MikroModell
Stoffe im Fluss

Development of a mass balance model and guidelines for reducing emissions of micro pollutants with regard to water quality

The "MikroModell" project: substances screening and modelling in Dresden, Chemnitz and Plauen (Germany)

Peter Krebs, **Jörg Seegert** *et al.*
Technische Universität Dresden

NonHazCity seminar – Turku, 30 May 2017

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GELSENWASSER GAS. STROM. NATÜRLICH WASSER.

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DRESDEN

- since 1206

Photos: www.dresden.de


Technische Universität Dresden
- since 1828
TECHNISCHE UNIVERSITÄT DRESDEN
Photo: TUD/Eckold

Challenges

- up to 70.000 new chemical substances each day
- 100.000 (OECD) / 30.000-70.000 (daily use) // 5.000 environmental relevant or rather harmful!
- **how to handle?**
- precautionary measures / polluters pay principle vs technological measures (4. sewage treatment)
- ecological-economic / legal aspects
- role of the consumers / public?
- political debate

Project partners

Technische Universität Dresden

Institute of Urban Water Management

Institute of Hydrobiology

Institute of Water Chemistry

Institute of Clinical Pharmacology and Therapies / Research Network Public Health

Chair of Economics (betriebliche Umweltökonomie)

Technische Universität Bergakademie Freiberg

Professorship of Public Law (Öffentliches Recht)

Zweckverband Wasser und Abwasser Vogtland, Plauen

Eins energie Sachsen, Chemnitz

Stadtentwässerung Dresden GmbH

Project funding

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Plauen (Vogtland)

Dresden

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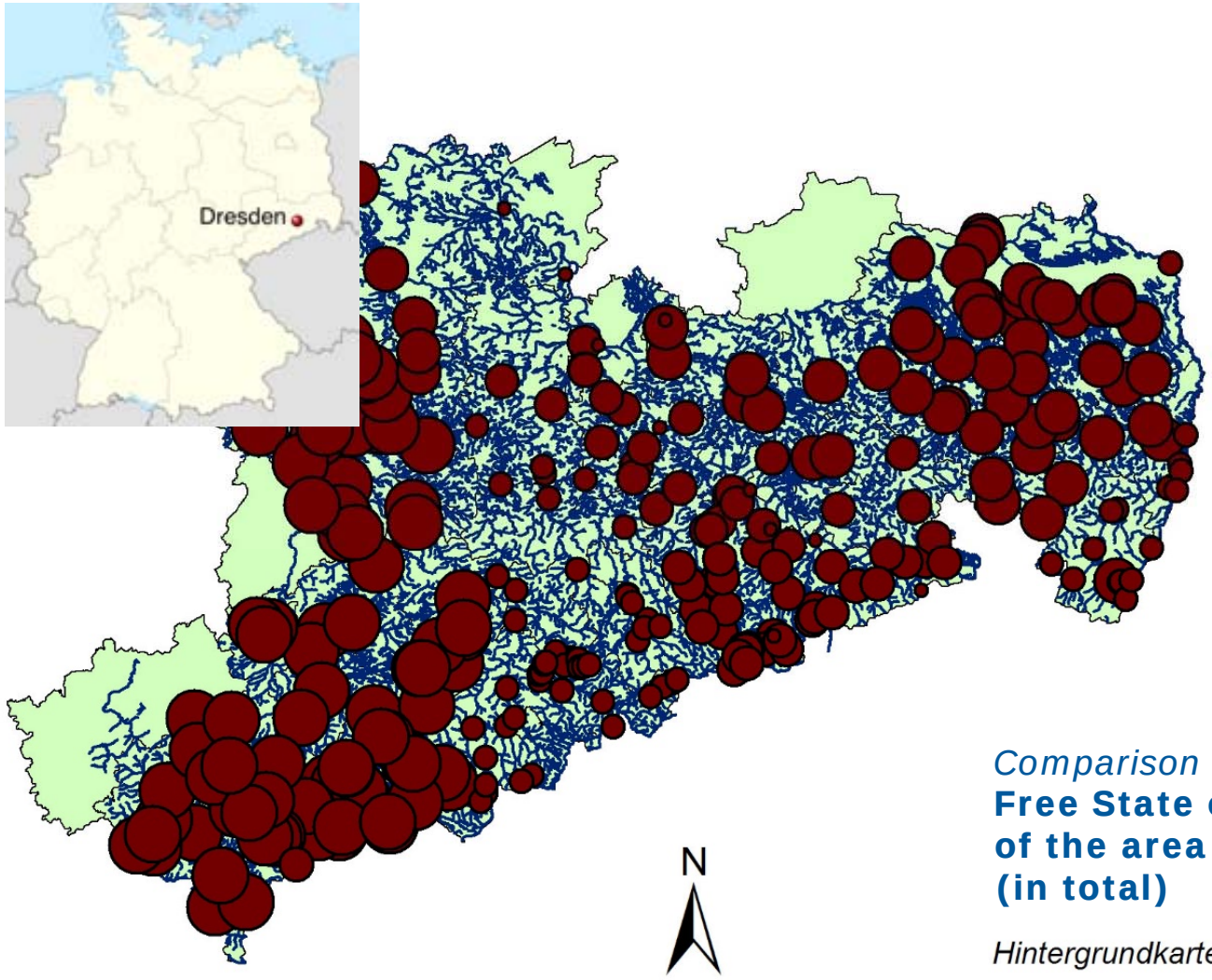
Project area (of investigation)

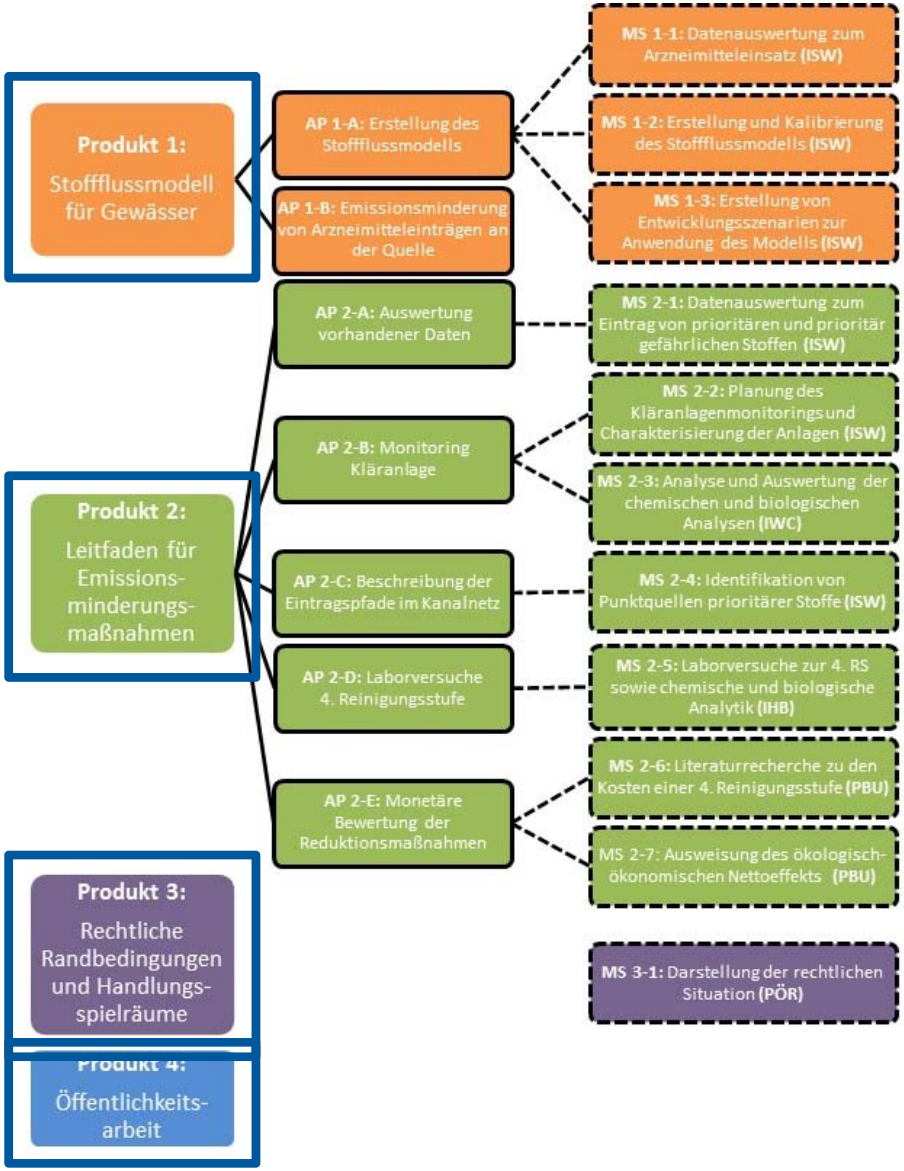


Comparison of scale

Free State of Saxony ~ 5 %
of the area of Finland / Germany
(in total)

Hintergrundkarte Freistaat Sachsen [ArcGIS, 2015]

Project structure / objectives



> four products

(1) development of a mass balance model

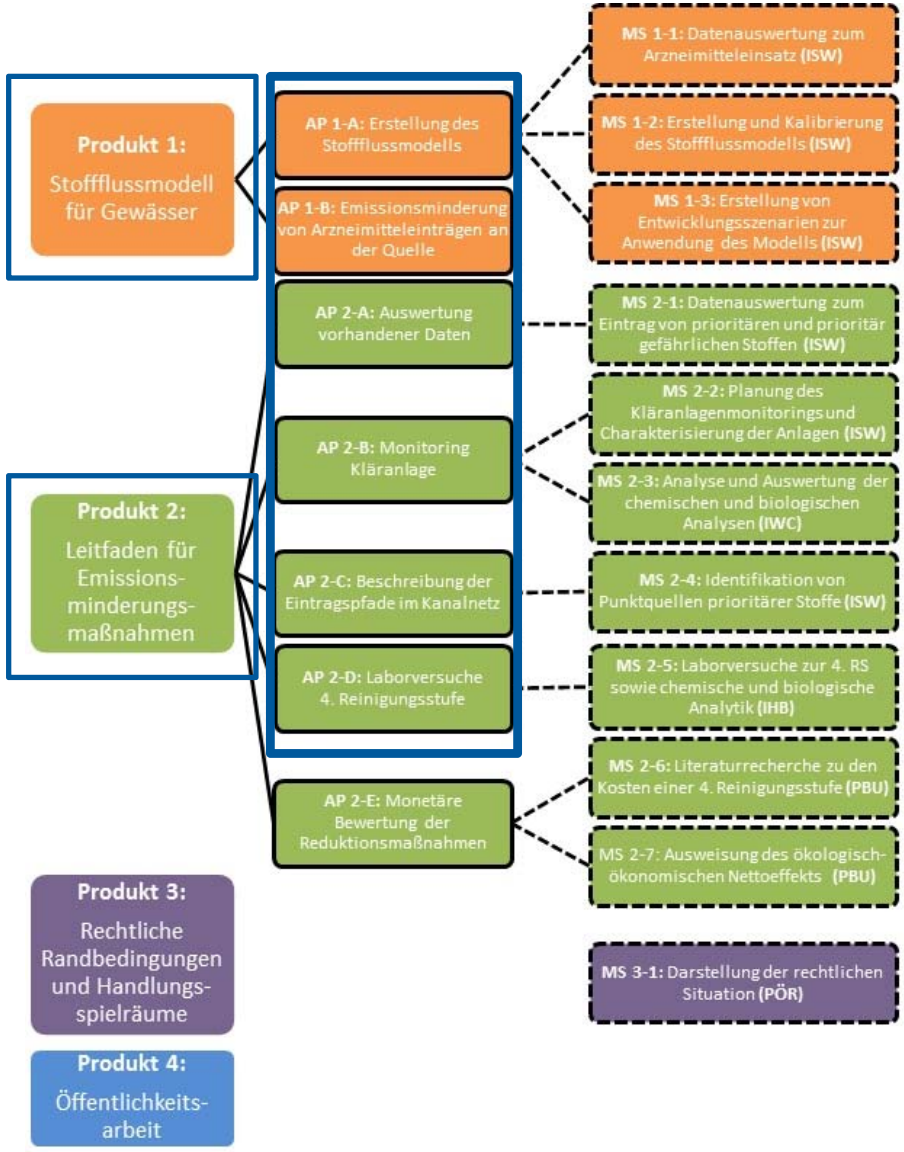
(2) guidelines for reducing emissions of micro pollutants - monitoring

(3) regulatory framework (law)

(4) public relations

with various corresponding ***work packages*** *and* ***milestones*** *resp.*

Project structure / objectives



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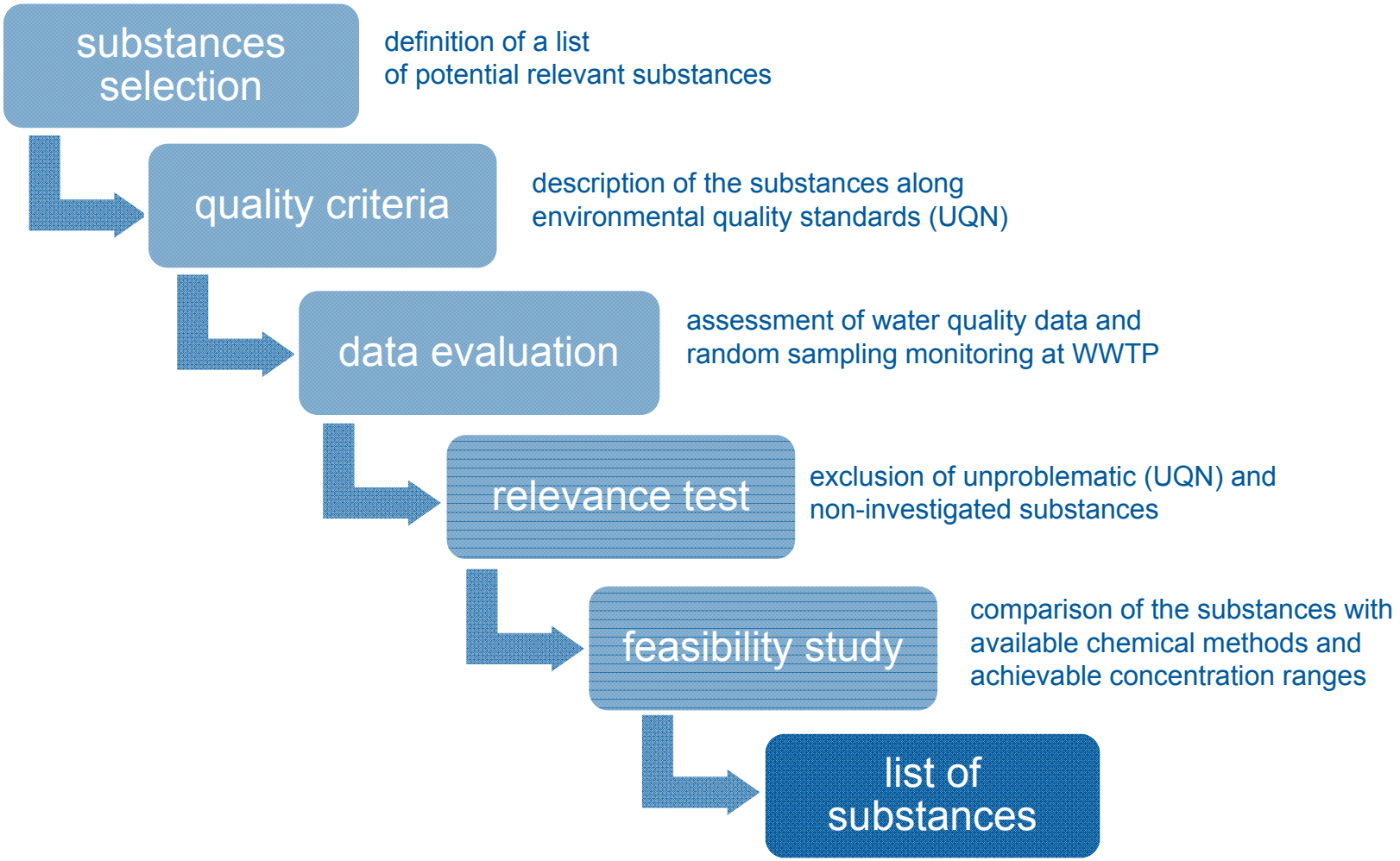
with various corresponding ***work packages*** *and* ***milestones*** *resp.*

Topics

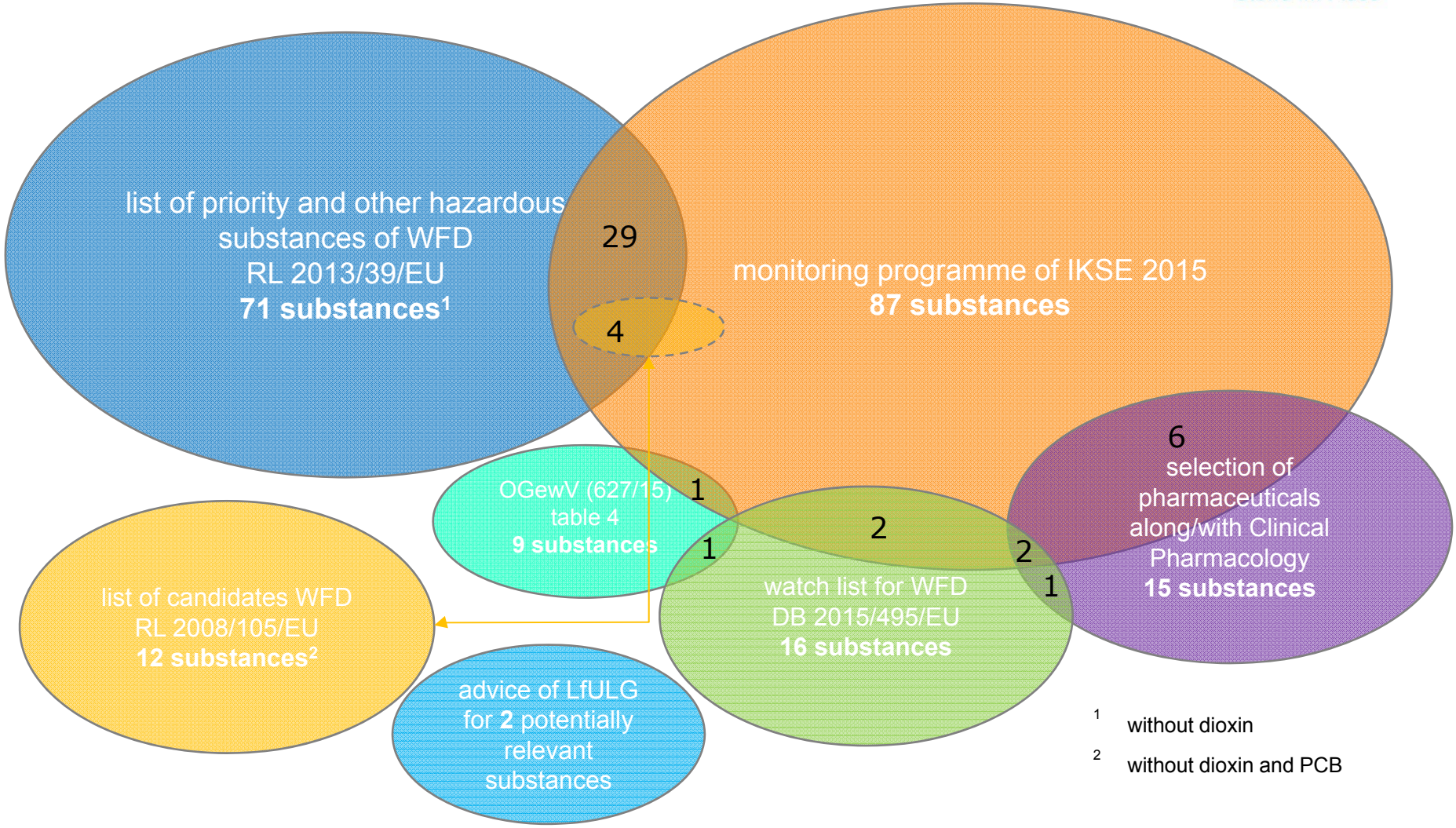
- selection of substances
  for monitoring as well as modelling
- monitoring (preliminary results)
- modelling aspects (preliminary results)
- institutional settings
  for additional monitoring/screening actions

> **focusing mainly on <u>methodological</u> aspects**
due to missing/not yet confirmed results

Method/s of substances selection



Selection of priority substances



∑ 159 substances for alignment with river quality data of Chemnitz, Elbe & Weißer Elster!

53 substances to investigate

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8 PAC
Fluoranthen
Benzo(a)pyren
Benzo(b)fluoranthen
Benzo(ghi)perylen
Benzo(k)fluoranthen
Benzo(a)athracen
Pyren
Indeno(1.2.3-cd)pyren

5 industry and household chemicals
Perfluoroctansulfonat (PFOS)
Perfluoroctanoat (PFOA)
Benzotriazol (Korrosionsinhibitor)
Tolyltriazol (Korrosionsinhibitor)
4-Nonylphenol

15 pharmaceuticals
Ibuprofen
Diclofenac
Paracetamol
Naproxen
Metoprolol
Sulfamethoxazol
Eurytromycin
Clarithromycin
Ciprofloxacin
Bezafibrat
Gabapentin
Carbamazepin
Metformin
Iomeprol
Fluoxetin

19 pesticides and biocides
Diuron (Herbizid)
Isoproturon (Herbizid)
Terbutryn (Biozid)
Metazachlorsäure (Herbizid)
Metazachlorsulfonsäure (Herbizid)
Metolachlorsulfonsäure (Herbizid)
Dimethachlorsäure (Herbizid)
Dimethachlorsulfonsäure (Herbizid)
2-Hydroxy-Terbuthylazin (Herbizid)
Imidacloprid (Insektizid)
Dimethoat (Insektizid)
Nicosulfuron (Herbizid)
p,p-DDT (Insektizid)
pp-DDE (Insektizid)
p,p-DDD (Insektizid)
o,p-DDD (Insektizid)
Dicofol (Akarizid)
Hexachlorbenzen (Fungizid)
Irgarol (Biozid/Fungizid)

3 heavy metalls
Cadmium
Nickel
Quecksilber

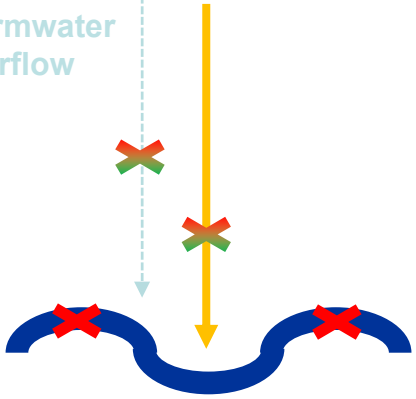
1 food additives
Acesulfam (Süßstoff)

2 hormones
17β-Estradiol
17α-Ethinylestradiol

Monitoring at Wastewater Treatment p.

KA Plauen
110.000 EW (CSB)

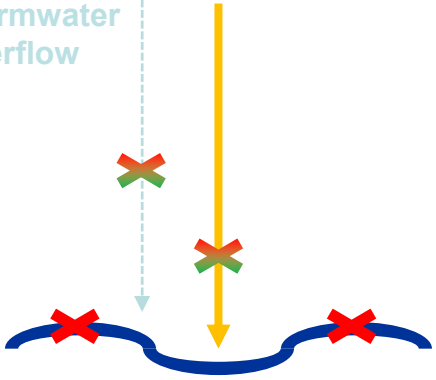
stormwater overflow



Weiße Elster, MNQ = 1,8 m³/s

KA Chemnitz-Heinersdorf
280.000 EW (CSB)

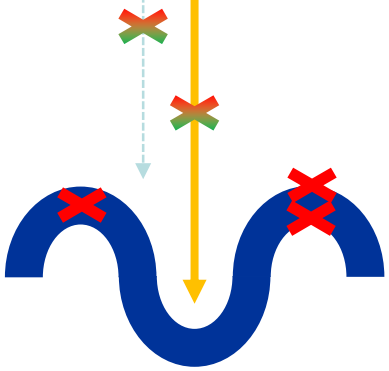
stormwater overflow



Chemnitz, MNQ = 0,67 m³/s

KA Dresden-Kaditz
770.000 EW (CSB)

stormwater overflow



Elbe, MNQ = 106 m³/s

chemical monitoring

chemical/ecotoxicological monitoring

Monitoring (preliminary results)

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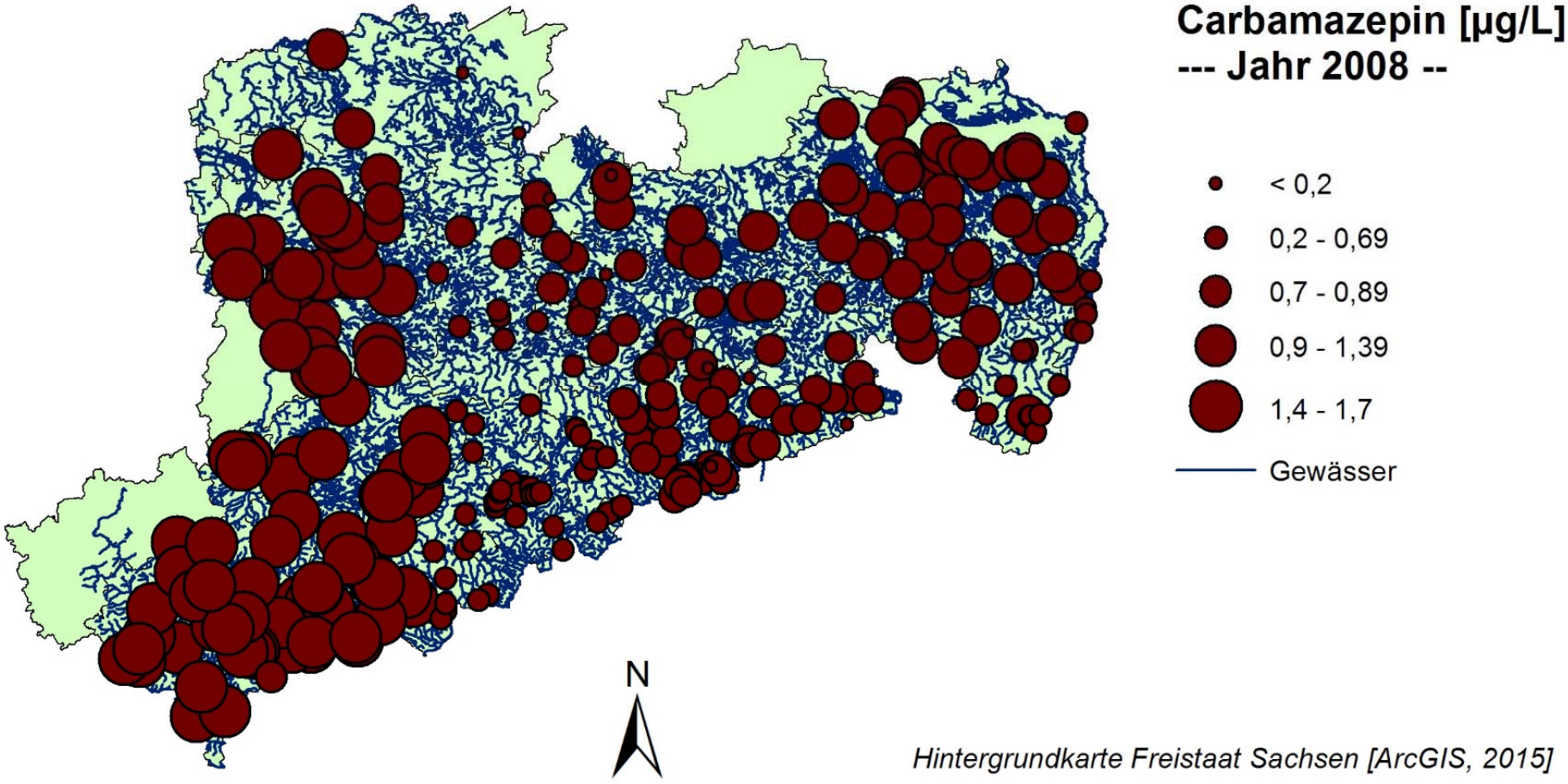
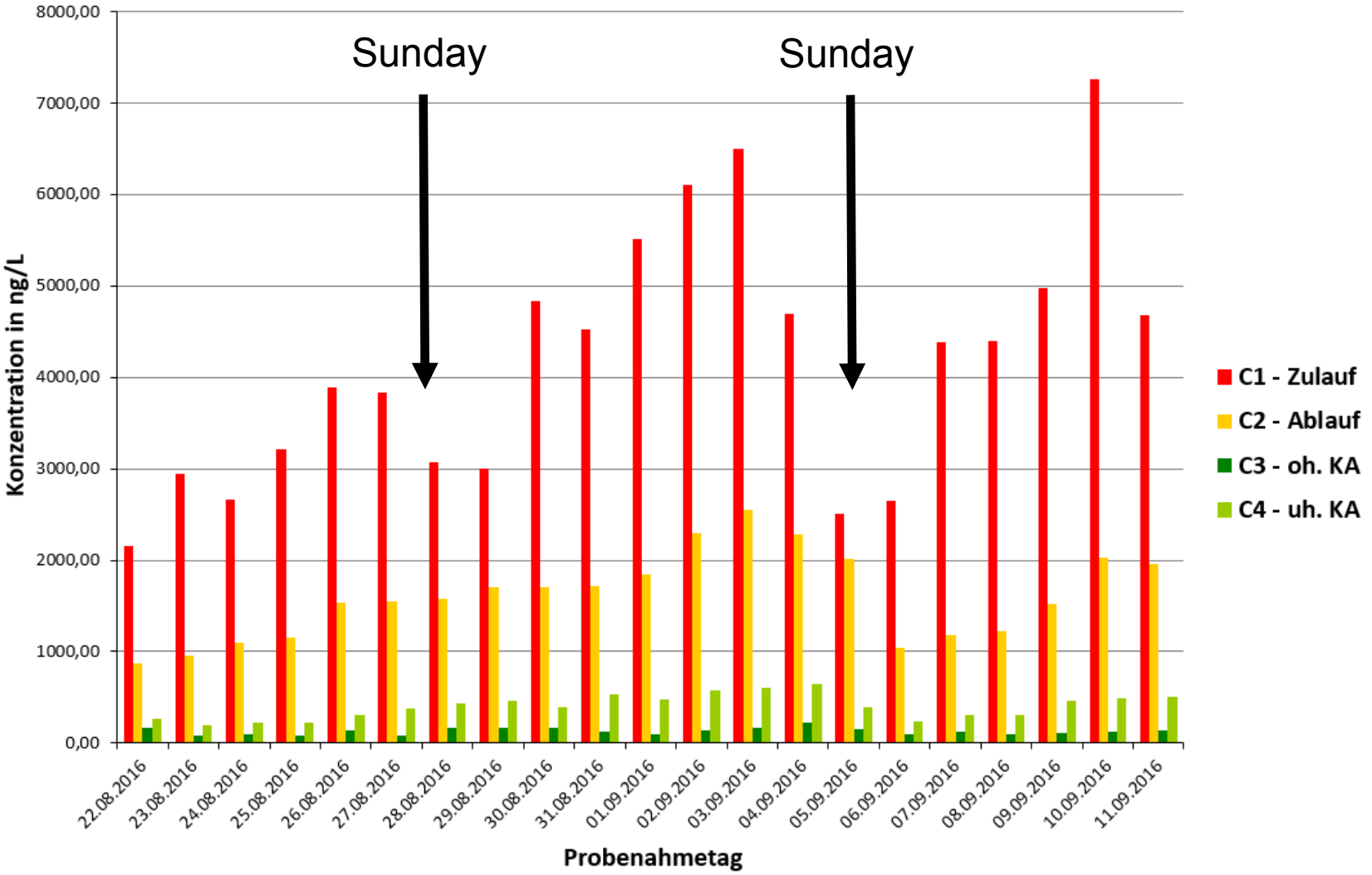


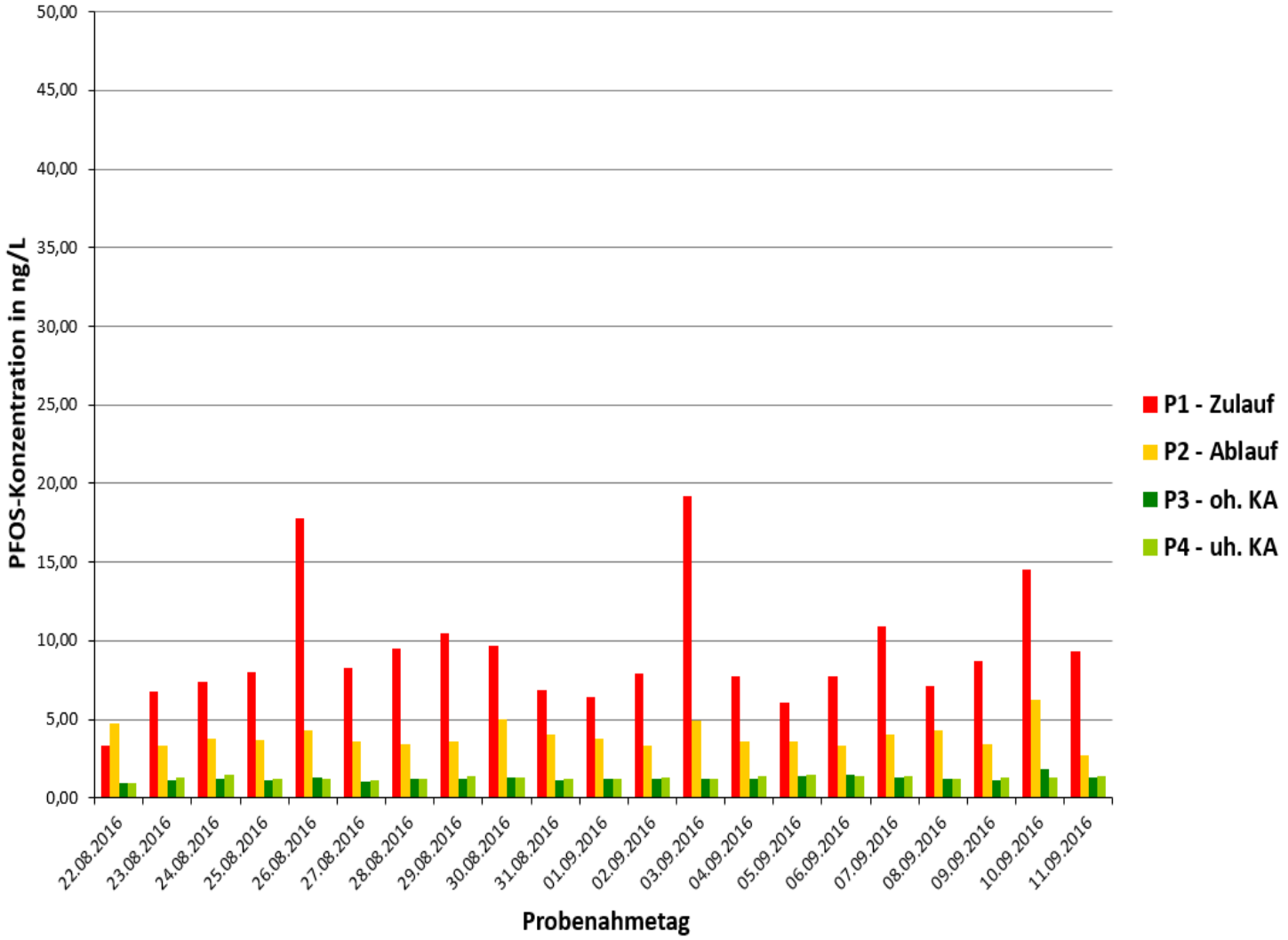
example/s: temporal resolution

(1H-Benzotriazol, Chemnitz)



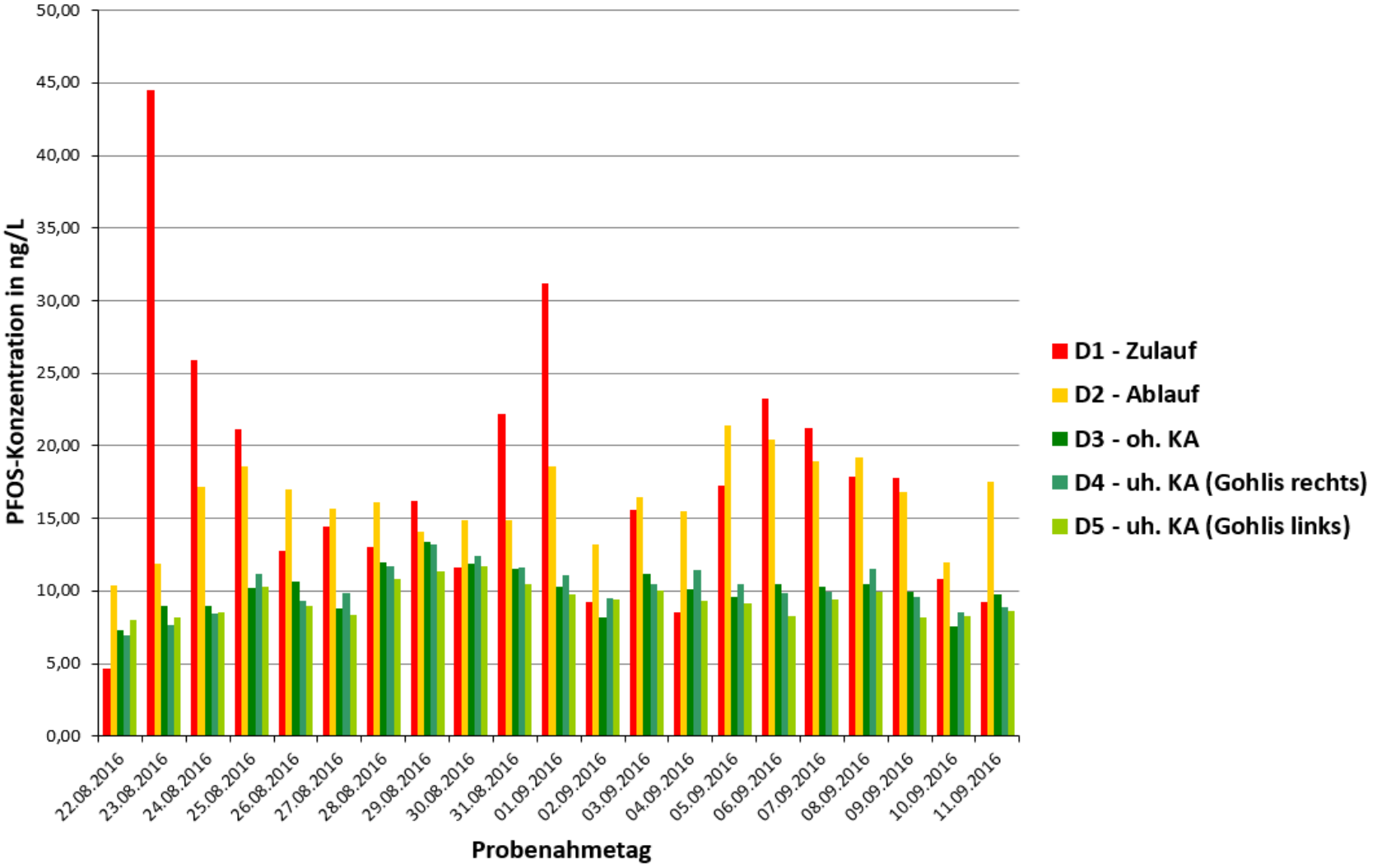
example/s: site specific differences

(PFOS, Plauen)



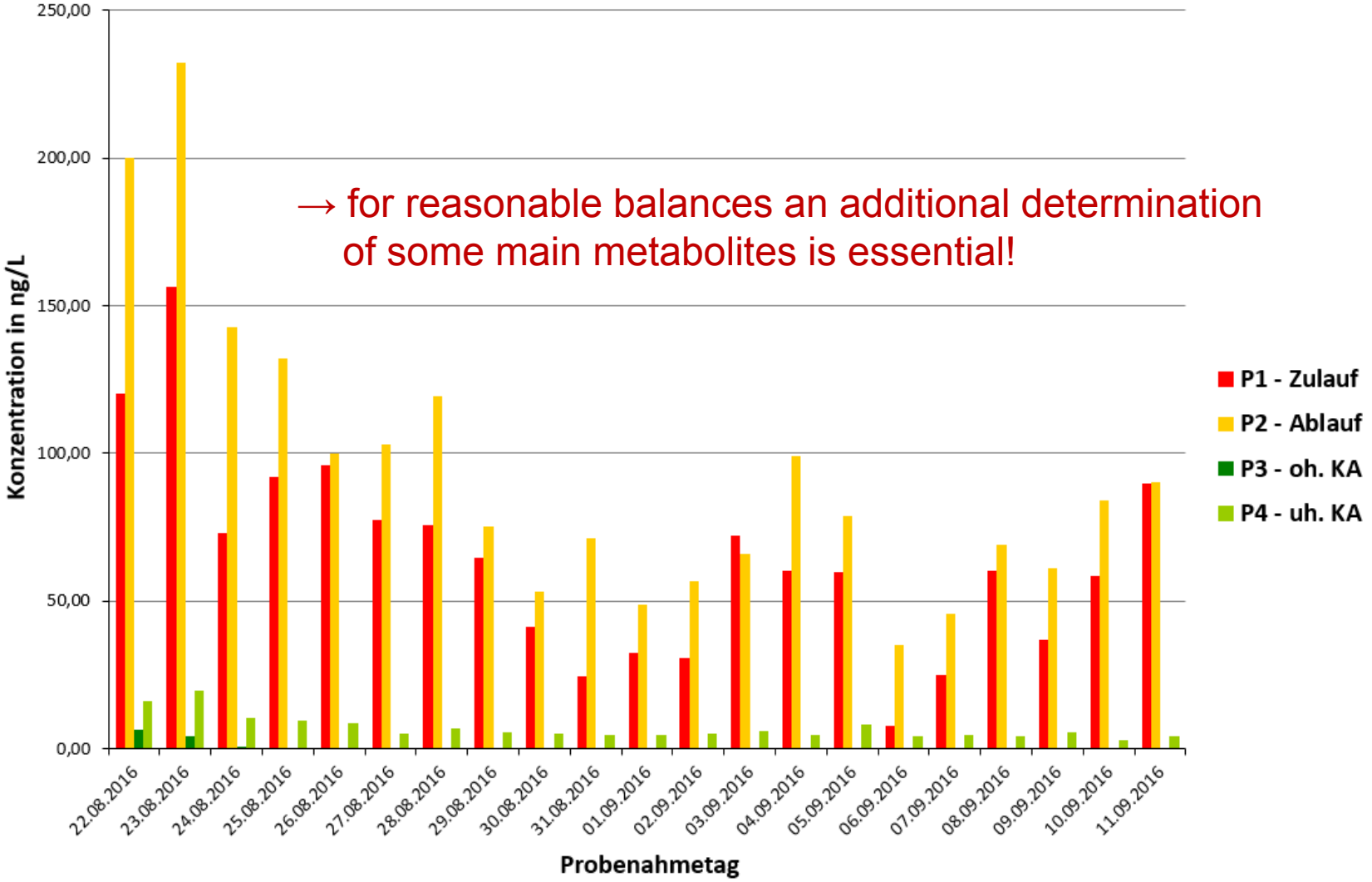
example/s: site specific differences

(PFOS, Dresden)

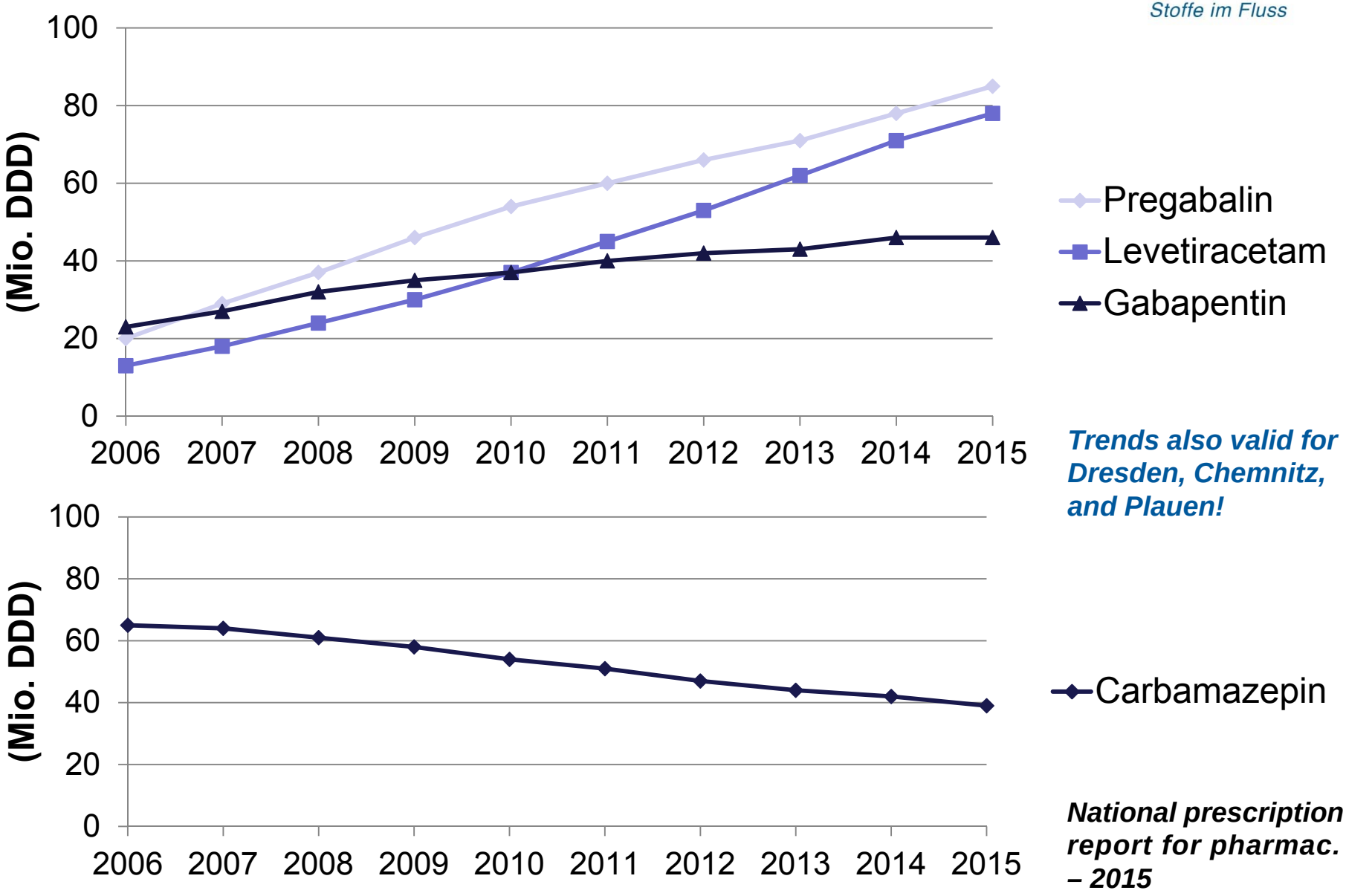


example/s: effects of metabolites

(Carbamazepin, Plauen)



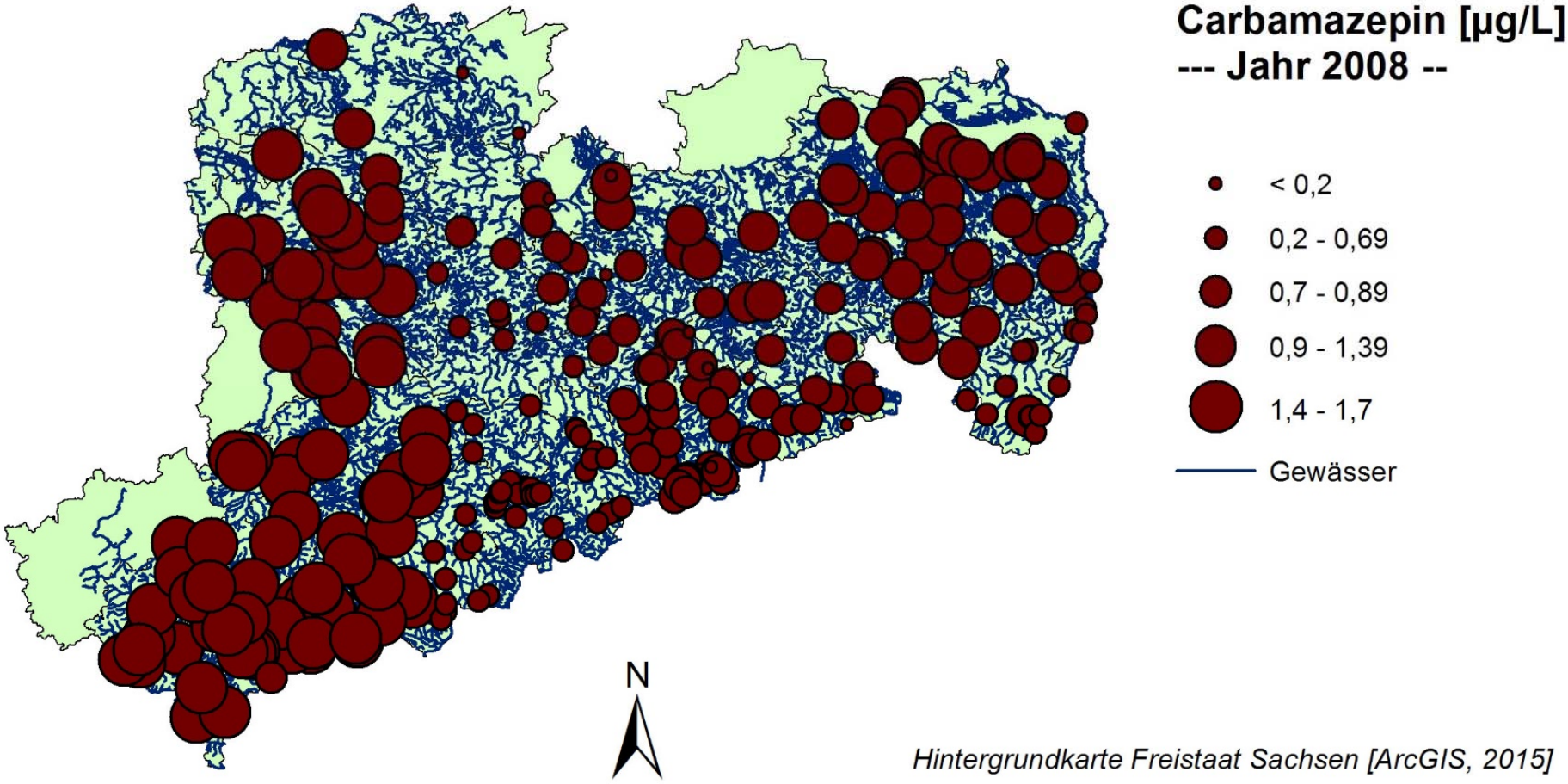
Trends of Antiepileptic for Germany



Trends also valid for Dresden, Chemnitz, and Plauen!

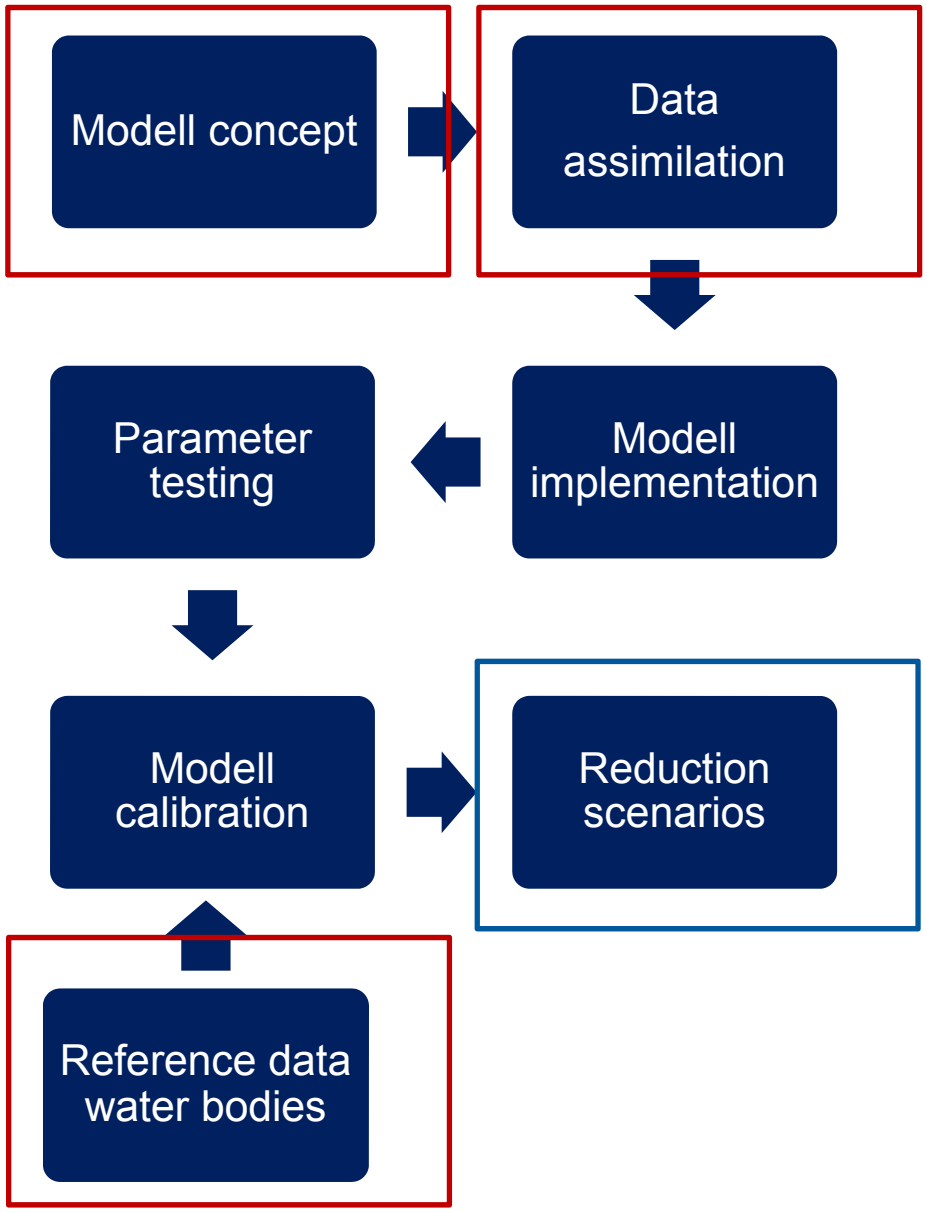
National prescription report for pharmac. – 2015

Modelling aspects



Hintergrundkarte Freistaat Sachsen [ArcGIS, 2015]

Methodological approach



- spatial-temporal differentiation for the prescription of pharmaceuticals in Saxony
  - reliable mass balancing
  - acute impacts
- data driven model development
  - identification of relevant (impact) parameters, e.g.
  - size of area, river water quality, excretion rate
- slight parametrisation of the mass balance model
  - less assumptions and variables, but significant information potential
  - gaining data and information by identifying patterns

Methodological approach

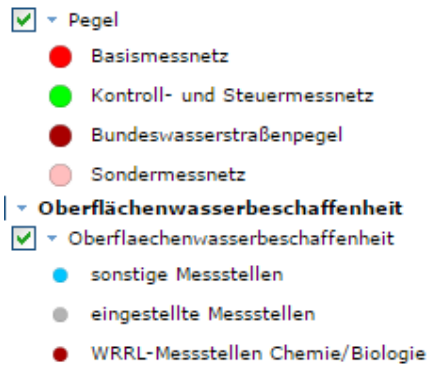
Input data for modelling

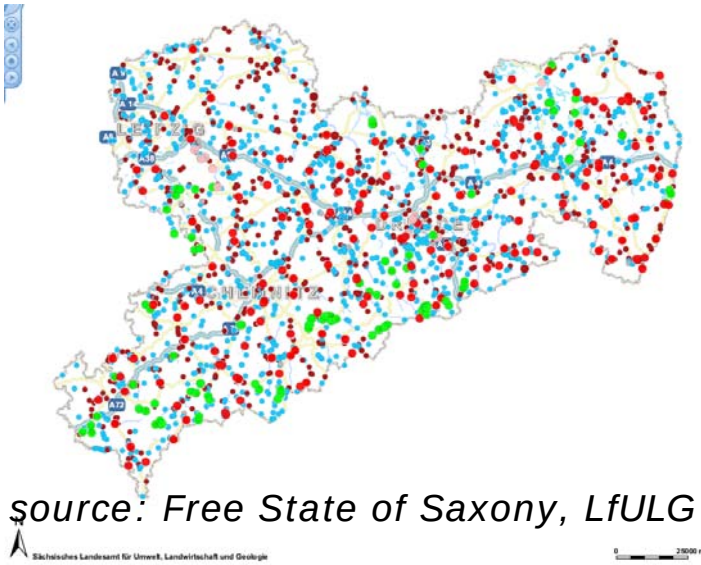
- inhabitants (Micro census)
- hospitals (carrying capacity)
- prescription (DDD) of pharmaceuticals
- number of insured people
- WWTP + connection rate
- river network

→ link through postal code or municipality

input data for mass balances

- data of subs. concentration:
  - 1003 monitoring spots
  - two weekly to quarterly
  - for rivers annually
- data of discharge:
  - 216 monitoring spots
  - daily basis



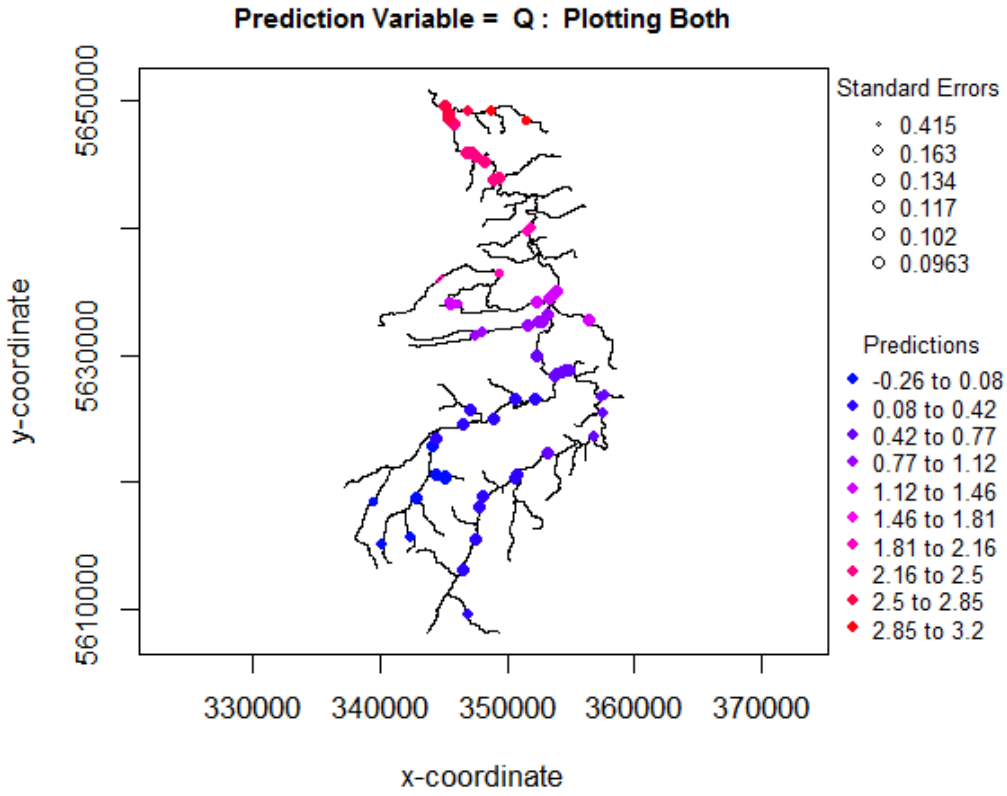


source: Free State of Saxony, LfULG

Mass balances (of Carbamacepin)

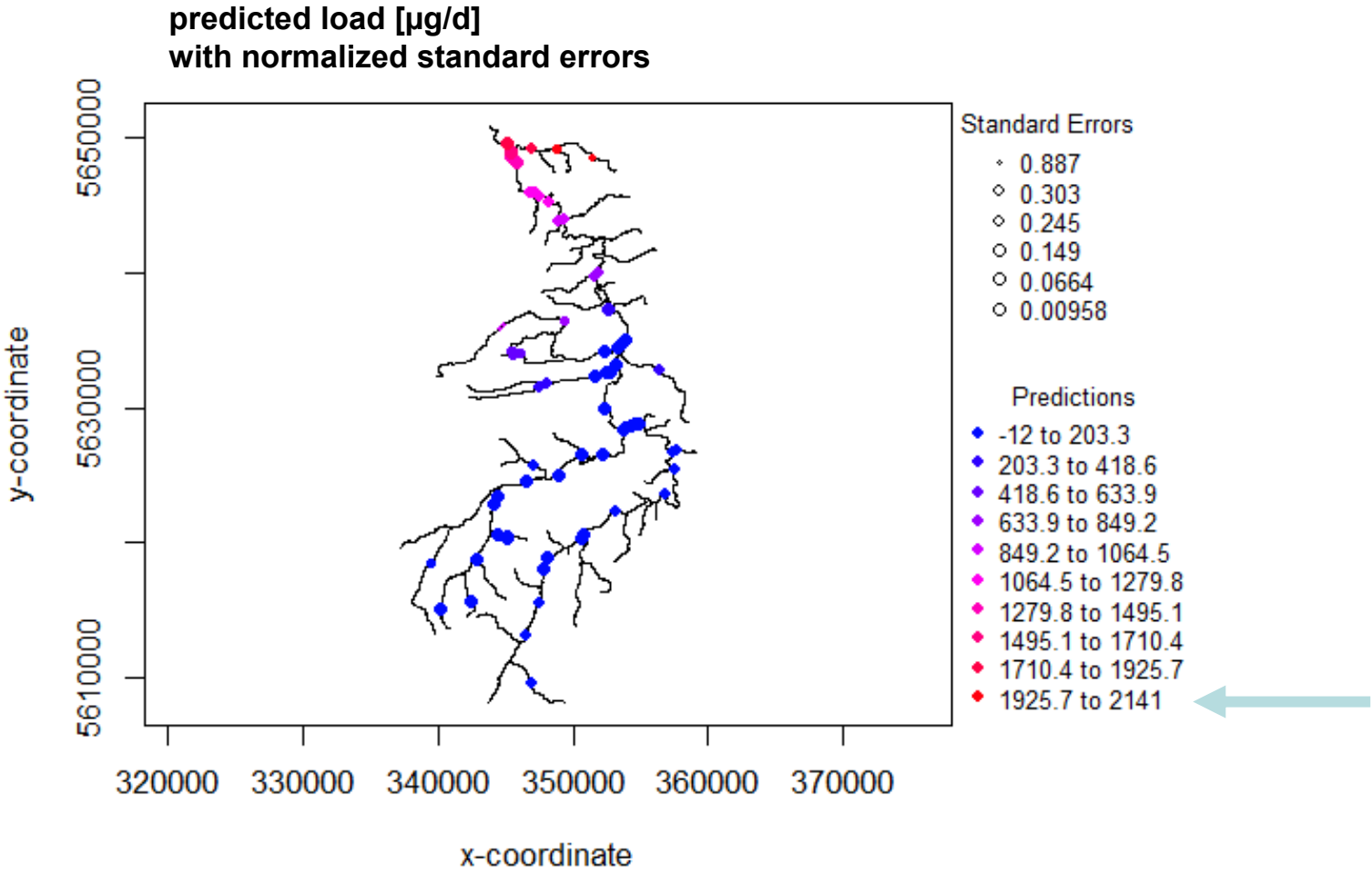
- Interpolation of **discharges** for water quality monitoring spots
- automatic optimisation of interpolation procedere
- mass balances from measured concentrations and measured / interpolated discharges
- very good fit

example: river basin of Chemnitz, 17.02.2014



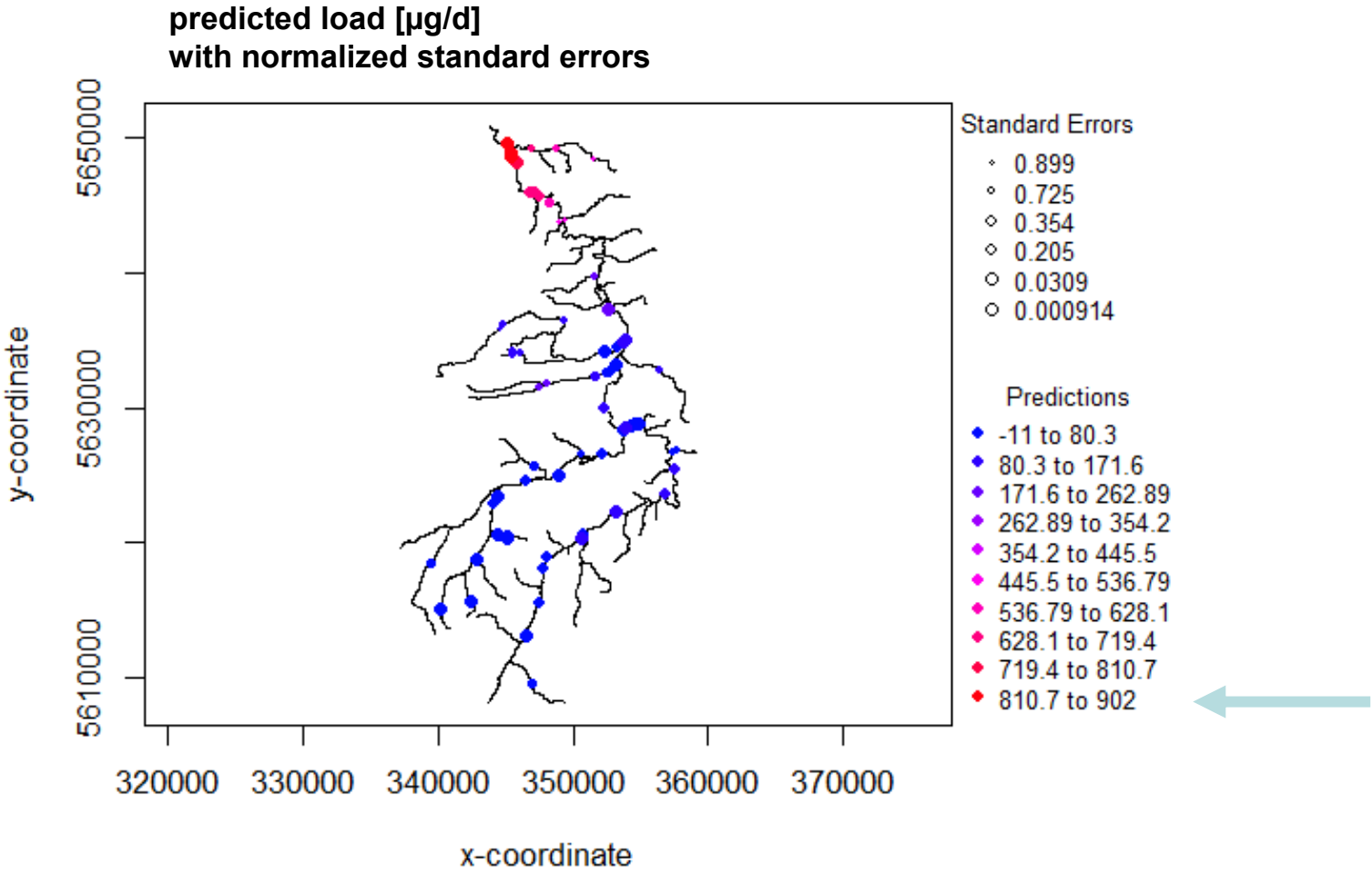
Mass balances

Carbamacepin, river basin of Chemnitz – 17.02.2014



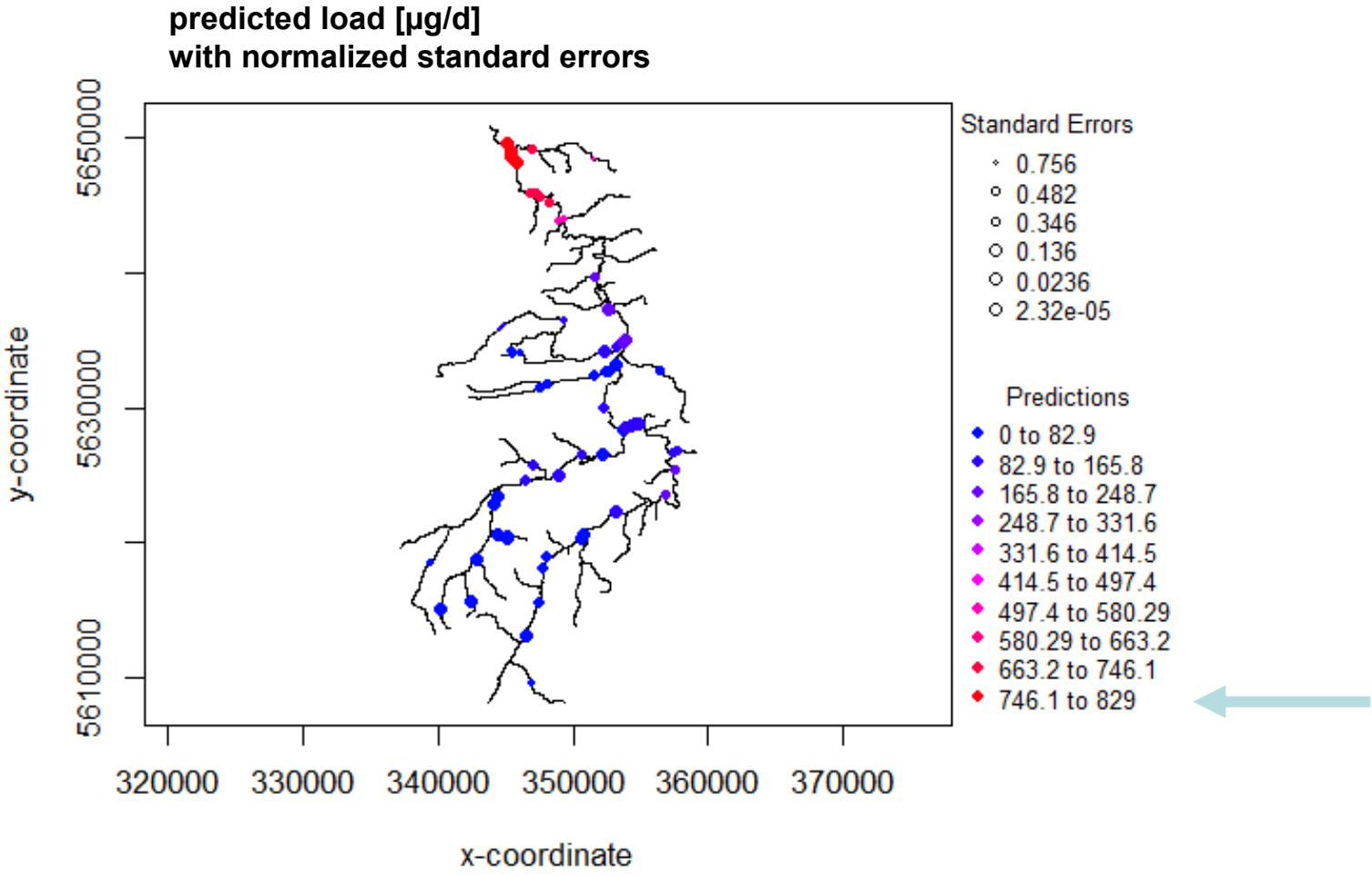
Mass balances

Carbamacepin, river basin of Chemnitz – 23.06.2014



Mass balances

Carbamacepin, river basin of Chemnitz – 27.10.2014



Institutional settings

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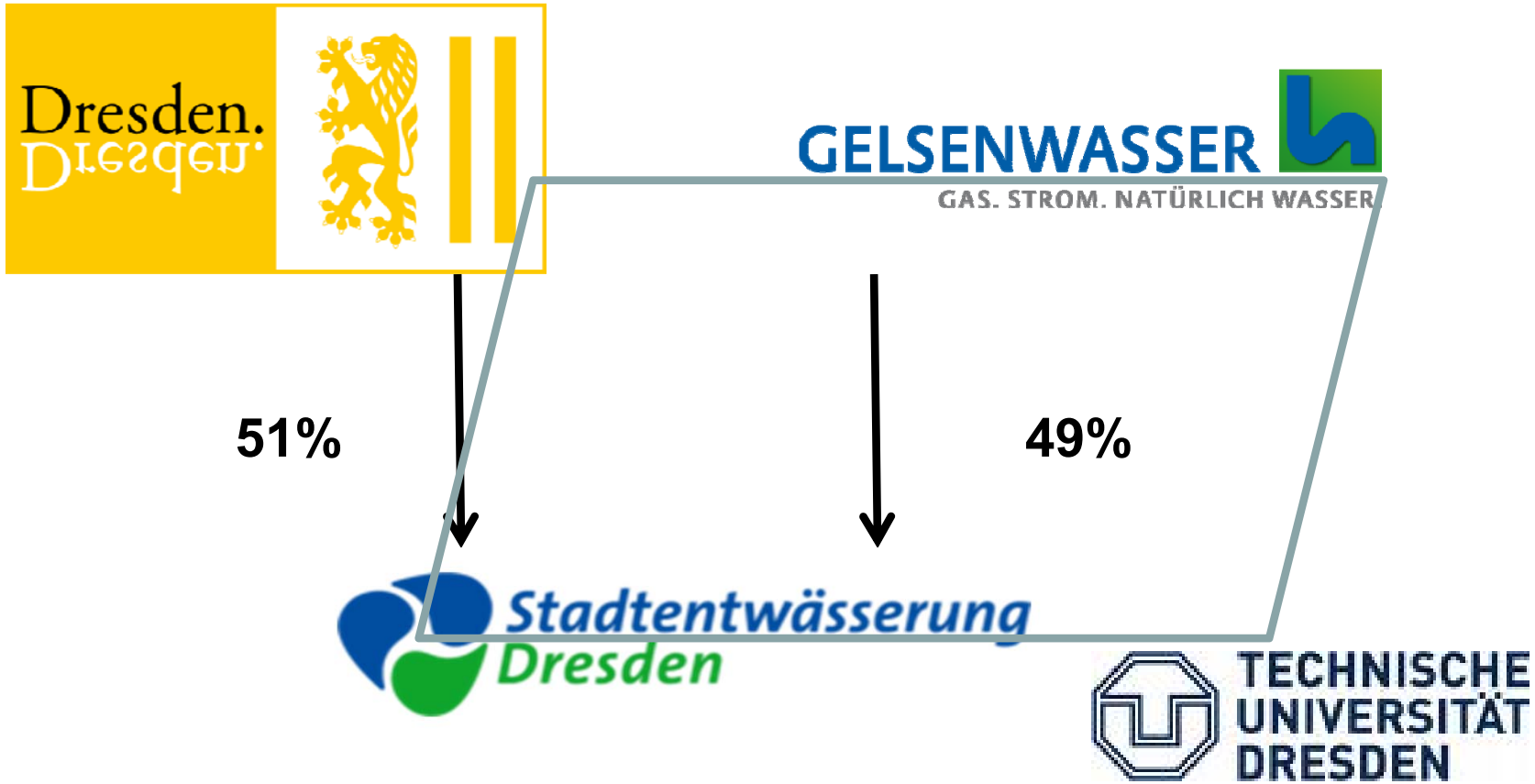
Public private partnership + science

Ehemalige Stiftungsprofessuren, die von der TU Dresden weitergeführt werden

Professuren	Zeiträume	Stifter
›Professur für Hydroverfahrenstechnik (ehemals Stiftungsprofessur für Industriewasserwirtschaft)	2014 - 2015 2006 - 2010	Gelsenwasser AG



Many thanks for your attention …

and of course to DBU, the Free State of Saxony and GELSENWASSER for the generous funding!

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