Are wastewater treatment plants in the Emscher-Lippe-area fit for purpose under conditions of climate change?

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KLIMZUG
Klimawandel in Regionen

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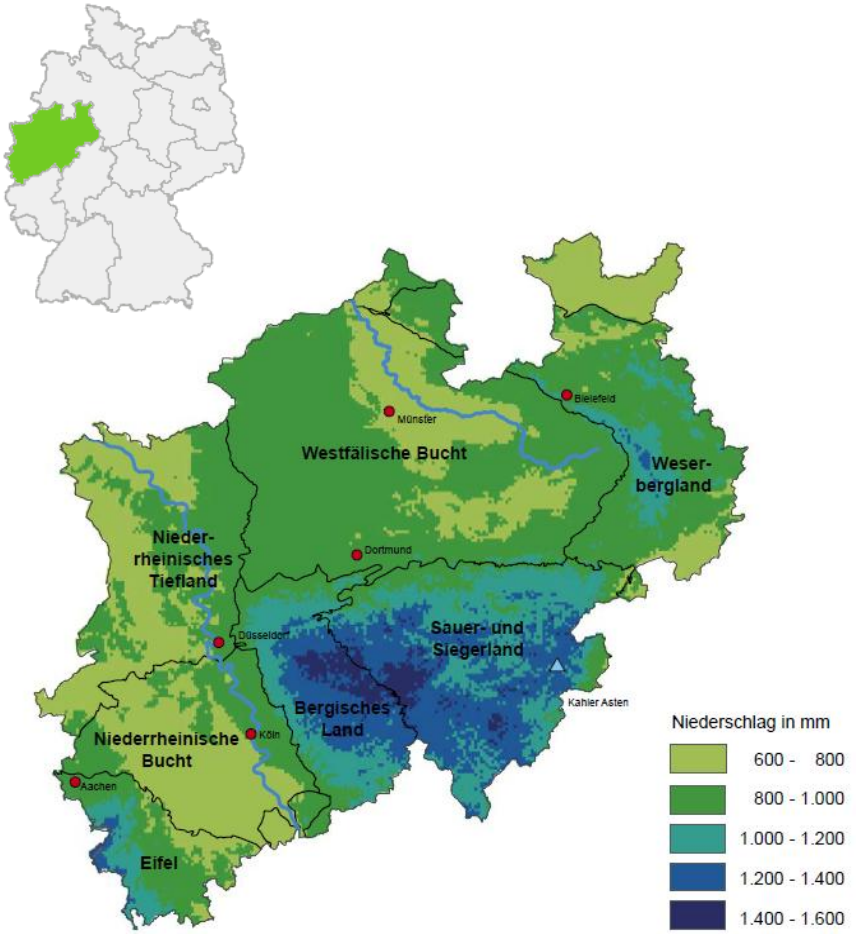
Climate change in the Emscher-Lippe-Area until 2100



source: Genßler et al. (2010)

mean accumulated annual precipitation
in North Rhine-Westphalia
between 1979 to 2008

Climate prediction for the Emscher-Lippe-Area

➡ temperature increase of 3-6°C

➡ accumulated annual precipitation ±5%, but

➡ up to 30% more rainfall in winter

➡ up to 30% less rainfall in summer

Impacts of climate change on operation of wastewater treatment plants

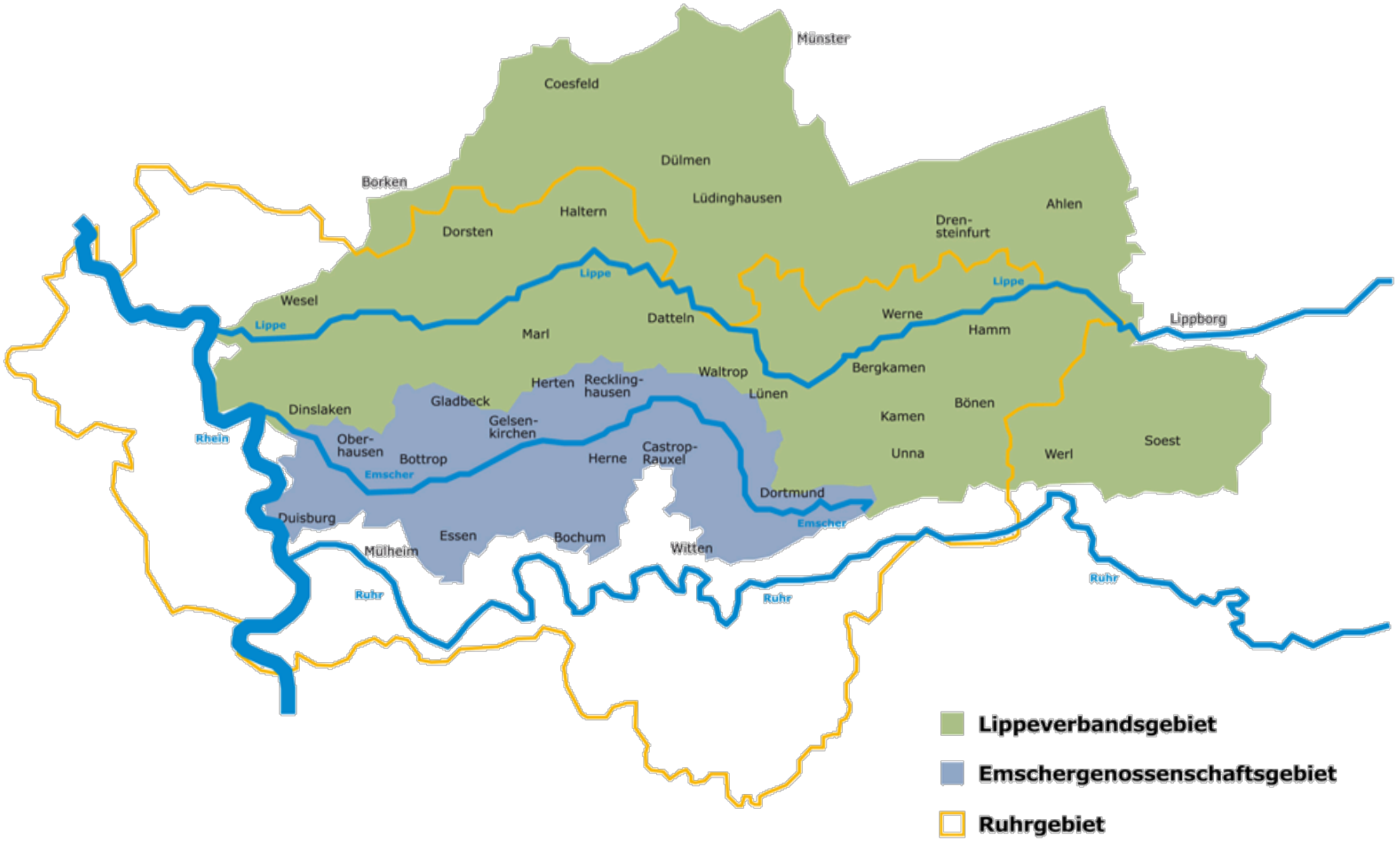
1) increase of temperature may lead to higher temperature of wastewater

2) changing precipitation behaviour results in different conditions for the influent of wastewater treatment plants in case of combined sewer systems

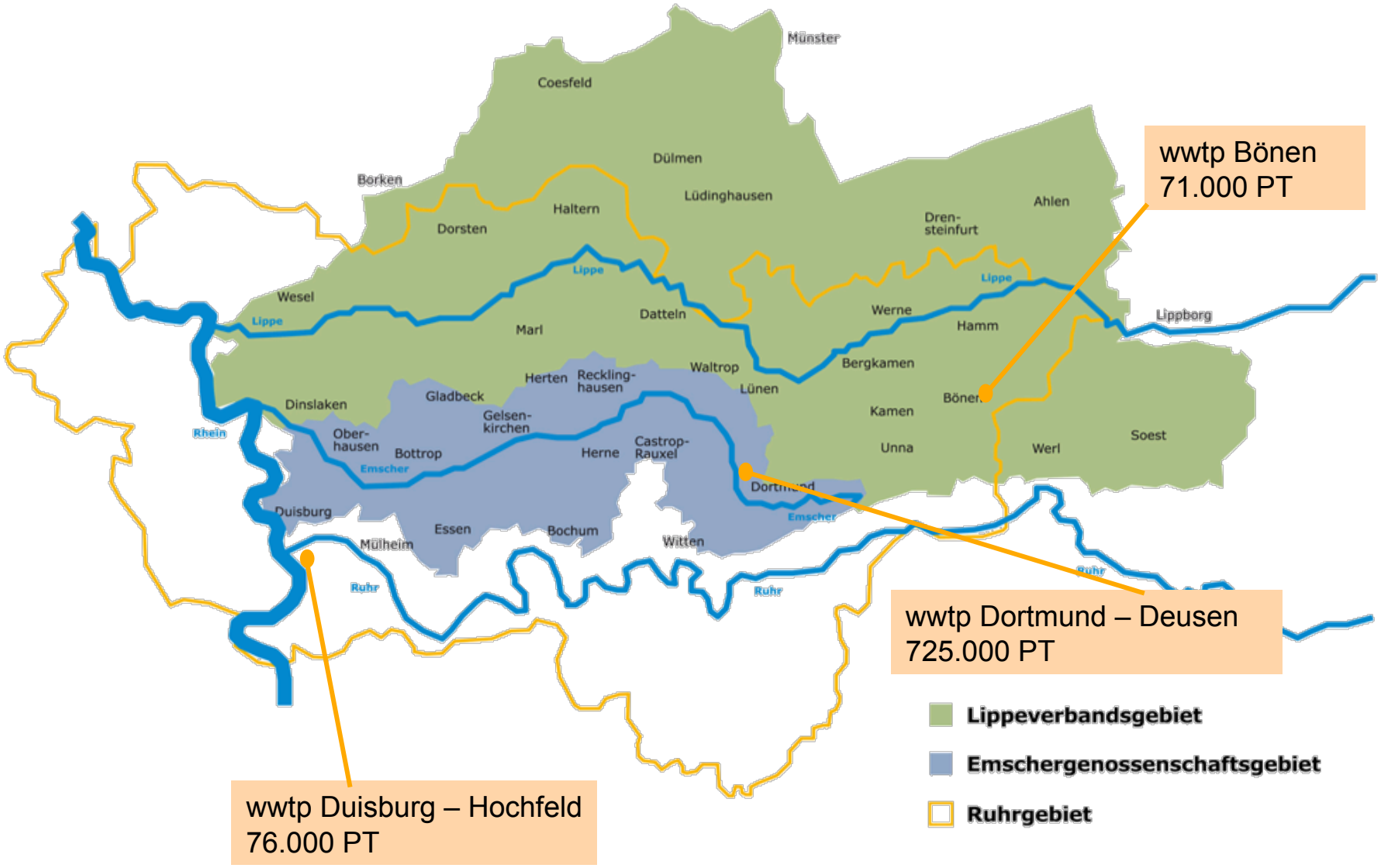
3) after longer dry weather periods rainevents favour the occurance of flushes in combined systems

⇒ experiments with real plants too complex / not possible, therefor modelling of wastewater treatment plants and simulation of szenarios related to climate change

Emscher-Lippe-Area



Location of investigated wastewater treatment plants in the Emscher-Lippe-area



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Modelling of wastewater treatment plants

- using simulation system SIMBA 6.3 to build models and run simulations
- based on ASM theory
- modelling of implemented process technologies as well as operation and control strategies
- different approches of influent (depending on future rain) and wastewater temperature modelling

Inflow / wastewater temperature for WWTP model Dortmund-Deusen

temperature of wastewater:

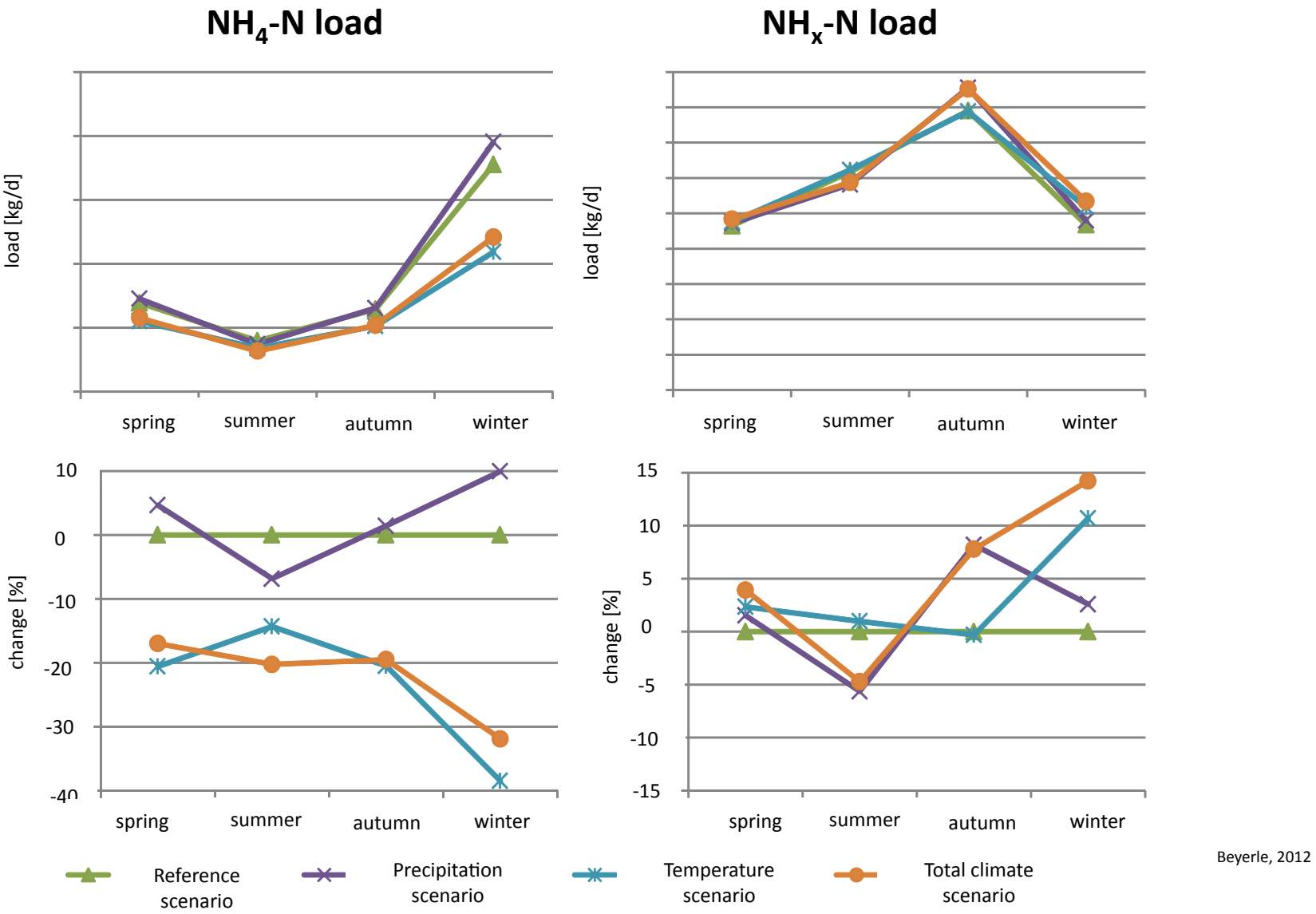
- temperaturecurve derived from predictions for climate change

precipitation:

- historic WWTP inflow multiplied with percentage of forecasted change of seasonable rainfall in case of wet weather flow

→ separate rainfall and temperature szenarios as well as combined szenarios (temperature calculated as mixed temperature in case of rain event)

Results of simulation runs of WWTP model Dortmund-Deusen - effluent loads of nitrogen compounds -



Beyerle, 2012

Inflow / wastewater temperature for WWTP model Bönen

temperature of wastewater:

- measured temperature curve, addition of 1°C and 2°C

precipitation:

- integrated model (catchment area + wastewater treatment plant), differentiation in summer- and winterquarter

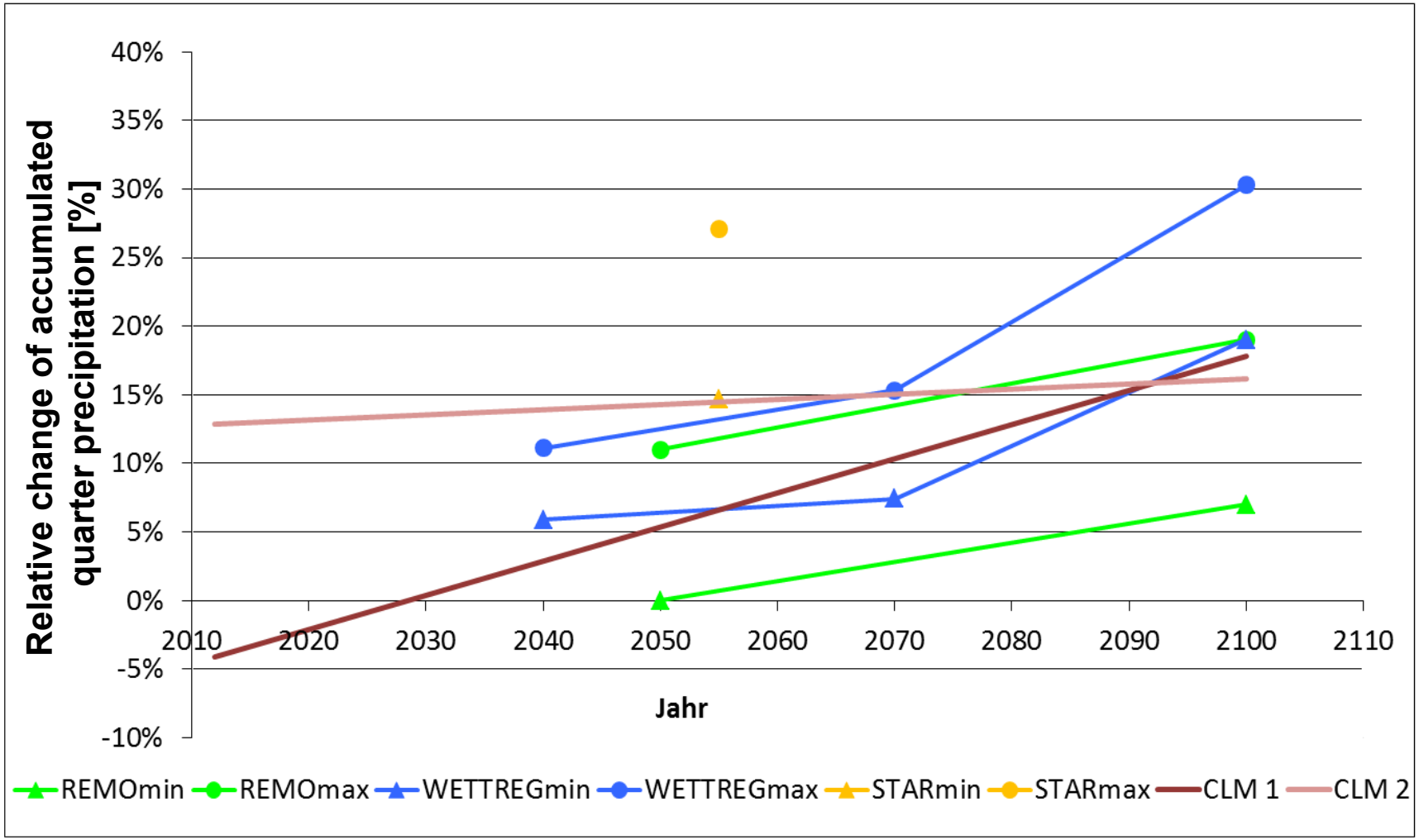
- precipitation and dry weather flow define inflow of WWTP

- rain series from climate model (CLM, Climate Local Model) and from generation based on ensembles; long term consideration (100 years respectively 100 realisations)

→ separate rainfall and temperature szenarios as well as combined szenarios (temperature calculated as mixed temperature in case of rain event)

Derivation of szenarios

Ensemble consideration of forecasted winter precipitation



Mühle, 2012

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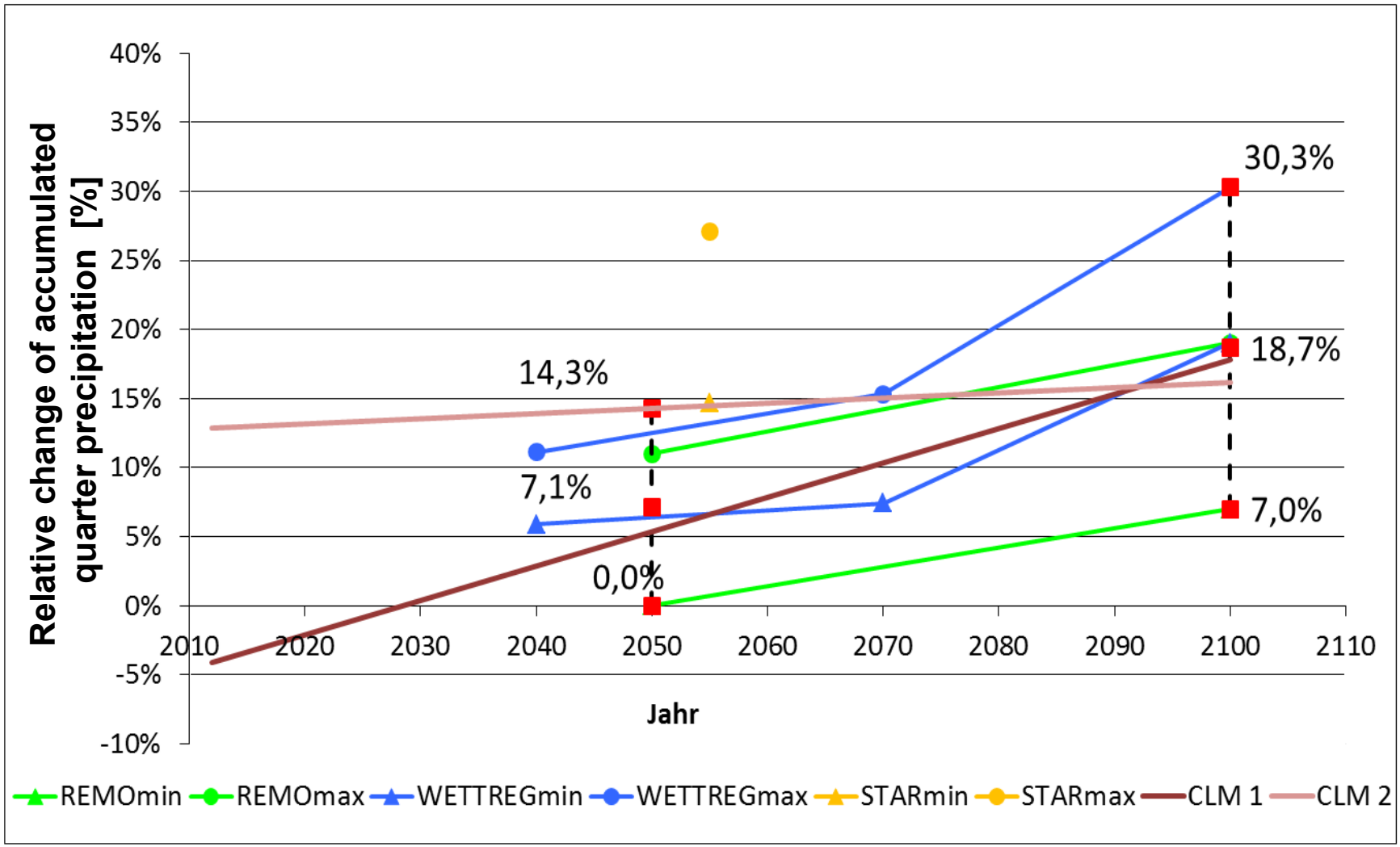
Derivation of szenarios

Coefficients of change for precipitation in winter



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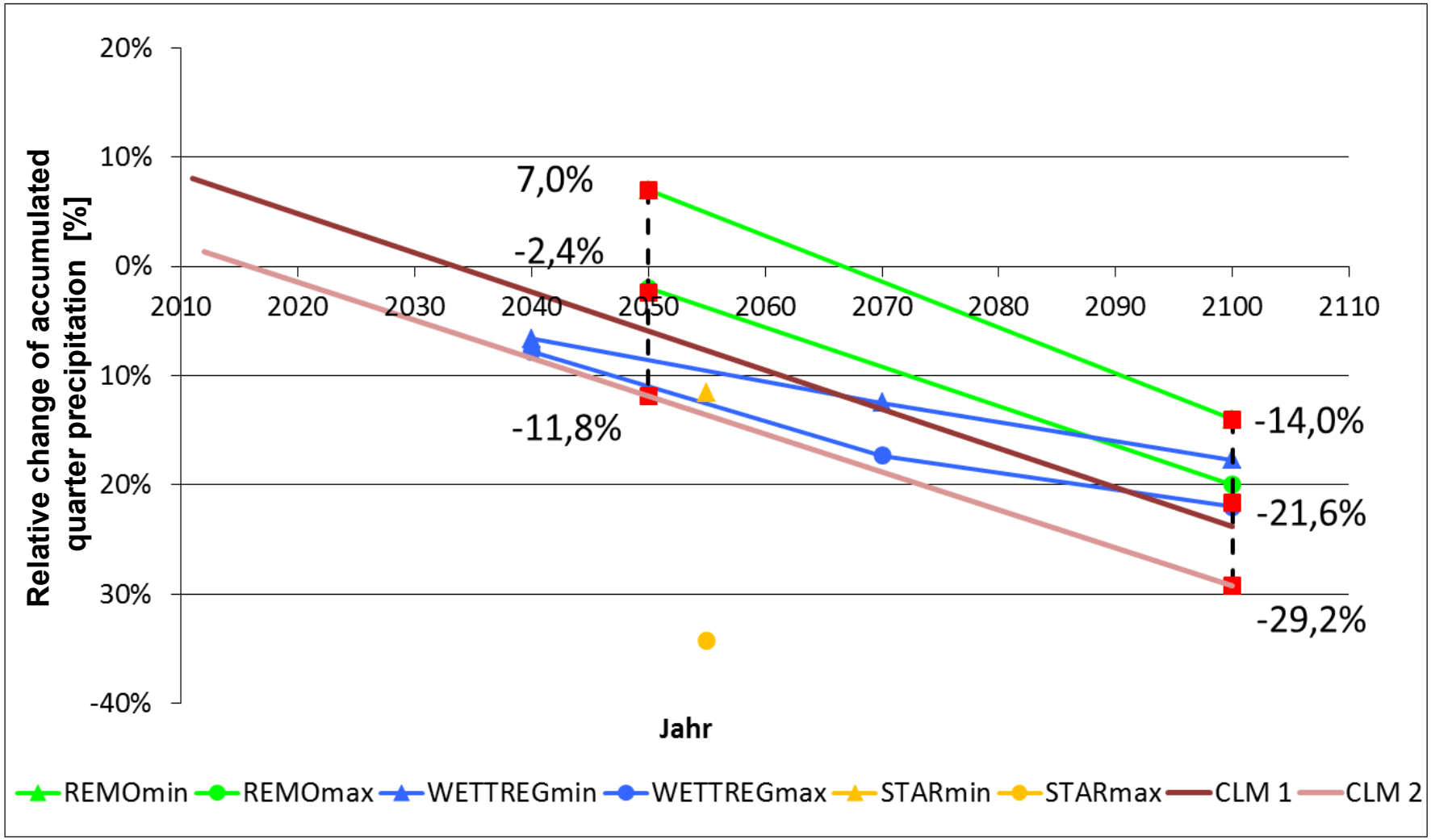
Derivation of szenarios

Coefficients of change for precipitation in summer



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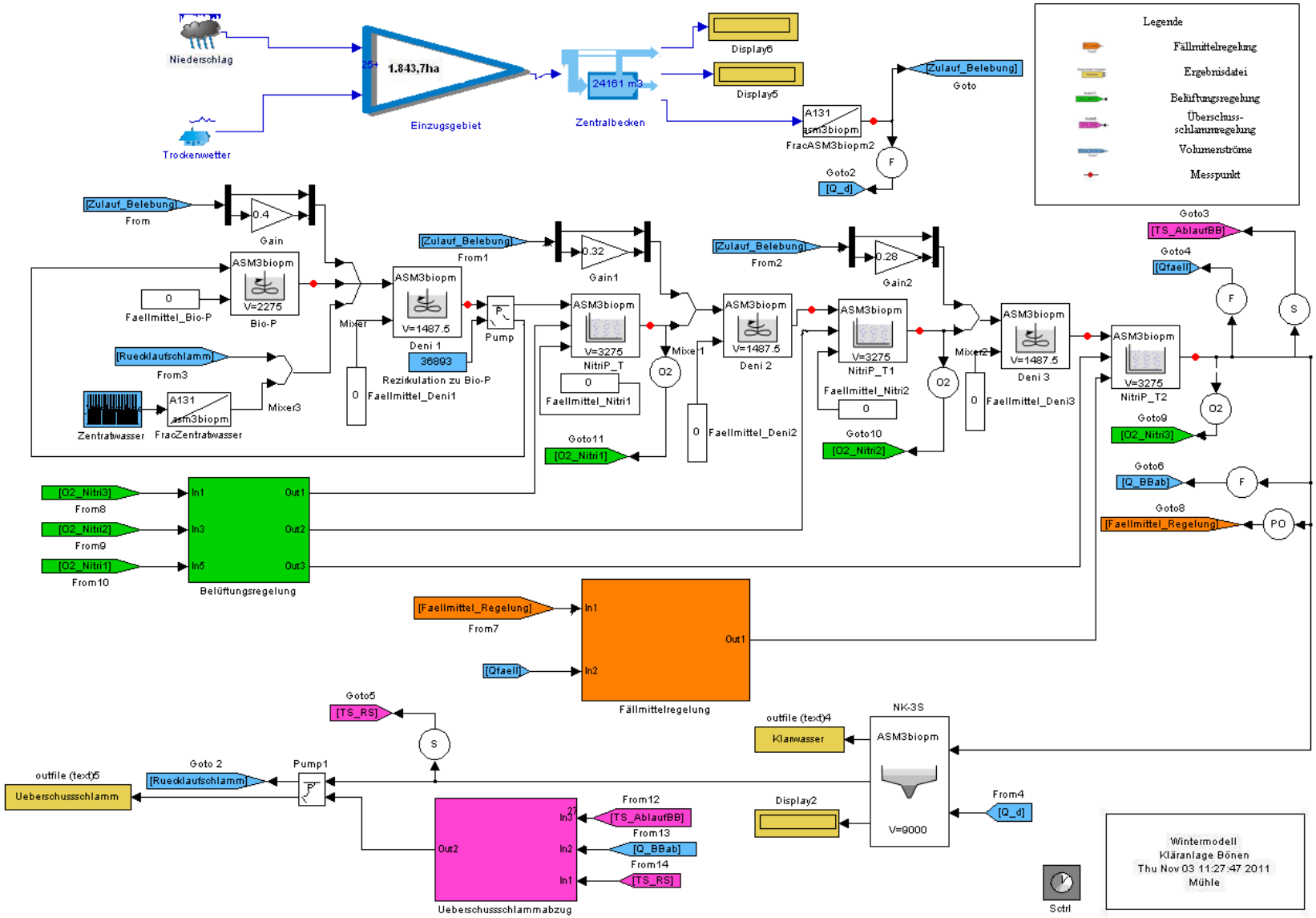
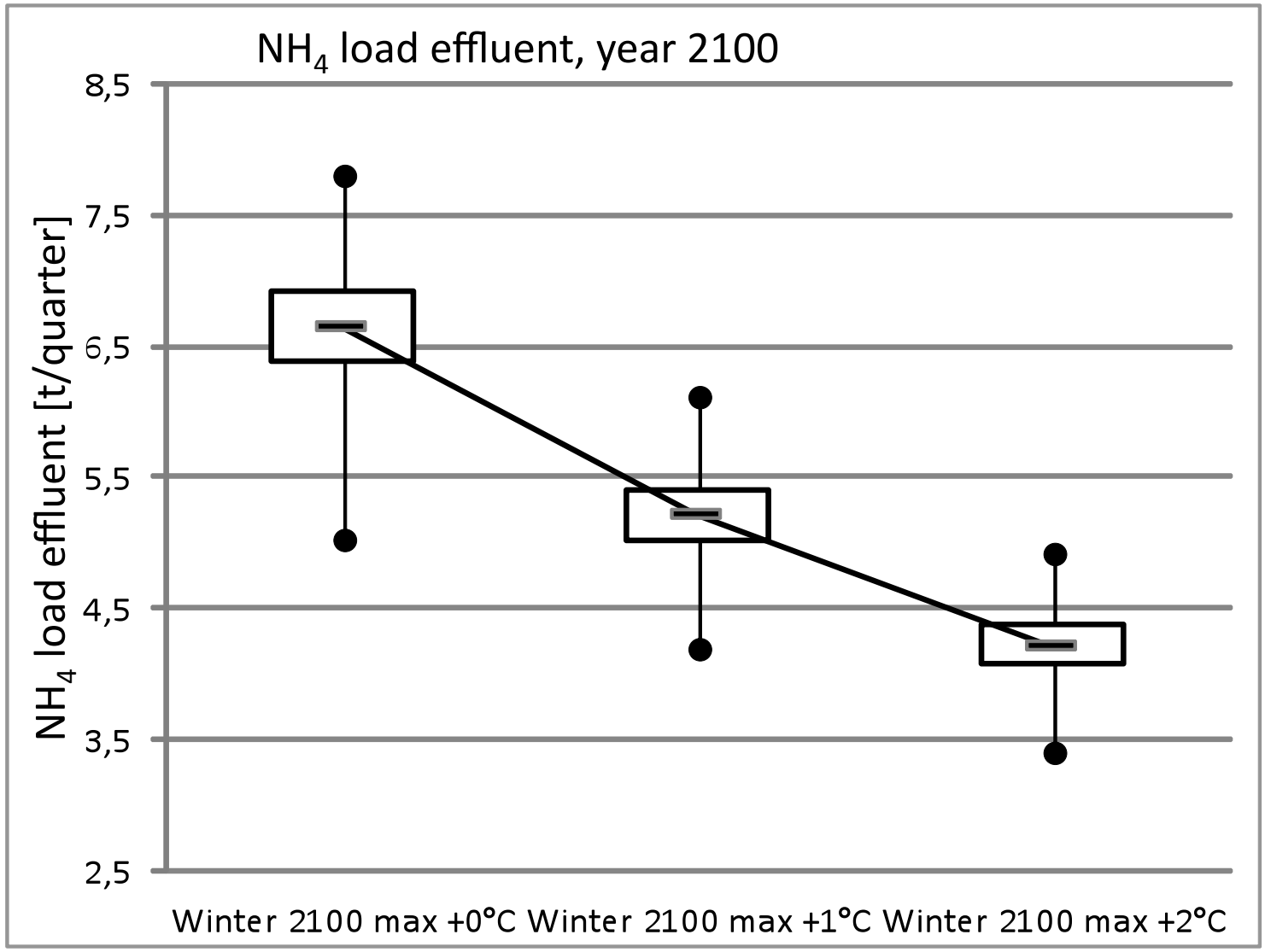
Screenshot of integrated model WWTP Bönen



Results of simulation runs of WWTP Bönen -ensemble szenario winter max-



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Inflow / wastewater temperature for WWTP model Duisburg-Hochfeld

wastewater temperatures:

- 12,3 °C; 17,4 °C ; 21,6°C

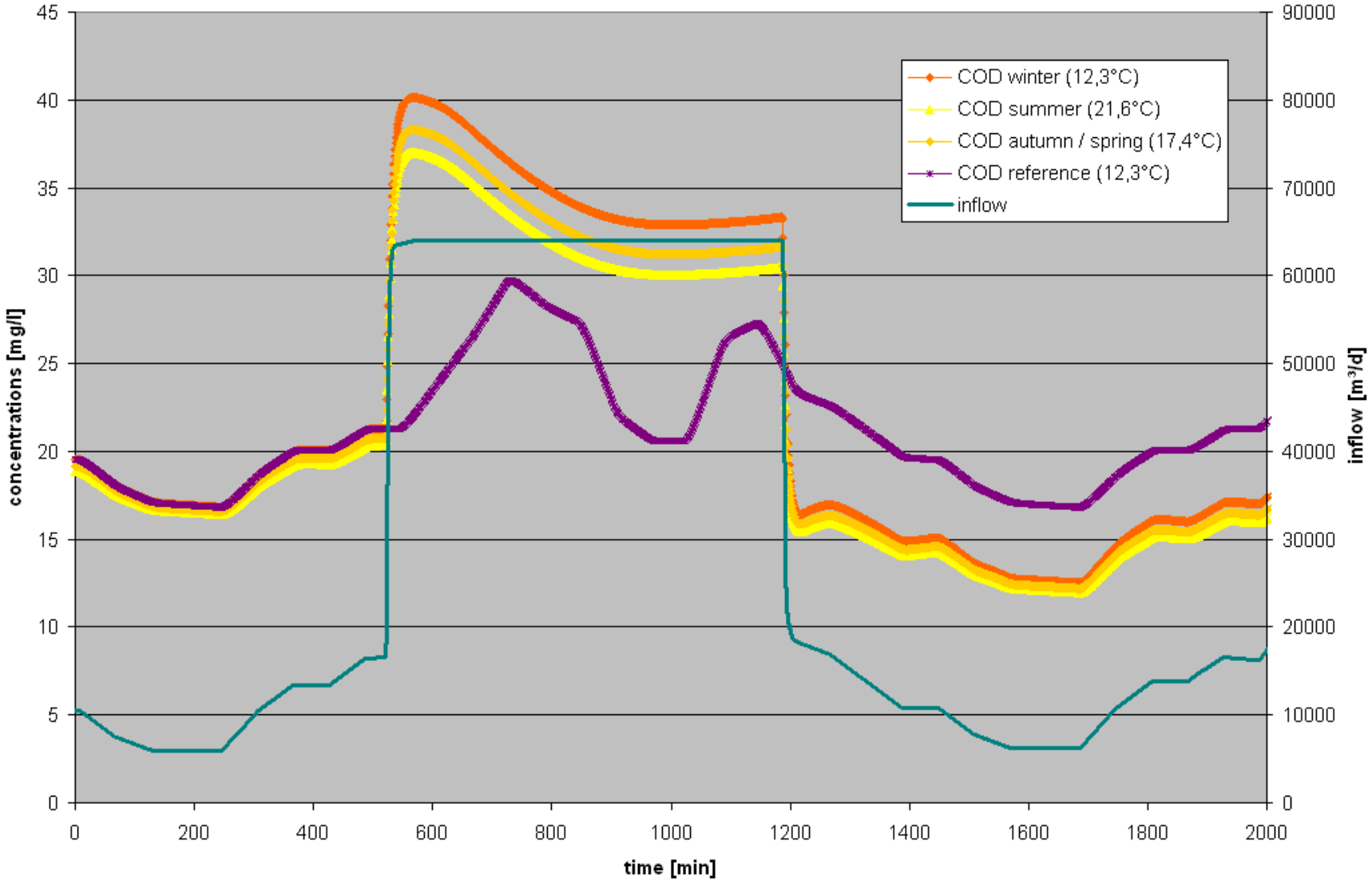
precipitation:

- inflow of wwtp from detailed, separate sewer system model, rain on part of the catchment area to generate first flush
- accumulated pollution load at surface: 40 kg/10.000 m²
- Rainevent: Euler Typ II (KOSTRA DWD, column 9, row 49), hN: 21,7 mm
- volume of stormwater tank 12.500 m³

→ simulation of first flush effects on cleaning capacity

Results of simulation runs on wwtp Duisburg-Hochfeld

Comparison of effluent qualities at different wastewater temperatures after rainevent



conclusion

- requirements of prevailing water quality discharge regulations will still be met after forecasted climate changes will be come true
- minor negativ impacts on the operation of wwtp will happen
- first flushes - if they occur - my lead to exceedance of monitoring values
- increasing wastewater temperatures lead to better cleaning capacity
- results are sewer- , plant- and regionspecific
- no need to adapt wwtp to climate change in the Emscher-Lippe-area

Further considerations

⇒ flood hazard on wwtps

⇒ proof optimazation potential due to impacts of climate change

⇒ have a look at technical and demografical developments and consumer behaviour

Thank you for your attention!

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