Assessment of the Bioclimatic Risk as Base for Resilient Urban Climate Adaptation Strategies: Case Study for the City of Chemnitz, Germany

Prof. Dr. Petra Schneider, Dipl.-Ing. Nicole Gottschalk
Dipl.-Phys. Carina Kühnel, Hanna Lehnert, Dr. Thomas Scharbrodt

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Introduction

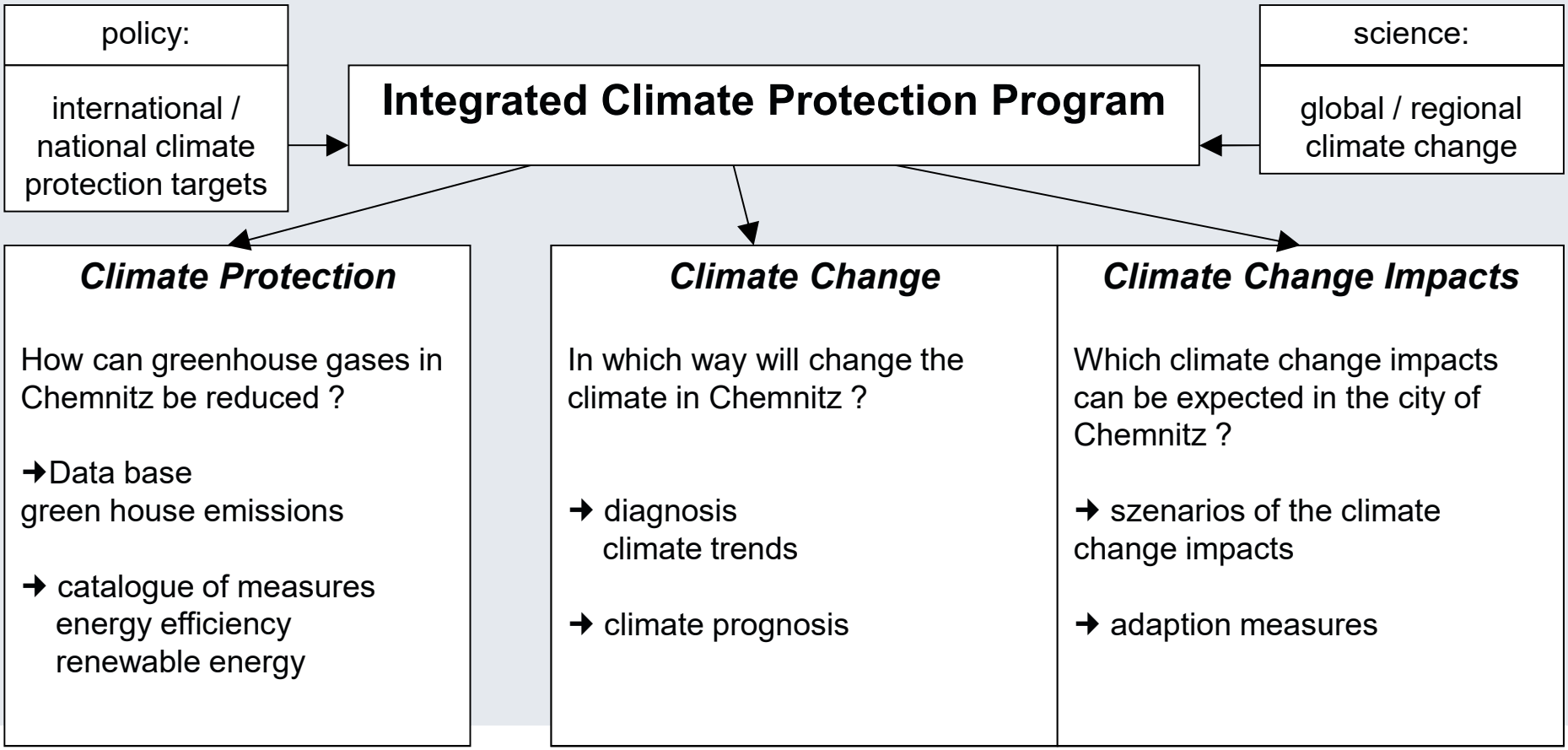
Chemnitz is the third-largest city in Saxony, Germany, with about 249.000 inhabitants.

It is a part of the Saxon triangle metropolitan area comprising 3.5 million people.

The “City of Modernity“ was and still is an industrial centre, having car supply and textile industry.

Integrated Climate Protection Program

On 27.02.2008 the City of Chemnitz decided the elaboration of an **Integrated Climate Protection Programme** including climate change adaption measures.



Adaptation Program to Climate Change

Scope of the Study

(1) **Climate diagnosis and climate prognosis** for Chemnitz City taking into consideration the state of the art in terms of climate change, especially in the urban area (data base climate prognosis data for Saxony → regionalisation),

(2) **Impact analysis for the relevant environmental factors** and

(3) **Risk analysis as well as conclusion of adaption measures**.

→ **development of action plan (adaptation strategy)** for preventive measures and desaster management

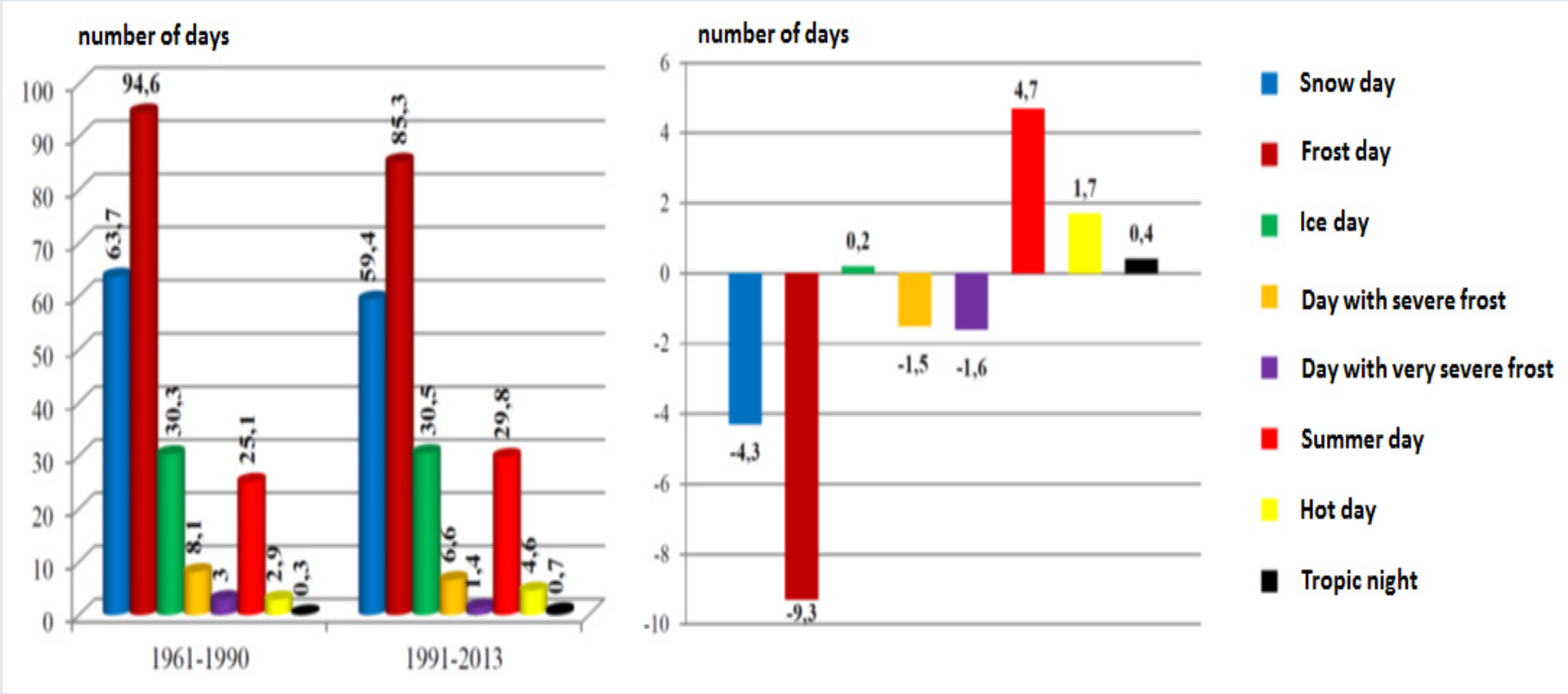
→ Provision of conclusions and guidelines for the city development concept in terms of reduction of the GHG and adaption to climate change

Climate Diagnosis
Data Base 1950 - 2010

- Annual Minimum Temperature: -18,3°C (1950‘s) → -13,8°C
- Annual Maximum Temperature : 31,4°C (1950‘s) → 32,8°C
- Summer Days with temperature > 25°C: +1,8 days/decade
- Hot Days with temperature > 30°C: +0,5 days/decade
- Frost Days with temperature Tmin <0°C: -6,5 days/decade
- Ice Days with temperature Tmax<0°C: -0,2 days/decade
- Precipitation: Annual sum is constant, but more heavy rains
- Sunshine days: +207 h/a (1961-1990, 2001-2008)
- Wind speed: slightly increase
- Grass Reference Evapotranspiration: 526 mm/a →591 mm/a

Update of the Climate Data Base in 2015

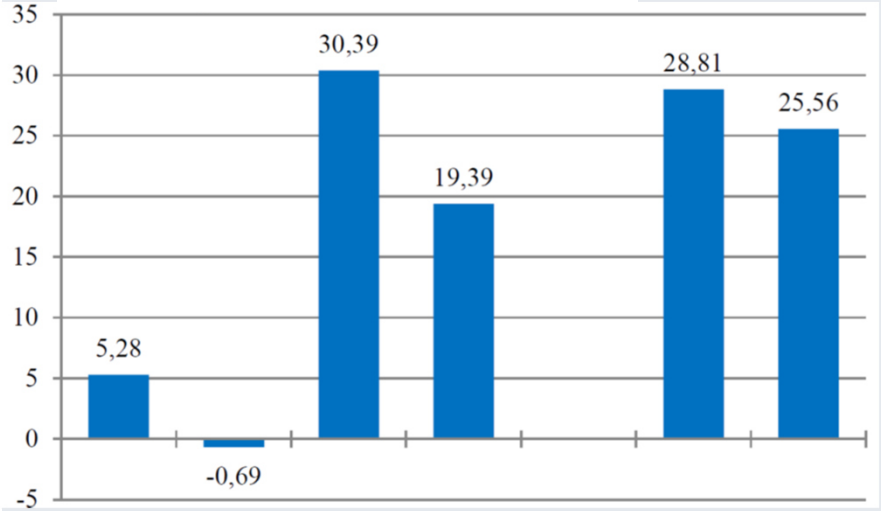
Comparison of the time periods 1961 – 1990 and 1991 - 2013



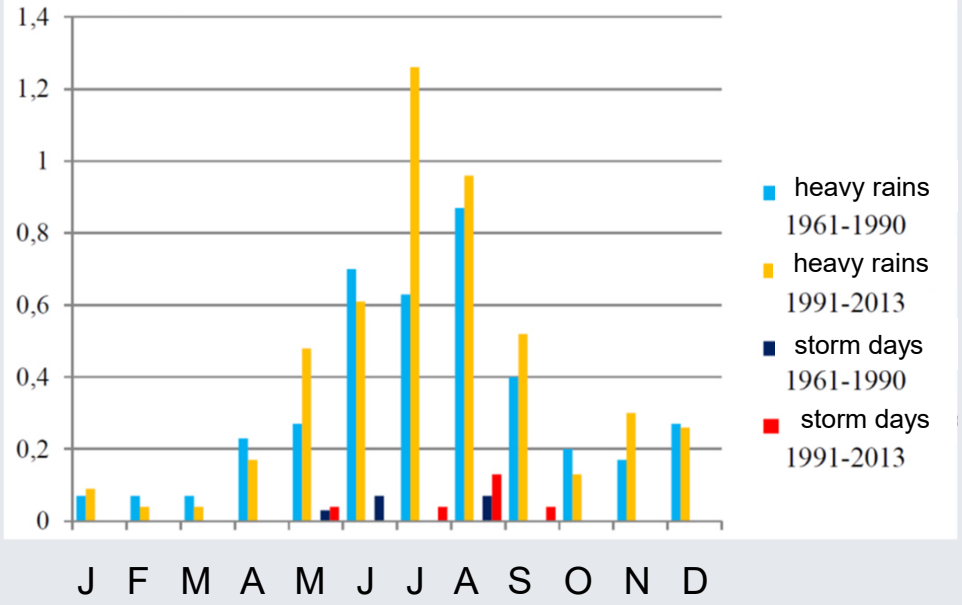
Update of the Climate Data Base in 2015

Comparison of the time periods 1961 – 1990 and 1991 - 2013

Change in precipitation
(in mm/a)



Days with heavy rains and storms
(number of days)

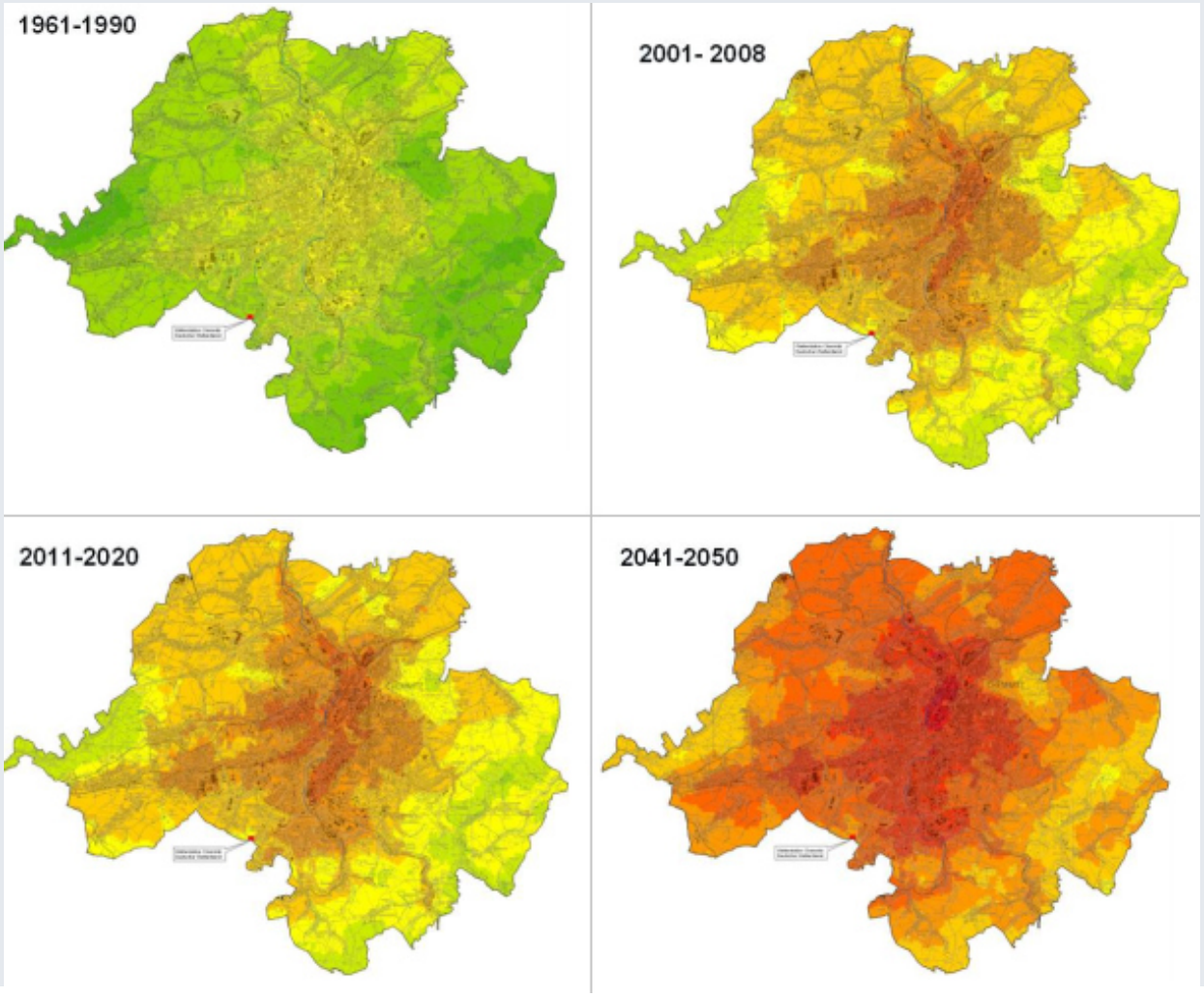


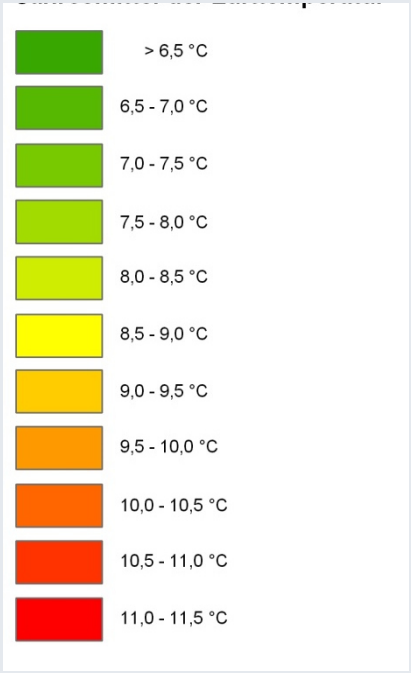
Hazard-/ Risk Analysis

Main Hazards:

- climate extrema, especially heavy rain, hailstorm, moderate temperature increase
- changes in the water balance and resulting impacts for fauna and flora due to reduced groundwater recharge
- increase of UV-radiation (impact by irradiation)
- increase of the fire risk (temperature increase, soil drying)
- impacts on the soil nutrition balance, risk of nutrient and/or pollutant mobilisation
- increase of the population of weeds and /or parasites by increase of the duration of the vegetation period and better winter survival conditions

Climate Diagnosis and Climate Prognosis





Annual average of air temperature

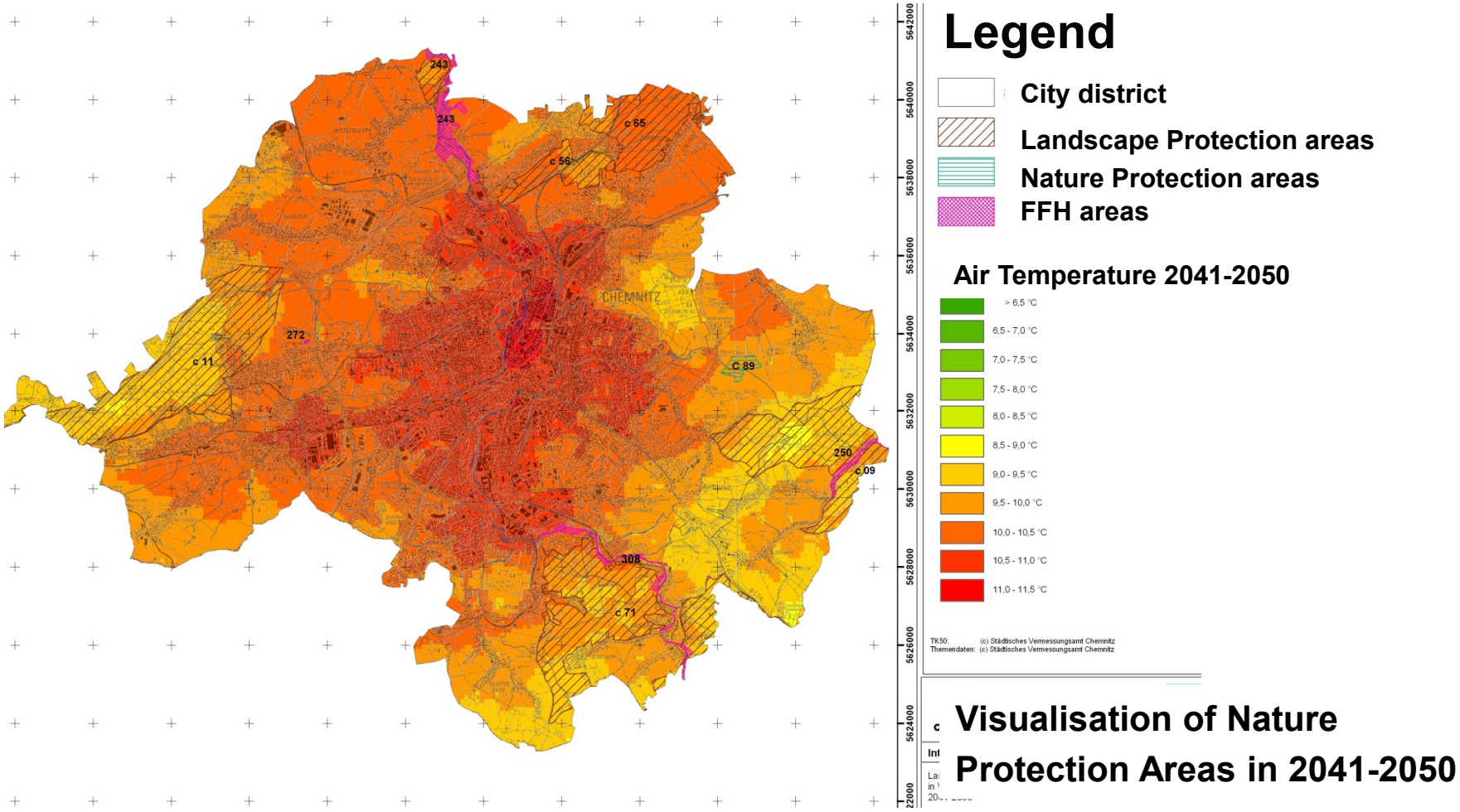
1961-90: Climate Station of German Weather Station around 7,5°C

2011 – 2050: WEREX prognosis data, downscaled to Chemnitz City

→ Centre of city around 9°C

(Schneider, et. al. 2011; DOI 10.1007/978-94-007-0785-6_31)

Temperature Prognosis Maps



Visualisation of Nature Protection Areas in 2041-2050

(Schneider, et. al. 2011; DOI 10.1007/978-94-007-0785-6_31)

Bioclimate Risk Assessment

The bioclimate decribes the climate, as it influences, and is influenced by, biological organisms → the totality of all factors of the climate affecting living organisms.

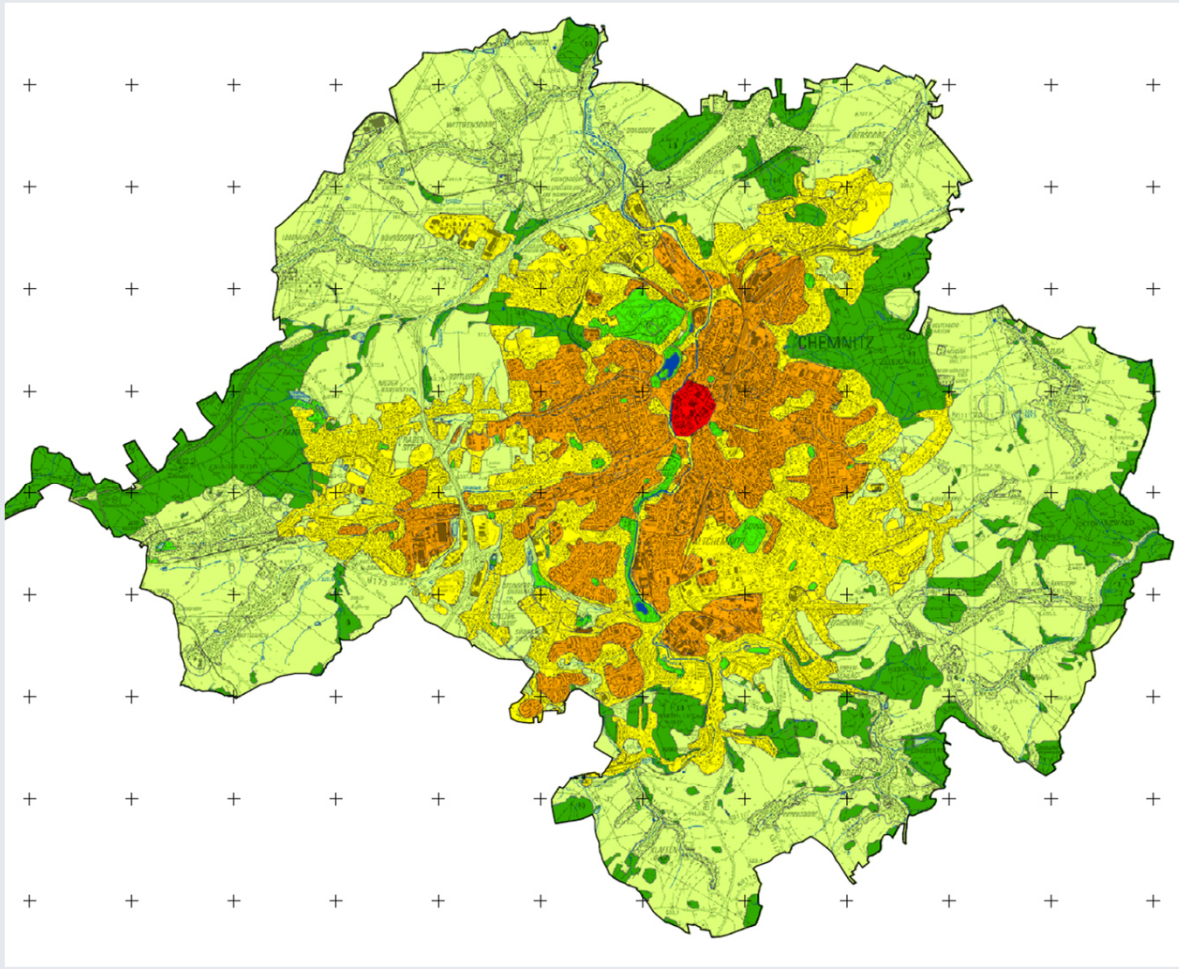
Bioclimatic variables are derived from the monthly temperature and rainfall values in order to generate more biologically meaningful variables.

Parameters determining the bioclimate are the Mean Predicted Vote Index (PMV), the Heat Index (HI) and the Windchill (WC).

The bioclimatic pressure was determined as dependent from height and the Homogeneous climate-response units (HCR Units).

In the urban climate of Central Europe, the bioclimatic sensation is shifted towards the increasing thermal pressure (in Chemnitz this is the city centre).

Homogeneous climate-response units



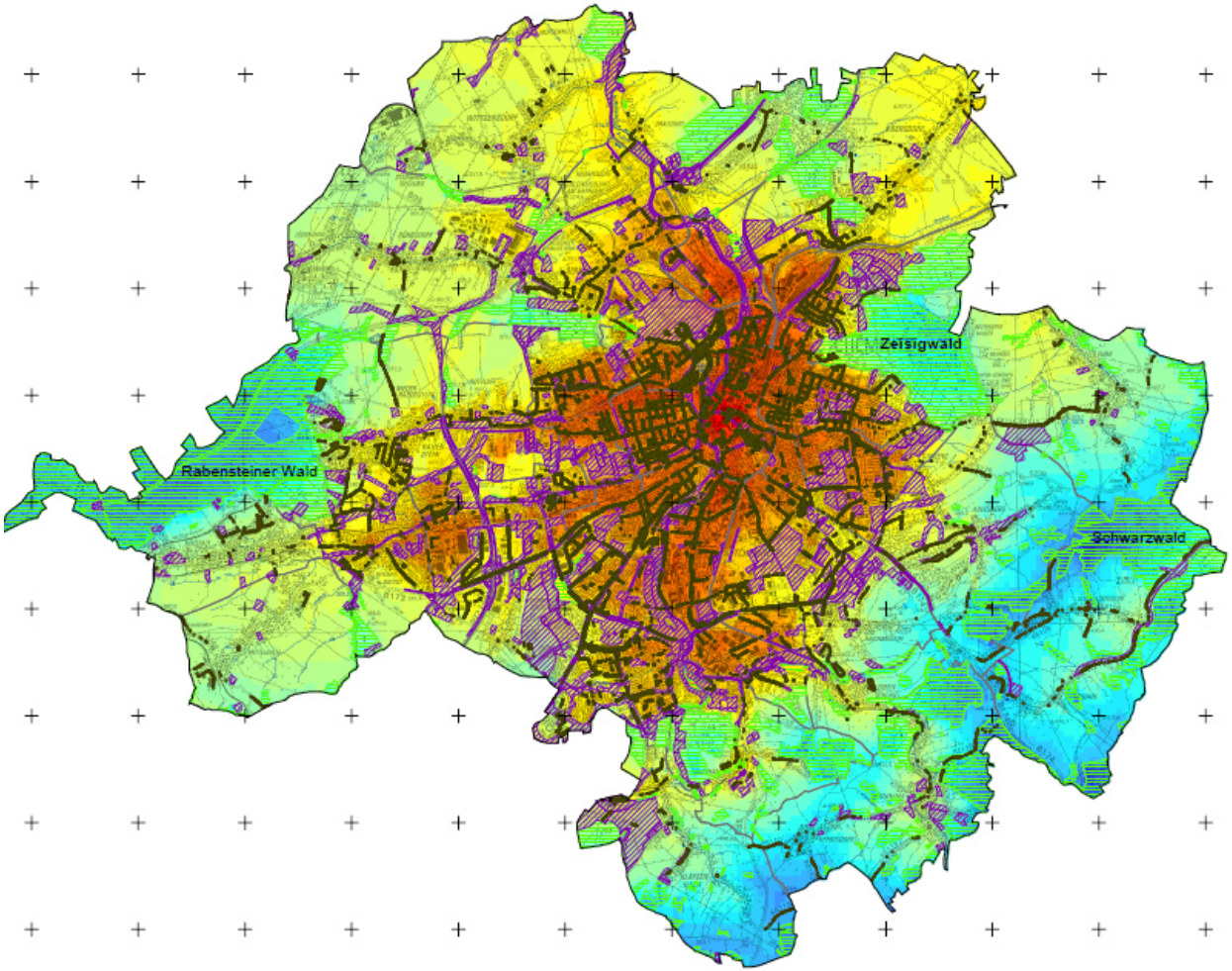
Legend

City border

Flächennutzung

- City center
- City
- City periphery
- Exterior
- City park
- Forest
- Lake or river

Bioclimate Risk Map
Urban Trees and Forest



Legend

- City district
- City border
- green space
- forest
- tree cadastre

Bioclimatic Risk

- Very low
- Small
- Moderate
- High

Adaptation
Measures in Progress

- Adaptation is fixed in the City Development Concept
- more greenspace – adapatation planning – resilient design
- Risk and catastrophy action plan, public awareness
- Integral training program for climate change and adaptation
- Increase of the use of renewable energy:
  - to reach 30 % power generation
  - to reach 14 % heat generation
- Target: reduction of CO_2-emissions per inhabitant to 2,5 t/a
- Traffic Development Concept, Air Protection Plan
- Establishment of cycling path concept
- City of Chemnitz is member in the Climate Association participating in several climate protection activities

Adaptation Plan for the City

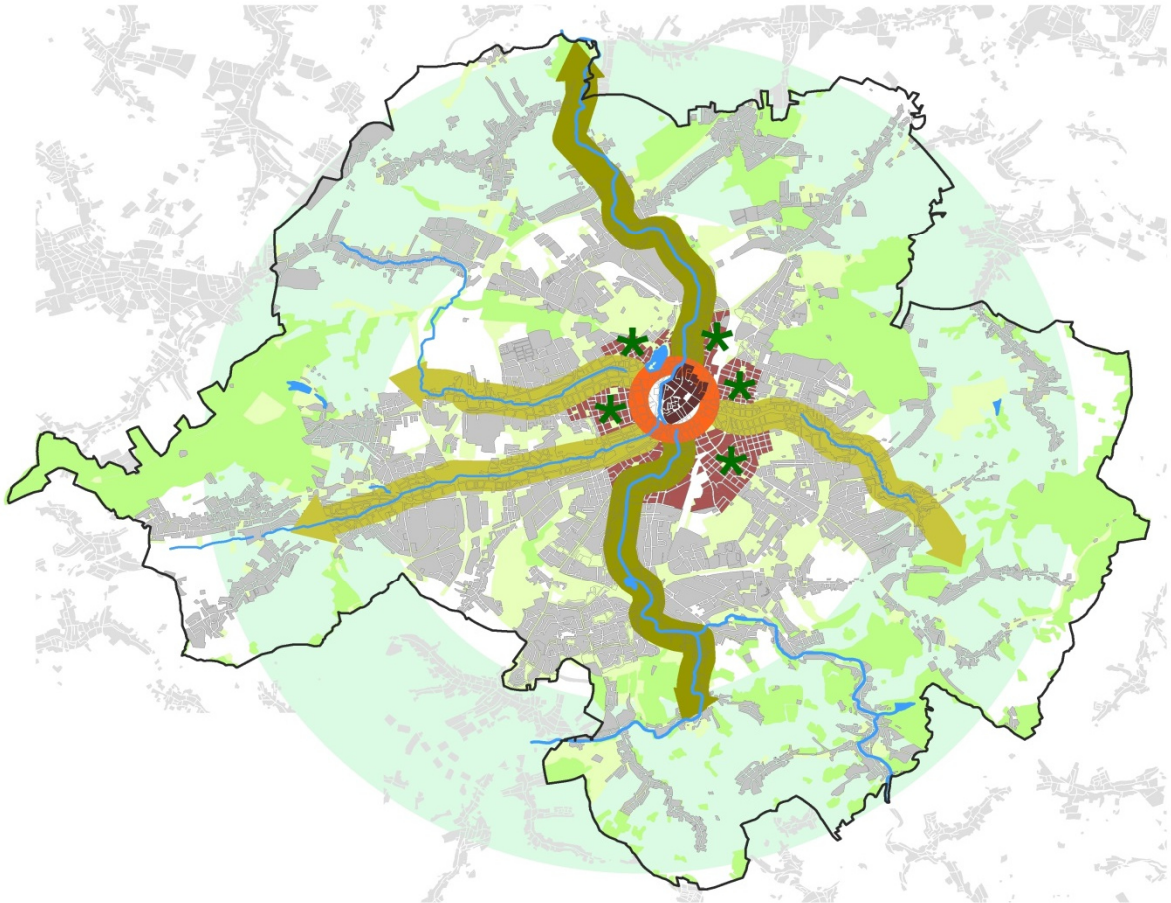
Implemented Measures

- Communal buildings:
  - internal/external trainings for energy saving methods
  - Instruction on the thrifty use of energy and water
  - Construction/sanitation of buildings in low energy standard
  - Energetical assessment of communal properties
  - Monthly control of the heating and power consumption since 1993
- Conversion of public lithing (energy saving lamps, pilot testing LED)
- Evaluation of CO_2-balances
- Support of the use of renewable energy for citizen (for instance photovoltaic systems, provision of communal roof space)

Implemented Measures

- support public transport, provision of bicycles for employees in the public sector, creation of a pedestrian friendly infrastructure
- solar- and gas fuel stations, charging stations, speed limits
- pilot projects since 2006:
  - traffic: agenda forum mobility
  - biodiversity: Environmental Centre, agenda 21, adaptation garden
  - Environmental Centre / Agenda Office with Protestant Centre „Society in times of climate change and lack of resources“
  - Public workshop „Energy efficiency versus buildings conservation?“
  - Public workshops on electromobility (2013, 2014, 2015)
- energy consulting for citizens

City Development Concept



City Development Concept 2020

Development of green space

- Green ring
- Green belt with connecting function
- Green belt with zoning function
- Pilot project for green space in the centre
- create more green space
- Permanent structural greenspace
- city centre

Thank you! Questions?