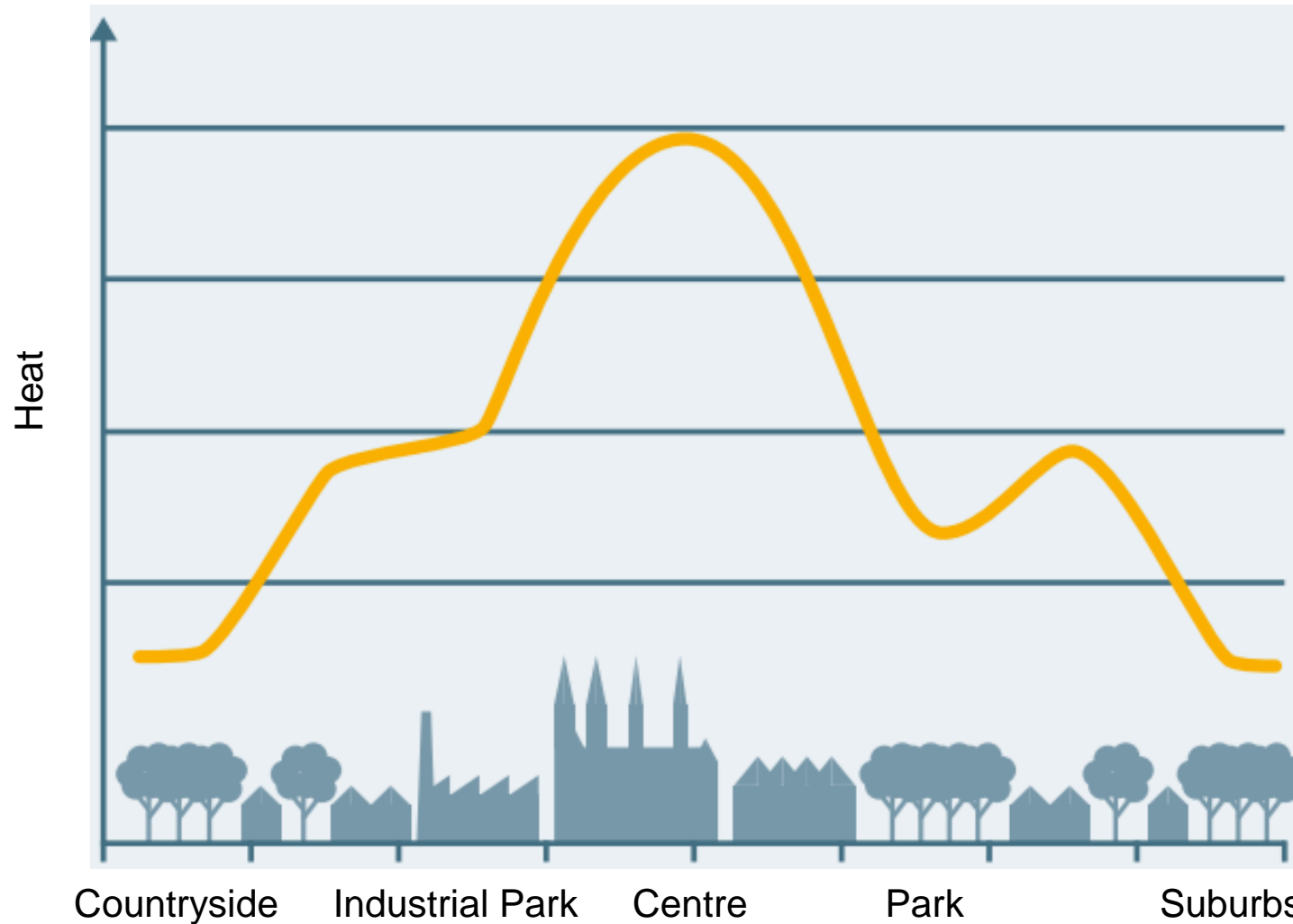
## How will climate change impact urban areas?



**Exacerbated through soil sealing and densification !**



## Urban Heat Island Effect



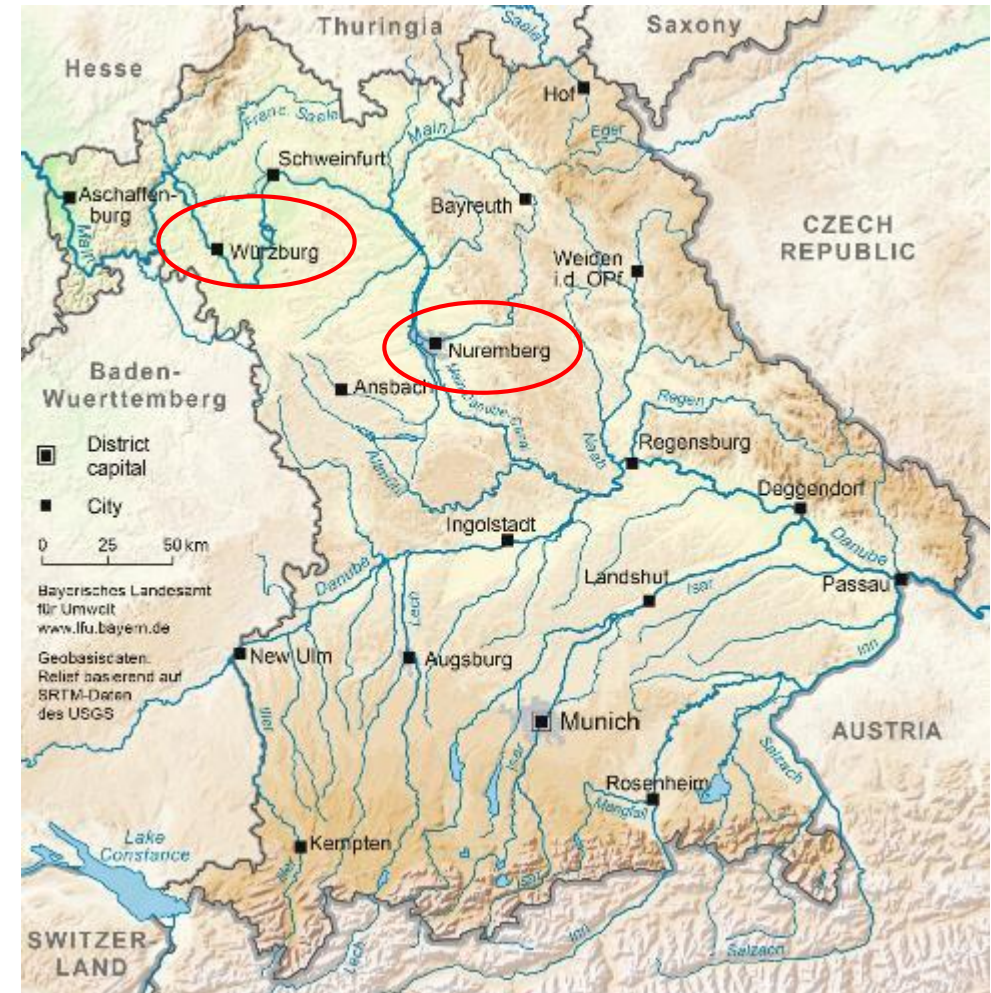
**Munich:**  
ca. 10°C difference  
on a hot day!



## How will climate change impact urban areas?

	<b>Nuremburg (Pop: 515 543)</b>	<b>Wurzburg (Pop.: 126 954)</b>
<b>Hot days (&gt;30°C):</b>	12/year to 45/year by 2100	11/year to > 50/year by 2100
<b>Tropical nights (min. 20°C):</b>	>1/year to 33/year by 2100	will increase
<b>Precipitation</b>	Less rain by 2100	Less rain by 2100 (more in winter, less in summer)

**=> Conclusion: Drier and Hotter!**





## Adaptation through Green-Blue Infrastructure

### Measures:

- 1) Permeable surfaces
- 2) Retention beds
- 3) Tree with underground water tank
- 4) Water storage tank
- 5) Multifunctional spaces
- 6) Stormwater drainage
- 7) Retention ditch
- 8) Nesting places
- 9) Green Courtyards
- 10) Green Facades
- 11) Green Roofs
- 12) Wetlands
- 13) Green Corridors
- 14) Cold-Air Corridors
- 15) Cold-Air Production Areas







## Examples from Bavaria – Water-Permeable Surfaces (1)

### Description:

- Remove sealed surfaces or create water-permeable surfaces, e.g. parking spaces, driveways or playgrounds
- Combine permeable layer with grass, where possible

### Climatic Effect:

- Improves groundwater regeneration
- Improves microclimate (evaporation)
- Improves biodiversity

Water-permeable parking spaces



© Wolfgang Färber

Grass pavers used for parking spaces or driveways



© Stefanie Schuster



## Examples from Bavaria – Water-Retention (2,7)

### Description:

- Permeable Flower Beds
- Permeable Ditches
- Placed alongside roads or in grass strips
- Water tanks underground, where possible
- Storage tank placed underneath trees

(water may be used for plants: quality must be assured)

### Climatic Effect:

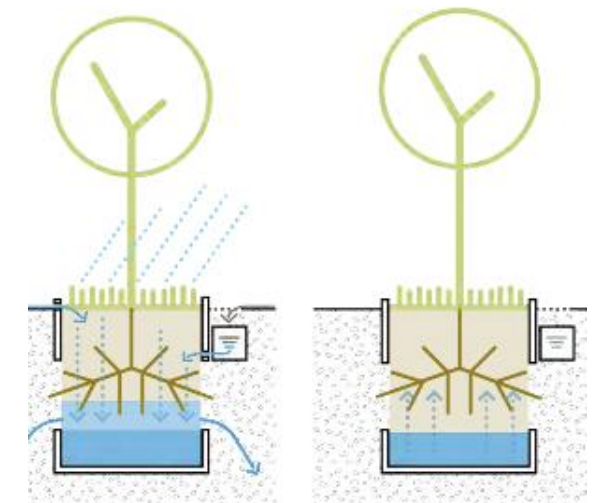
- Water retention (flood protection)
- Improves microclimate
- Improves groundwater regeneration
- Improves biodiversity

Permeable retention  
ditches  
at Ackermannbogen,  
Munich



© Alicia Bilang, München

Tree with  
underground  
water storage



© MUST Städtebau



## Examples from Bavaria – Multifunctional Green Areas (5)

### Description:

- water retention area used mainly for recreation in dry periods
- Green, permeable surface (where possible) with biodiversity-rich vegetation and trees

### Climatic Effect:

- Improves groundwater regeneration
  - Improves biodiversity
  - Trees provide shade (cooling effect)
  - Improves microclimate
- + Recreational activities



Multifunctional area in Eitensheim used as a playground, sports field and with (rain) retention function



## Examples from Bavaria – Green Facades/Roofs (10, 11)

### Description:

- Facade: Climbing plants (e.g. hydrangea, wild wine) or growing them in the facade
- Roof: Permeable layer of soil and plants, e.g. shrubs and trees
- Extras: Urban garden, playground, beehives, photovoltaic
- Retention roof, where possible
- Requires care

### Climatic Effect:

- Roof: Water retention (flood protection)
  - Cooling (building)
  - Improves microclimate
  - Improves biodiversity
- + Protection of facade/roof



Intensively-used  
Green Roof  
in Augsburg



Arabella Hochhaus  
in Munich (being built)



## Examples from Bavaria – Cold Air Corridors (14,15)

### Description:

- Wide, green corridors with low vegetation, e.g. grassy meadows or rivers
- Connect urban area and countryside to enable transport of cold (fresh) air into the city.

### Climatic Effect:

- Improve aeration of urban area, especially at night (reduce urban heat island!)
- Increase fresh air supply (local wind systems)
- + Benefits human health



Würzburg: Landesgartenschau Terrain (Gardening Exhibition) functions as cold-air corridor



## Adaptation Strategies – Municipal Instruments

### From Concept to Development

E.g. Business Park, Garching

- Rain retention concept for new industrial area with rain retention pond, green facades, biodiversity-rich green areas
- Measures put into legally-binding development plan
- Implemented by Developers => model-character

E.g. Housing District „Prinz-Eugen Siedlung“, Munich

- Former military barracks bought by city
- Development plan: climate-friendly quarter with wooden buildings, green roofs, maintaining old trees and biodiversity-rich green areas



Rain Retention Concept in the Garching  
Business Park © Stefanie Schuster, LfU



Prinz-Eugen-Siedlung, Munich © BuGG



# Thanks for your attention!

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## Interesting Links (German)

- More information on instruments that enable municipalities to implement green and blue infrastructure: Brochure „*Instrumente für Klimaanpassung vor Ort*“ (DE)

[https://www.bestellen.bayern.de/shoplink/stmuv\\_klima\\_016.htm](https://www.bestellen.bayern.de/shoplink/stmuv_klima_016.htm)

- More information on blue infrastructure: Brochure „*Wassersensible Siedlungsentwicklung*“ (DE)

[https://www.bestellen.bayern.de/shoplink/stmuv\\_wasser\\_018.htm](https://www.bestellen.bayern.de/shoplink/stmuv_wasser_018.htm)

- Regional climate scenarios for Bavaria (past trends and future projections) – *Bavarian Climate Information System*:

<https://klimainformationssystem.bayern.de/>

- More Information on climate change and adaptation on the LfU Homepage:

<https://www.lfu.bayern.de/klima/index.htm>