

ČESKÝ  
HYDROMETEOROLOGICKÝ  
ÚSTAV

# Impacts of climate change on urban landscape in the Czech Republic

A review

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**With thanks to the team of Complex Study of Climate Change Impacts in  
the Czech Republic**

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# Outline

- Relevant climate change trends and scenarios
- Urban Heat Island
- Impacts of Climate change in urban environment
- Measures



# Study of Climate Change Impacts

- Study serves as an expert input to the process of update of **National Strategy for Adaptation** and **National Action Plan for Adaptation**
- Client: **Ministry of Environment of the Czech Republic**
- Coordinator: **Czech Hydrometeorological Institute**
- Project duration: **November 2018 to June 2019**

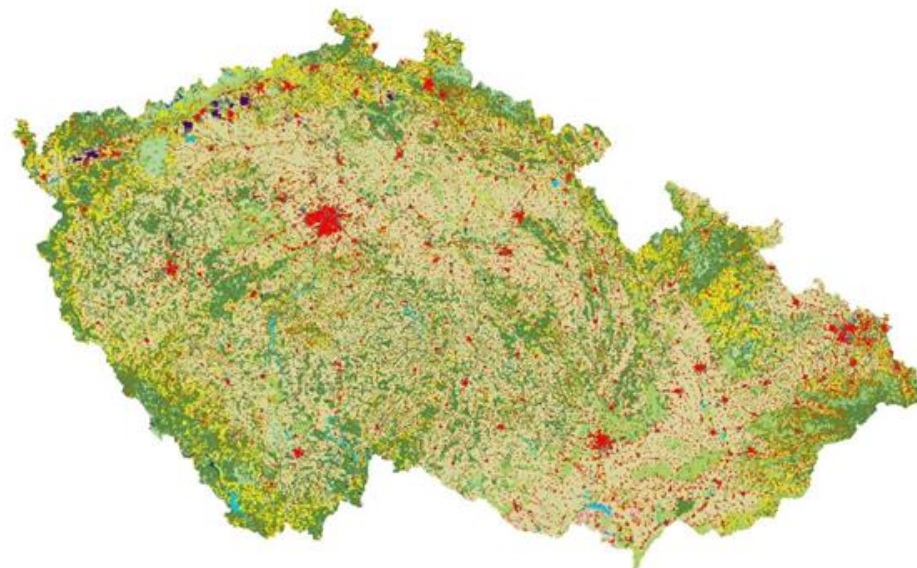


Ministerstvo životního prostředí



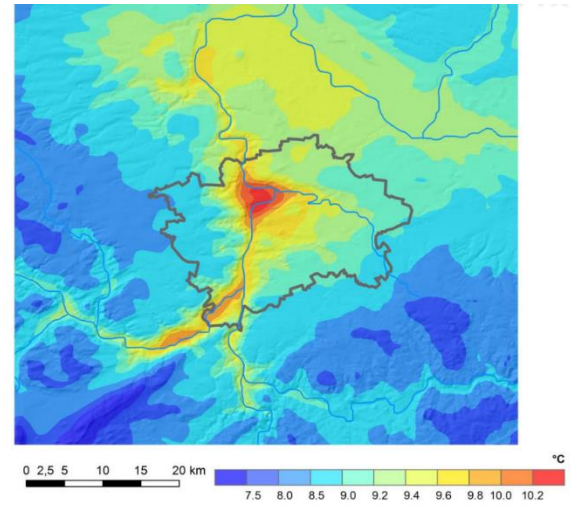
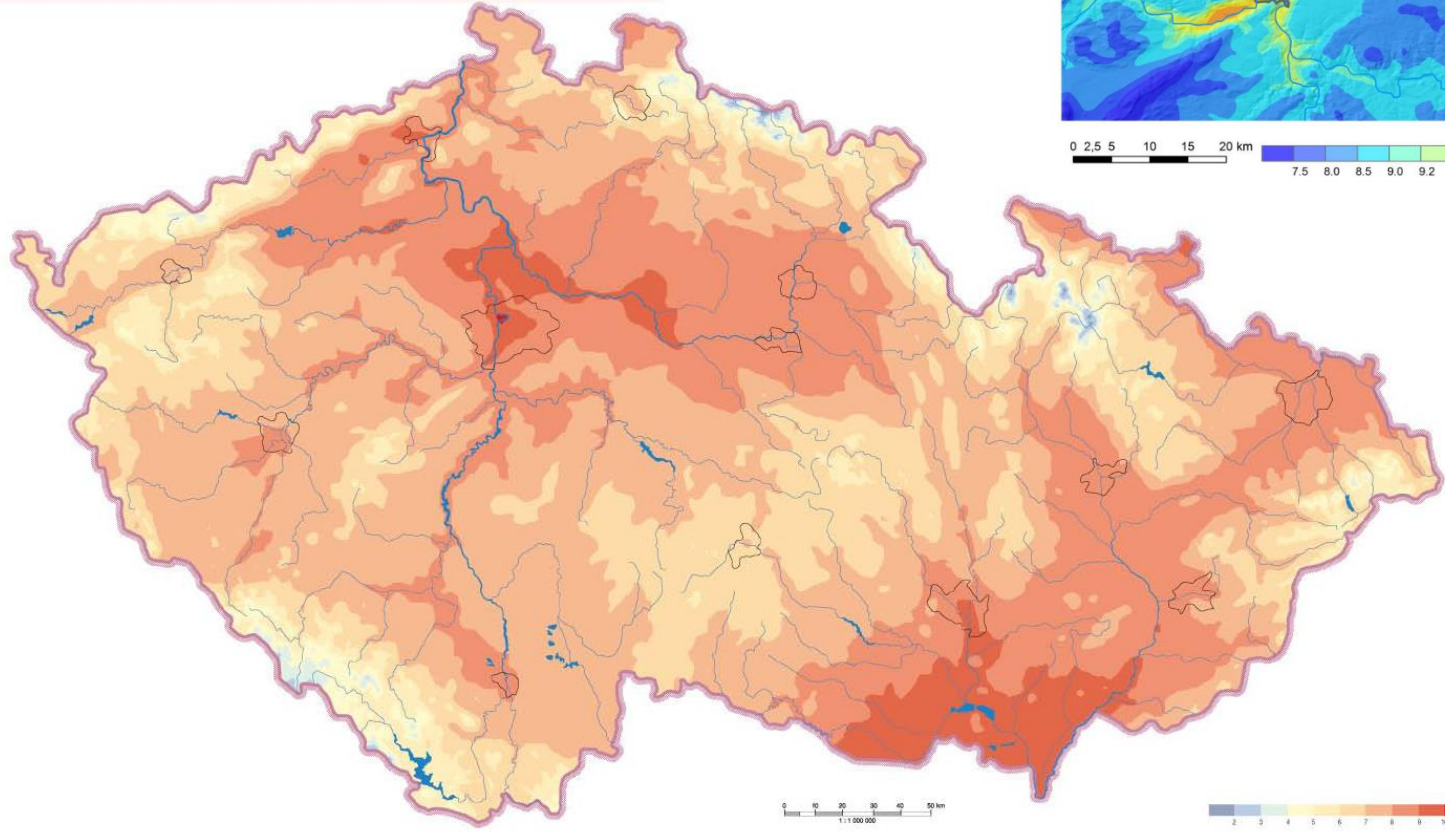
# Urban landscape

<i>Order</i>	<i>Municipality</i>	<i>Population</i>
1.	Praha	1 294 513
2.	Brno	379 527
3.	Ostrava	290 450
4.	Plzeň	170 936
5.	Liberec	103 979
6.	Olomouc	100 494
7.	České Budějovice	93 863
8.	Ústí nad Labem	93 040
9.	Hradec Králové	92 917
10.	Pardubice	90 335
11.	Zlín	74 947
12.	Havířov	72 382
13.	Kladno	68 804
14.	Most	66 644
15.	Opava	57 019
16.	Frydek-Místek	56 334
17.	Karviná	53 522
18.	Jihlava	50 724
19.	Teplice	49 563
20.	Děčín	49 226

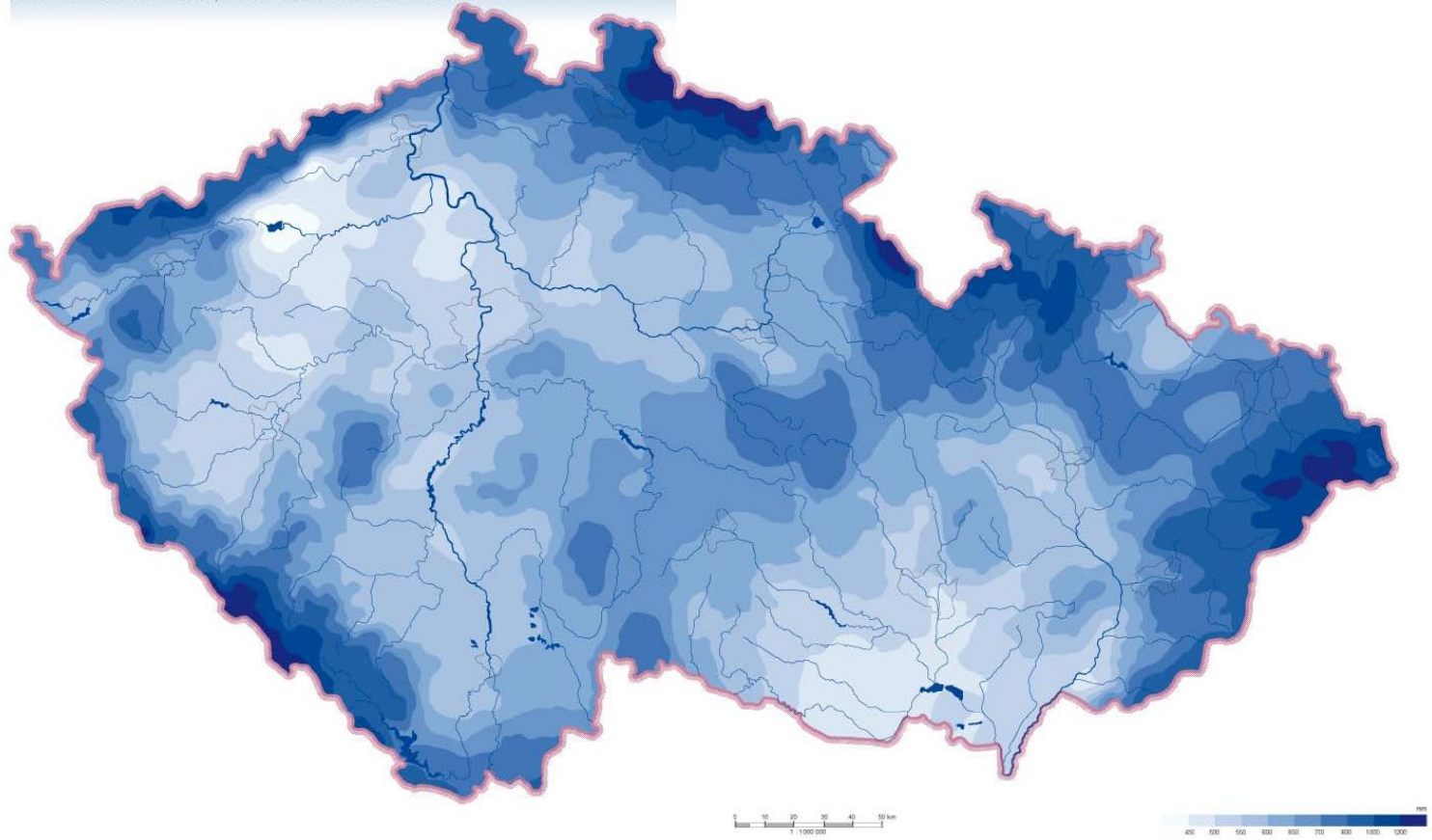


CORINE 2006 (CENIA, 2009)

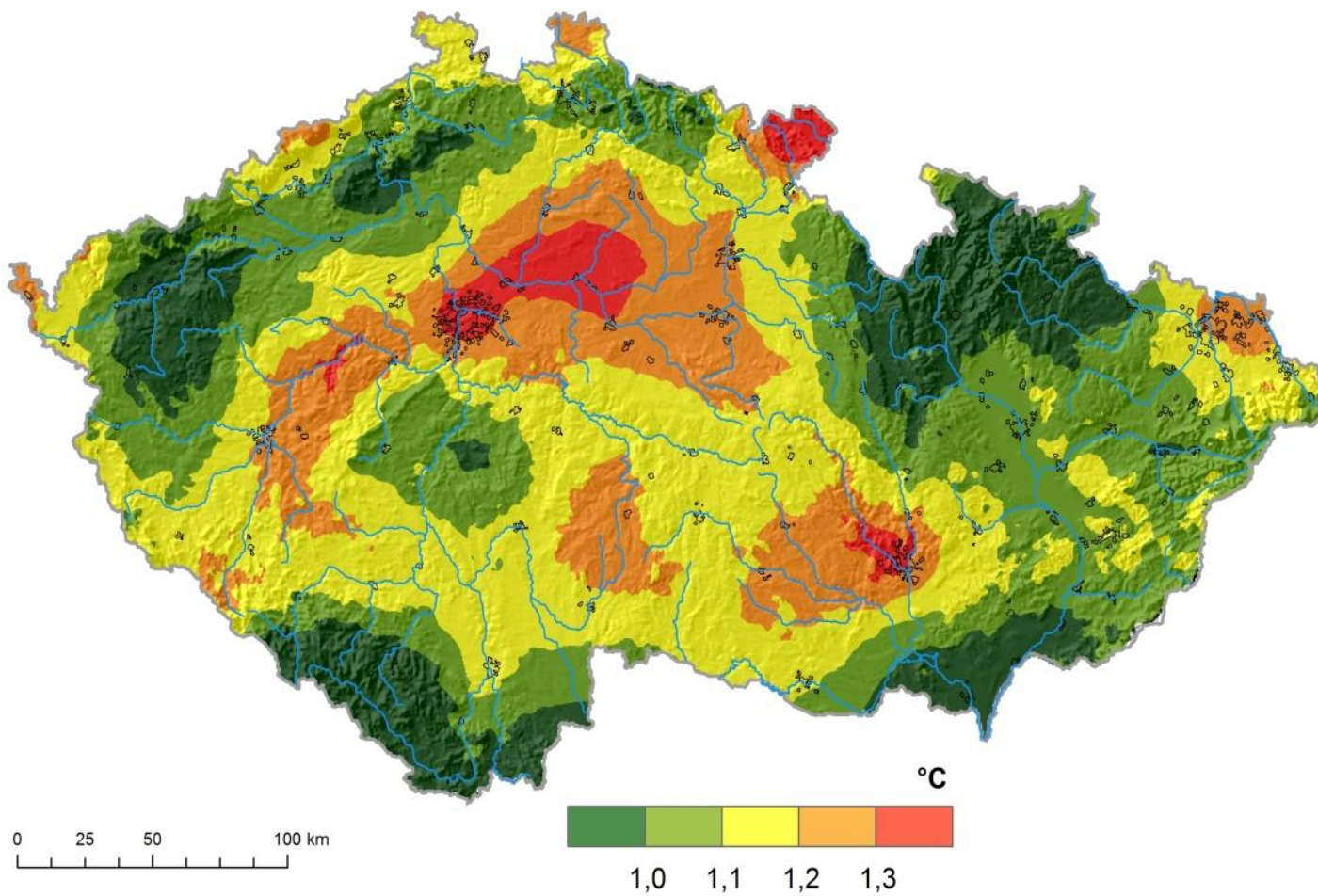
PRŮMĚRNÁ ROČNÍ TEPLOTA VZDUCHU / AVERAGE ANNUAL AIR TEMPERATURE



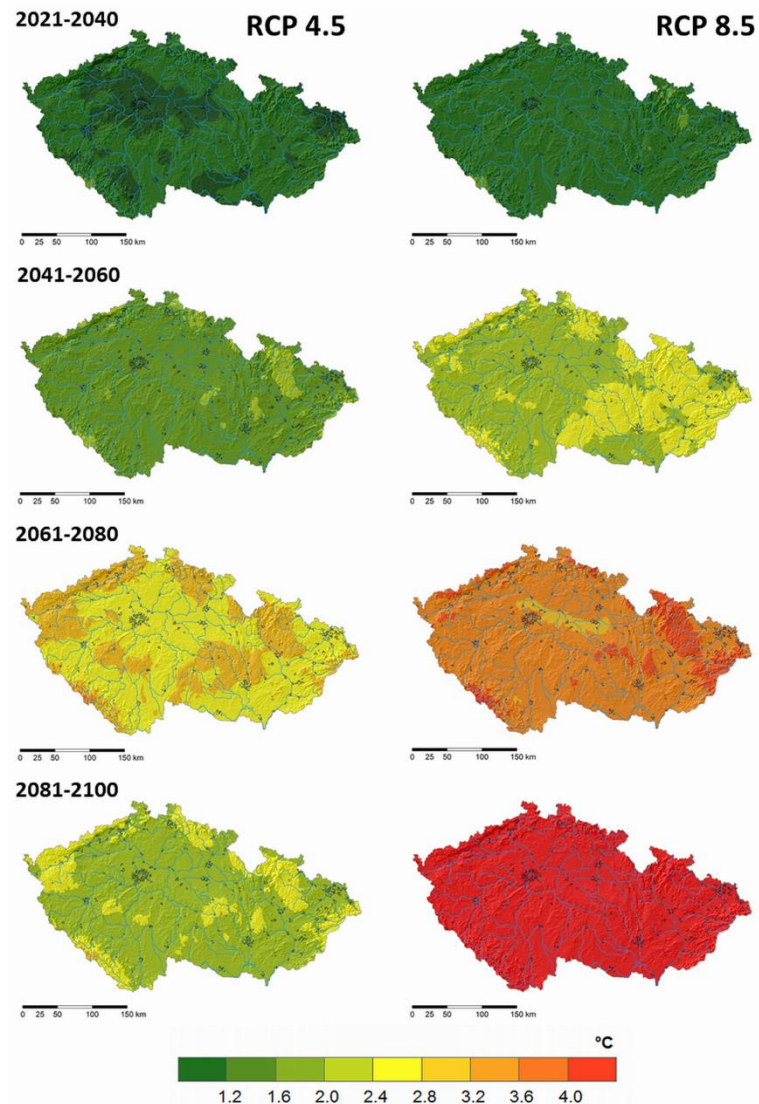
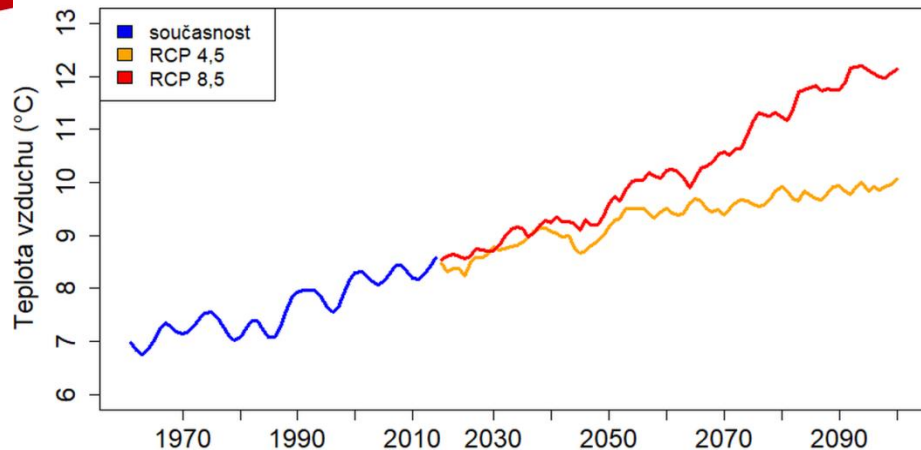
PRŮMĚRNÝ ROČNÍ ÚHRN SRAŽEK / AVERAGE ANNUAL PRECIPITATION TOTAL



Rozdíl roční teploty vzduchu v letech 2001-2016  
od normálu 1961-1990

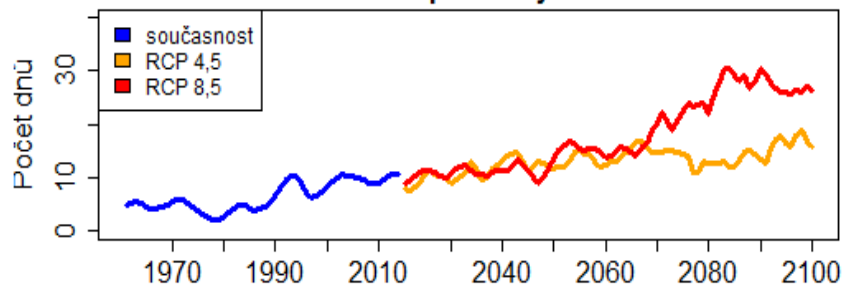


## Teplota vzduchu

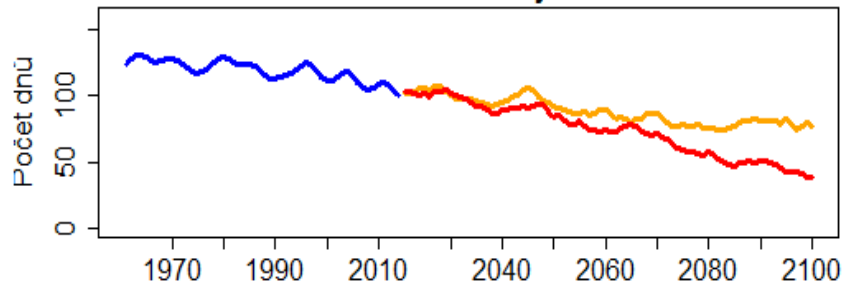


	Období	Rok	Zima	Jaro	Léto	Podzim
RCP4.5	2021–2040	0,9	1,1	0,8	0,7	0,8
	2041–2060	1,3	1,4	1,3	1,3	1,1
	2061–2080	1,8	2,2	1,8	1,7	1,5
	2081–2100	2,0	2,4	1,9	1,7	1,7
RCP8.5	2021–2040	1,0	1,1	1,1	0,9	0,9
	2041–2060	1,8	2,1	1,8	1,6	1,8
	2061–2080	2,8	3,3	2,8	2,6	2,6
	2081–2100	4,1	4,9	3,8	3,8	3,9

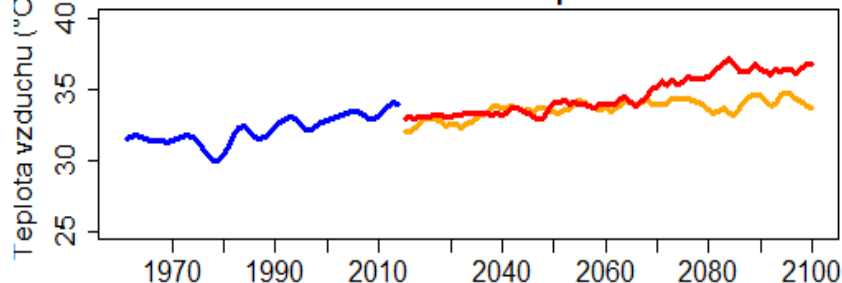
### Tropické dny



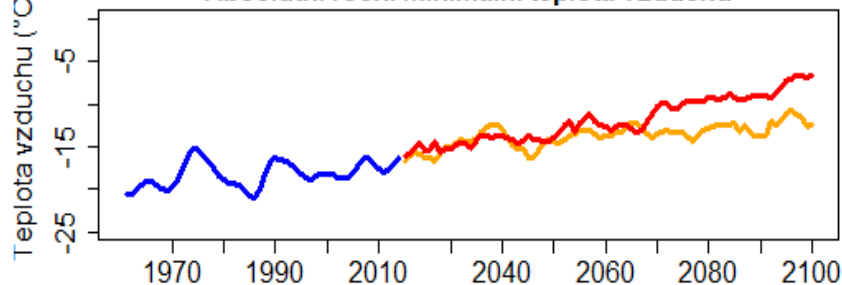
### Mrazové dny



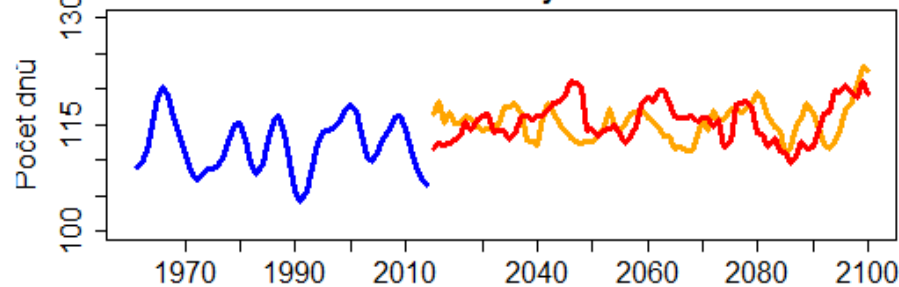
### Absolutní roční maximální teplota vzduchu



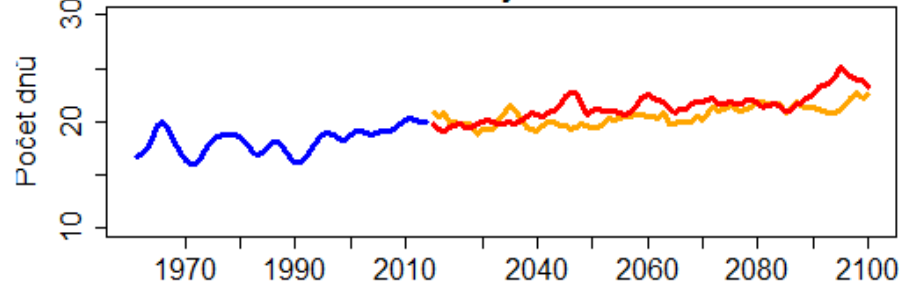
### Absolutní roční minimální teplota vzduchu



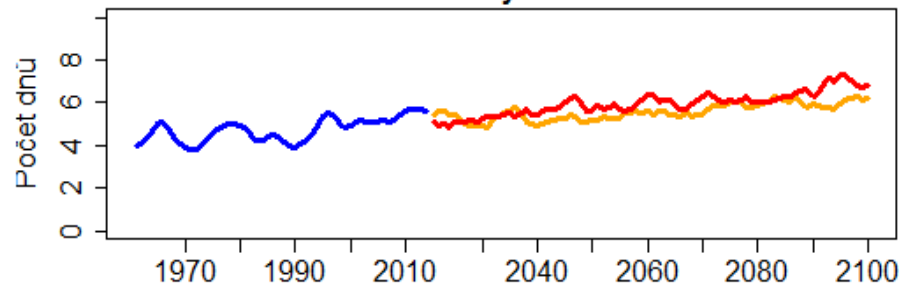
### Počet srážkových dnů



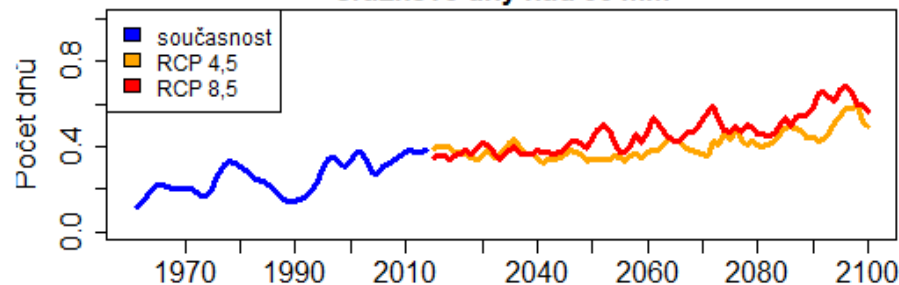
### Srážkové dny nad 10 mm



### Srážkové dny nad 20 mm



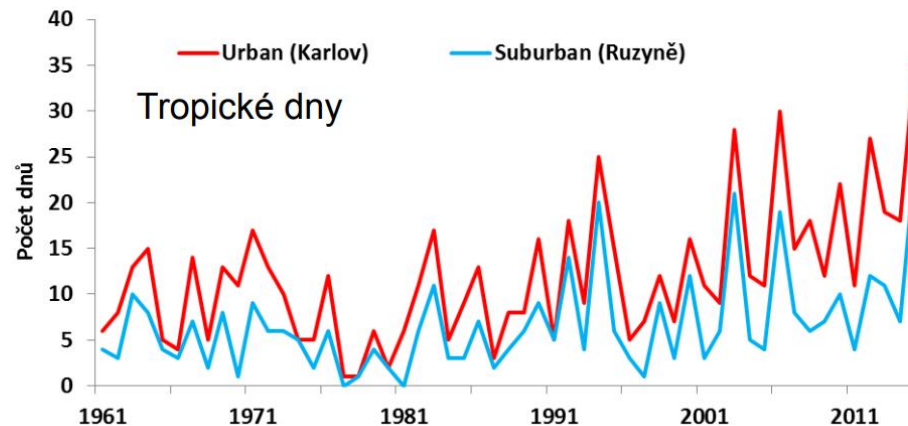
### Srážkové dny nad 50 mm

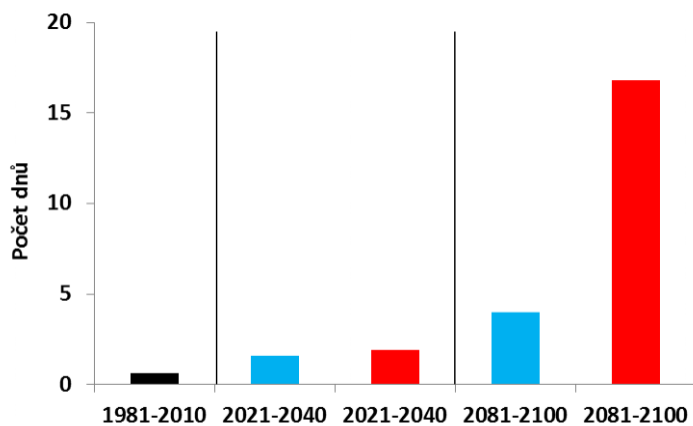


# Observed change in UHI

Over 1961-2016 following trends in UHI has been observed:

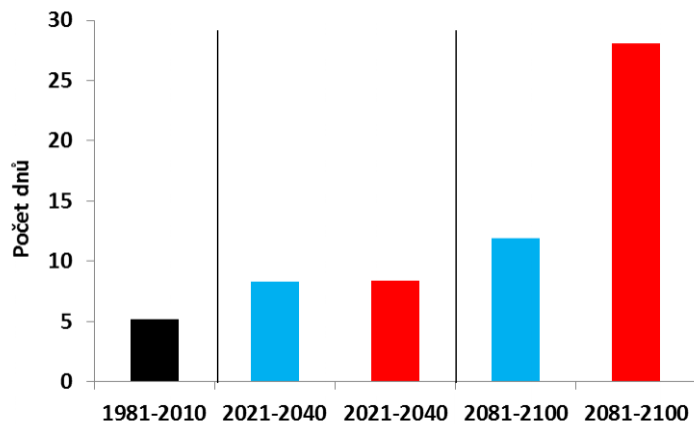
- $T_{min} = 0.16 \text{ } ^\circ\text{C}$  in 10 y
- $T_{avg} = 0.08 \text{ } ^\circ\text{C}$  in 10 y
- $T_{max} = 0.03 \text{ } ^\circ\text{C}$  in 10 y



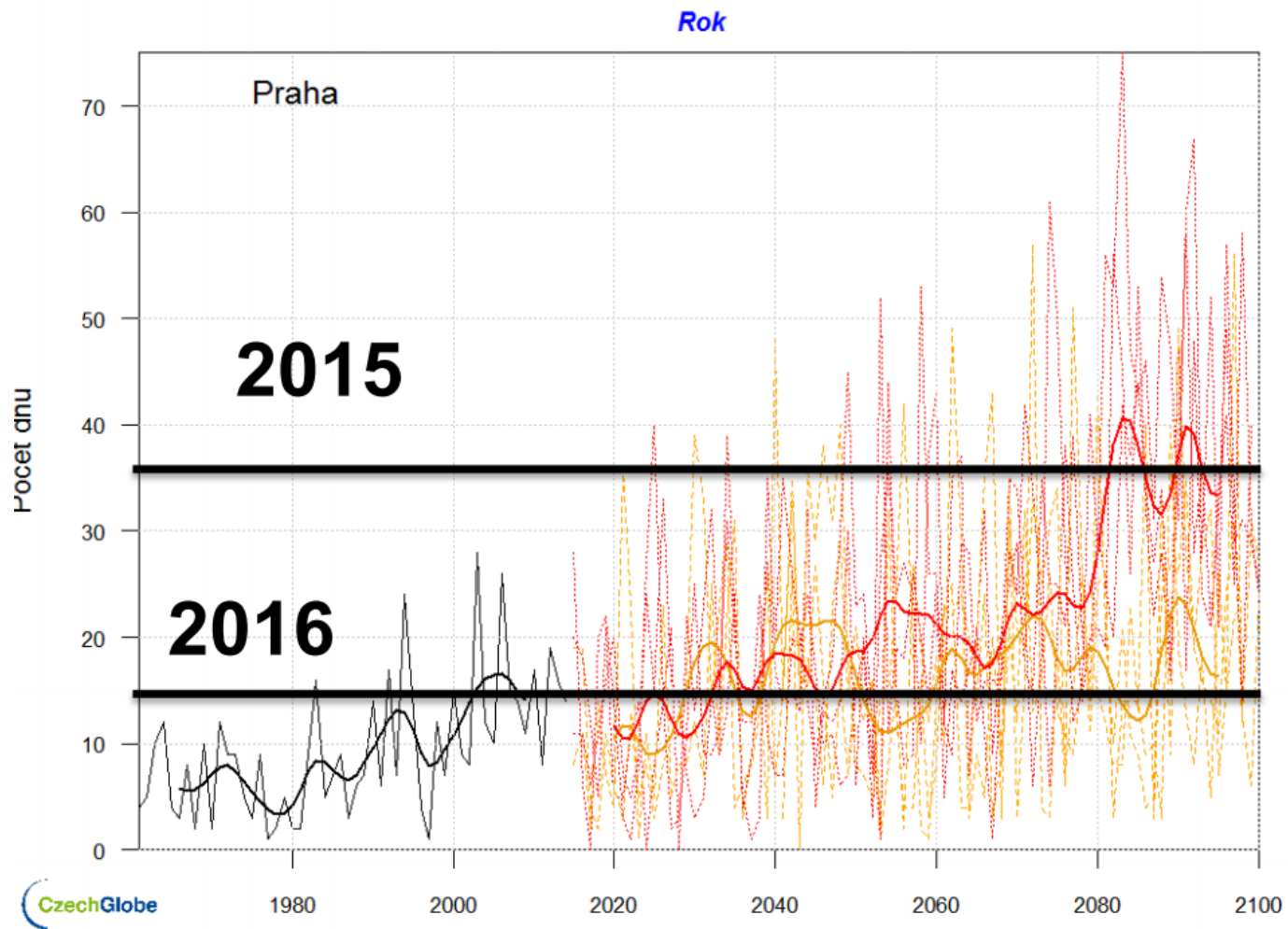


Expected number of hot nights ( $T > 20 \text{ } ^\circ\text{C}$ )

*Blue - RCP4.5, red - RCP8.5*



Expected number of heat waves (3 days of  $T > 30 \text{ } ^\circ\text{C}$ )



# Impacts of UHI

- Decrease of cold stress events
- Decrease of heating expenses
  
- More heat waves and heat stress
- Shortening of night comfort time
- Increase of air condition (energy consumption)
- Increased drought impacts



# Negative factors

- Large impervious area extent,
- Surface characteristics (albedo)
- High population density
- Lack of vegetation (trees) and water and its fragmentation
- Building construction (isolation, shadowing)
- Addition sources of heat (production, traffic, heating)
- Increase of vulnerable age groups (80+)



# Impacts of climate change

Following phenomenas are expected to be of concerns in the Czech Republic:

- Temperature Regime
- Heat Waves
- Drought
- Floods and Flash Floods
- Extreme Precipitation
- Other Extreme Meteorological Phenomena (wind, freezing etc.)



# Impacts of climate change

- Health and life risks
  - Heat stress
  - Psychological impacts
  - Open space injuries (wind, lightning, freezing, flooding).
- Economic impacts
  - Direct loss through damage to property and infrastructure
  - Flooding of surface and underground structures
  - Indirect loss from interruption of services and production
  - Decreased productivity of work (open space)
  - Increased cost of maintenance (green infrastructure, roads)



# Impacts – Heat Waves

- **Intensity of UHI ( $^{\circ}\text{C}$ ) =  $0,73\log_{10}(\text{population})$**
- In general municipalities < 10 000 inhabitants might be considered as rural environment
- Most vulnerable: municipalities > 75 000 in.
- Economic „gravity“ (daily migration)
- Future demographic trends:
  - Prague 1.5 mil inhabitants by 2050 (medium scenario)
  - Brno 370 000 inhabitants by 2030
  - Ostrava 275 000 inhabitants by 2040



# Impacts – Floods

Risk = hazard x **exposure** x vulnerability

## Alochtonous floods:

- 397 000 inhabitants living in 100y flood inundation area (4 % of population)
- **Olomouc** 36 000 inhabitants
- **Brno** 17 000 inhabitants
- **České Budějovice** 15 000 inhabitants
- **Praha** 15 000 inhabitants
- **Uherské Hradiště** 15 000 inhabitants
- **Přerov** 14 000 inhabitants
- > 5 000 inhabitants at **Krnov, Litovel, Kroměříž, Valašské Mezíříčí, Zlín a Šumperk**



# Impacts – Precipitation and Floods

## Autochtonous floods

2018 – Motolský potok 2 fatalities in underground part of the stream

Urban water management

- Drainage systems design and management
- Infiltration and retention
- Terrain and sub surface structures
- Buildings design
- Flood protection measures



# Impacts – Droughts

- Water supply interruption – impact on comfort, and potentially on health
- Increase of water use (irrigation)
- Water quality issues
  - in streams due to mixing ratio
  - Infrastructure – sewage systems
- Cascading effects – worst case scenario (though experiment):
  - Drought and heat wave (no local water resources)
  - Low flow – no water for cooling of power plants
  - Black-outs
  - Water supply interruption



# Impacts – Other Extremes

- Convective storms (lightning, wind bursts) and wind storms
  - High exposure - Kyriril (2007) 2 fatalities in Řevnice, Emma (2008) 2 fatalities on graveyard, Budapest (20. 8. 2006) 3 fatalities
- Icing and freezing phenomena – change of frequency (based on location and elevation)
- Others things to concern?
  - UV radiation,
  - faster spread of some diseases,
  - pollen allergies,
  - air quality (LA smog)



# Measures

## Management of water and green in the city:

- Distributed rainfall harvesting systems
- Infiltration
- Water elements
- Green areas

## Smart technologies:

- Forecasting service
- Decision support systems

## Smart and prepared people:

- Plans
- Awareness
- Rescue system

## Smart building and construction



# Measures

Any change might have some unintended consequences in complex systems

- New issues of concern
  - irrigation of green urban infrastructure
  - air quality
  - rainfall water harvesting and grey water use - micro pollutants
- New risks
  - vegetation fires in urban environment
- New opportunities
  - better planning (water demands)



# Conclusion

Future risks are result of:

- changed climate,
- changed exposure and
- changed vulnerabilities  
of society and individuals.





# Thank you for your attention

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