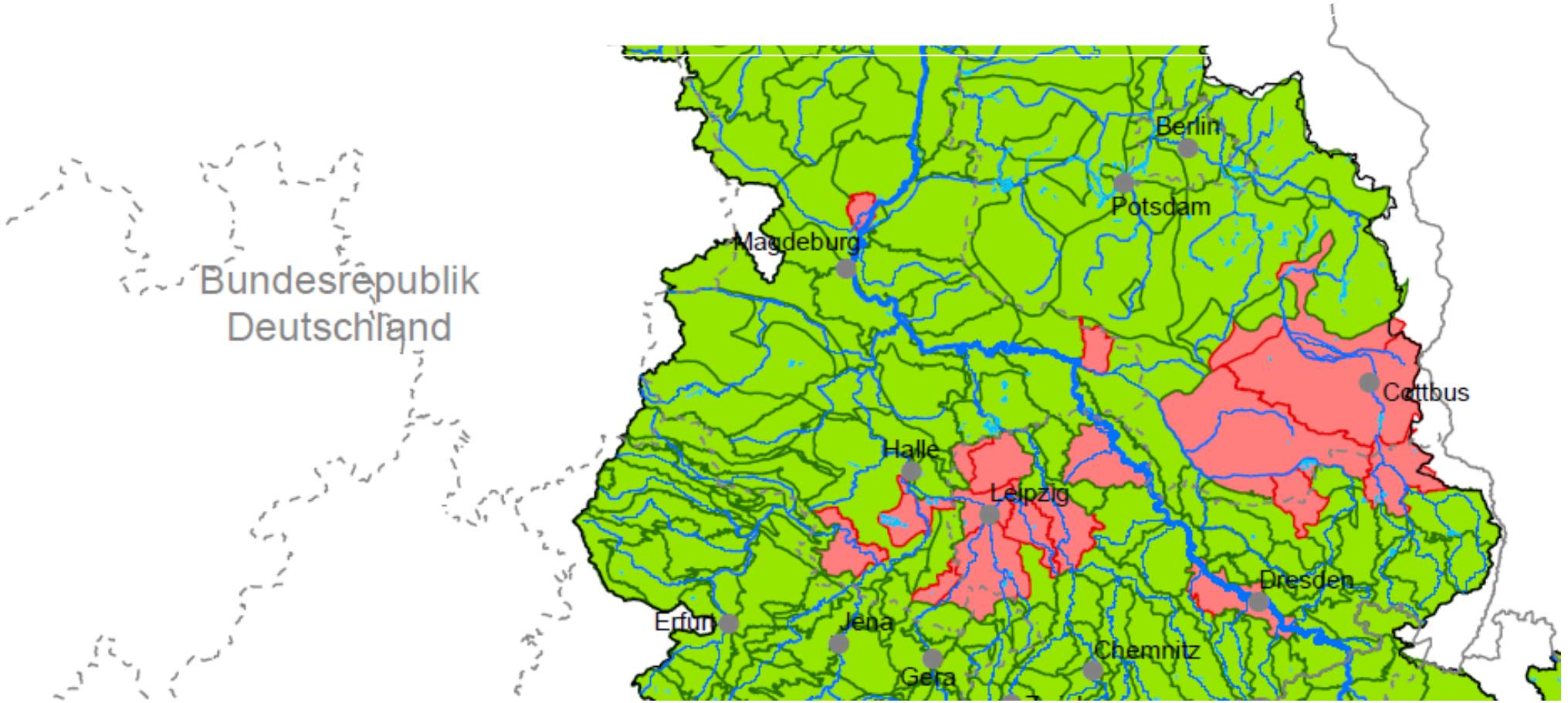
Quantitative management of groundwater bodies – Examples from Germany



Quantitative management of groundwater bodies – Examples from Germany

Structure:

1. Legal Basis
2. Common Methodology of the federal States
3. Groundwater Safe Yield
4. Example Lower Saxony
5. Example Saxony
6. Summary

1. Legal Basis

- **Water Framework Directive**
  - Article 4(b)(ii): „Member States shall … ensure a balance between abstraction and recharge of groundwater, with the aim of achieving good groundwater status …"
  - Annex V 2.1, Groundwater chemical status:
    - Parameter for the classification of quantitative status: Groundwater level regime
    - good quantitative status: the available groundwater resource is not exceeded by the long-term annual average rate of abstraction + …
- **German Water Act**
  - § 12 (1) No.r 1: The permit and the approval must be refused if ... harmful changes to the water body are to be expected which cannot be avoided or compensated for by additional provisions ...“
  - § 47 (1) No. 3: "... a good quantitative status includes in particular a balance between groundwater abstraction and groundwater recharge.“
- **German Regulation on Groundwater Protection**, § 4 (2) No. 1:

„The quantitative groundwater status is good if

1. the development of groundwater levels or spring discharges shows that the long-term average annual groundwater abstraction does not exceed the groundwater safe yield ...“

2. Common Methodology of the federal states

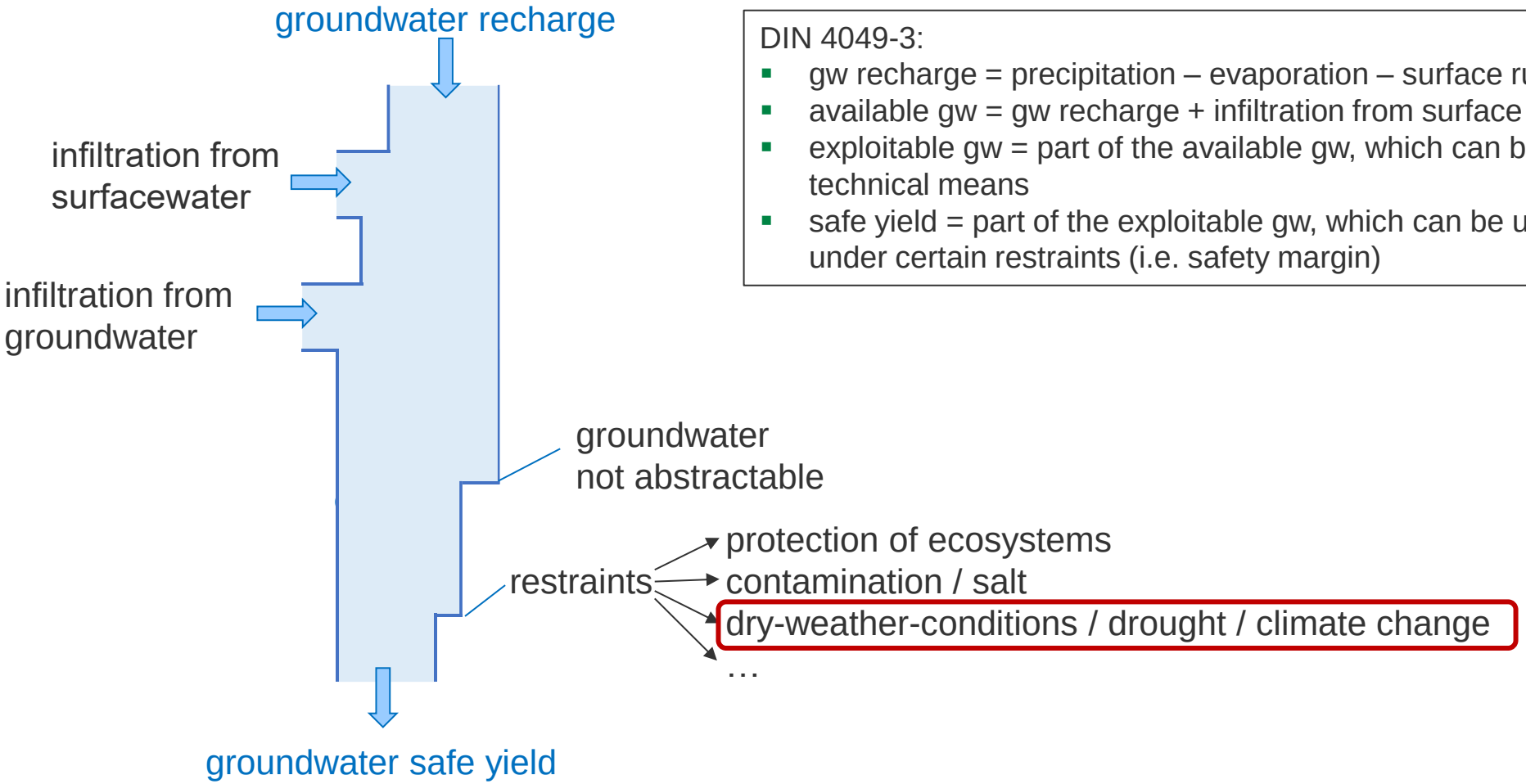
- Parameter for the classification of groundwater quantitative status
  a) Trend analysis of groundwater levels / spring discharges
  b) Water balance analyses of the groundwater bodies (approximate / detailed),
  c) associated surface waters,
  d) directly groundwater-dependent terrestrial ecosystems,
  e) salt intrusions

- Approximate water balance
  - Proportion (in %) of the long-term average annual abstraction quantities authorised under water legislation and long-term average groundwater recharge for the entire groundwater body:
    The total of the authorised extraction must not exceed
    1/3 of the long-term average groundwater recharge!
  - Groundwater recharge and total abstraction are calculated using country-specific methods..

- Detailed water balance
  - Comparison of authorised groundwater abstraction and groundwater safe yield (according to DIN 4049-3*) for the entire groundwater body:
    The total of the authorised extraction must not exceed
    the safe yield of the groundwater body

* Technical standard: Hydrology – Part 3: Terms for the quantitative hydrology

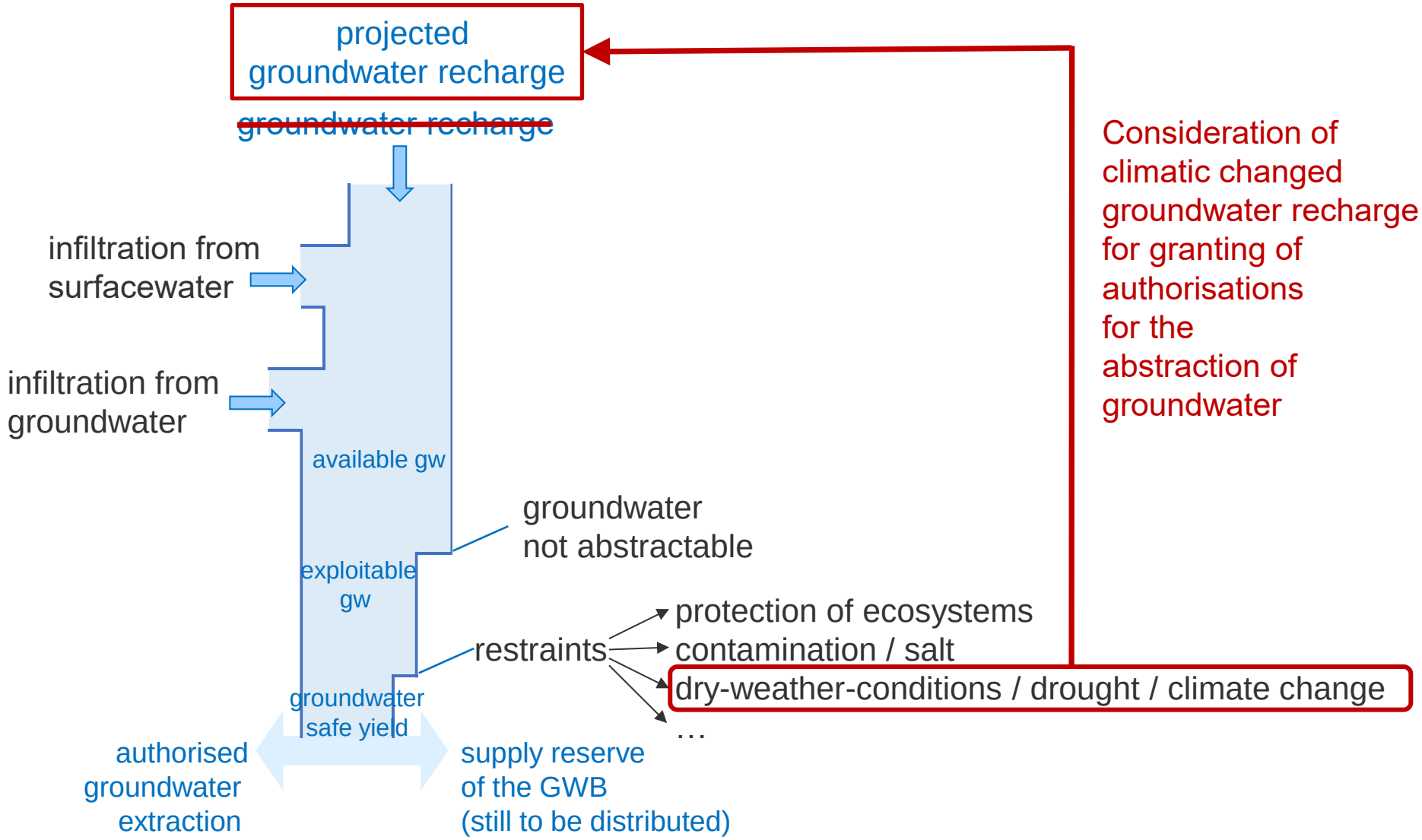
3. Grundwater Safe Yield



DIN 4049-3:

- gw recharge = precipitation – evaporation – surface runoff – interflow
- available gw = gw recharge + infiltration from surface water + gw inflow
- exploitable gw = part of the available gw, which can be abstracted by technical means
- safe yield = part of the exploitable gw, which can be used for water supply under certain restraints (i.e. safety margin)

3. Grundwater Safe Yield



4. Example Lower Saxony

https://www.umwelt.niedersachsen.de/startseite/themen/wasser/grundwasser/grundwasser_menge_stand/erlass_mengenbewirtschaftung/mengenmassige-bewirtschaftung-des-grundwassers-232216.html

Calculation of the groundwater safe yield:

- Basis: 11 climate models of the climate scenario RCP 8.5 for the ‘near future’ (2031 to 2060)
- Wasser balance model: mGROWA22 in a 500x500m-grid
- Calculation of the projected groundwater recharge for each grid element as the mean value of the from the 11 climate models of
  - average projected groundwater recharge for average conditions
  - 15th percentiles of the projected groundwater recharge for dry conditions
- Water balance at grid level: reduction of the projected groundwater recharge by the total of authorised groundwater abstraction

Further reduction

- in relation to the yield of the aquifer and to groundwater salinisation, to secure the required management lamella, to maintain the base flow

Management specification:

- Aggregation of the grid elements via a classification system on the groundwater body
- Designation of a significant supply reserve as a limit for new authorisation of groundwater abstraction in the groundwater body

5. Example Saxony

https://www.wasser.sachsen.de/download/Bewirtschaftungserlass_Grundwasser_F012023.pdf

Calculation of the groundwater safe yield for a groundwater body:

- Basis: 1 climate model of the climate scenario RCP 8.5 for the 'near future' (2021 to 2050) (in future: 7 models of each scenario RCP 2.6, 4.5, 8.5)
- Water balance model: Hydrotop-based model ArcEGMO (≈ 425.000 Hydrotops ≥ 10.000 m²)
- Derivation of a precipitation - groundwater recharge - function from the aggregated calculation results for each groundwater body:

  GWNp = m * Pp - n calculated using a climate model: Pp: projected precipitation
  GWNp: projected groundwater recharge
- Derivation of a typical precipitation P50 for each groundwater body: 50th percentile of a time series of precipitation values derived from measured values for the groundwater body
- Safe yield of the groundwater body(GWDn):

  GWDn = m * P50 - n
- Water balance at groundwater body level: reduction of the groundwater safe yield by the total of authorised groundwater abstraction → leads to the designation of the supply reserve of the groundwater body

No further reduction at groundwaterbody level

Management specification

- Check and if necessary: Adjust water law authorisations so that the water balance for GWK is balanced
- Observe the GWK's supply reserve for new applications
- Locally: No single groundwater abstraction may exceed the average annual groundwater safe yield, even when taking into account the future development of the local safe yield.

6. Conclusion

- Increasingly German federal states take climate change into account in groundwater management.
- However, due to their history and federal structure, the available data bases, approaches, modelling software and processing statuses differentiate between the federal states.
- The differences can only be minimised, not eliminated:
  Therefore a common working group currently develops key points to be considered in the calculation of the groundwater safe yield by all of the German federal states in equal measure. Results are expected in June 2025 and will be discussed.

Thank you for your attention!