Philipp Staufer, Selina Zehnder, Lena Mutzner, Felix Schlatter, Christoph Ort

Challenges with the elimination of micropollutants in the Canton Solothurn, Switzerland

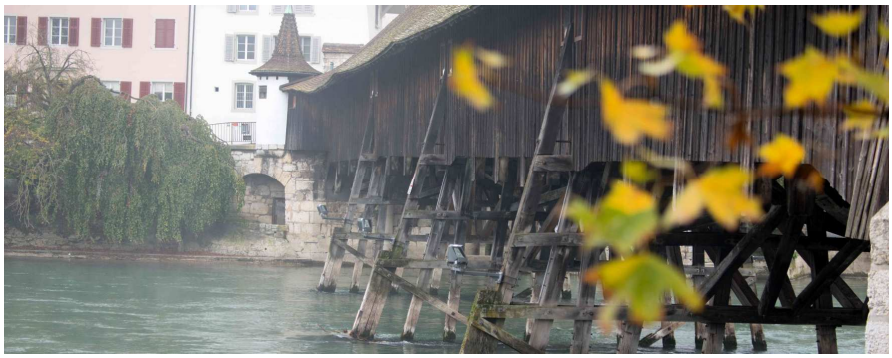
Elimination of micropollutants

new legislation in Switzerland

about 120 sewerage treatment plants (stp),
each to eliminate 80% of mp following one of five conditions:

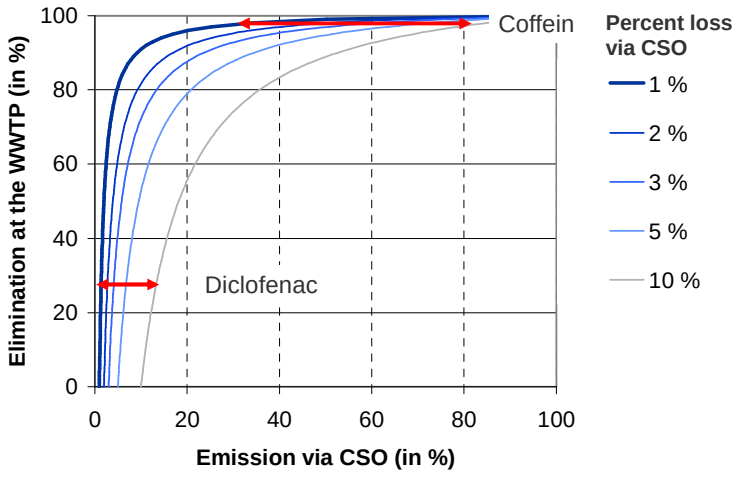
1. stp with more than 80'000 inhabitants,
2. stp with more than 24'000 inhabitants in catchments of lakes,
3. stp with more than 8'000 inhabitants,
   whose discharge make up more than 10% of the receiving water,
4. stp with more than 8'000 inhabitants
   if hydrogeological properties demand it
5. stp with more than 1'000 inhabitants
   if the ecology of the receiving water or drinking water production are at risk.

Challenges with the elimination of micropollutants in the Canton Solothurn, Switzerland



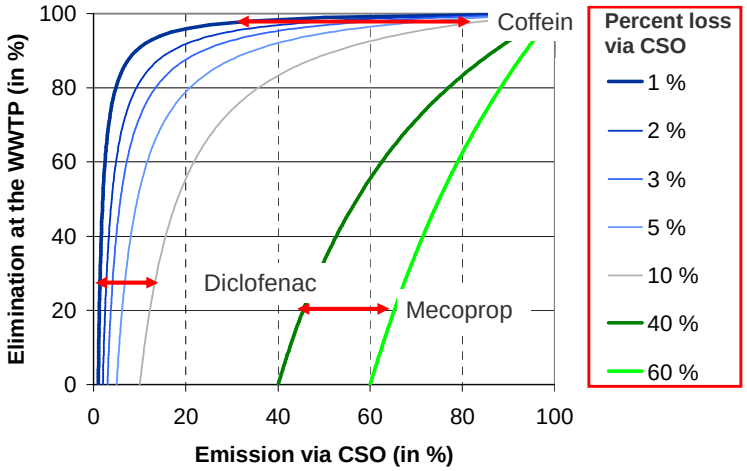
Emissionen aus Mischwasserentlastungen

Framework



Emissionen aus Mischwasserentlastungen

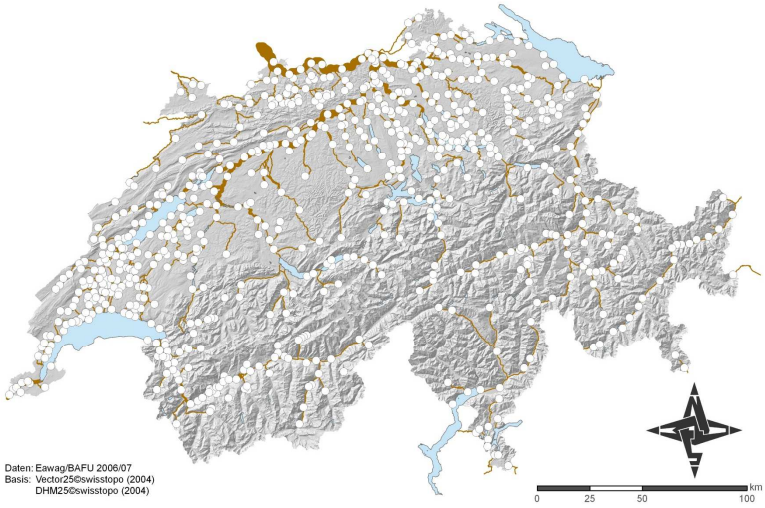
Framework



Inspired by Götz et al. 2010

Motivation

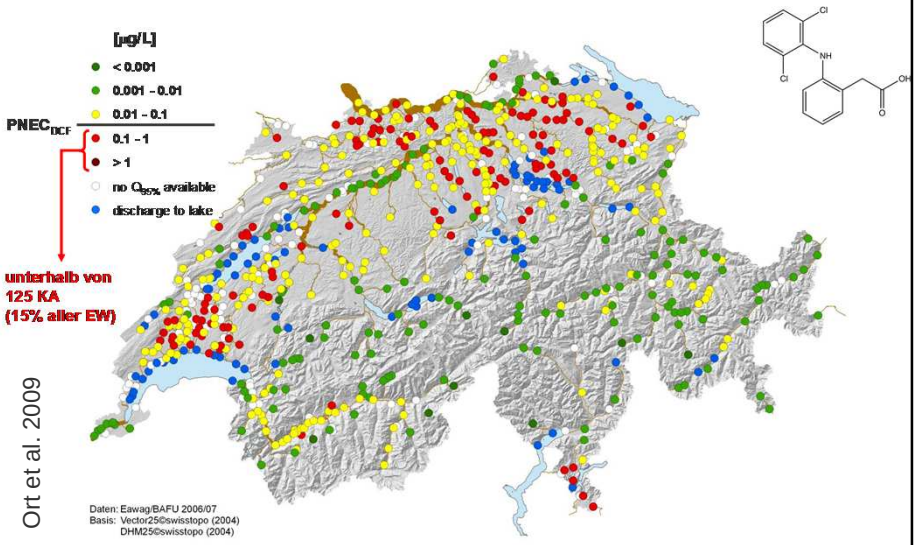
Emissions from wastewater treatment plant



Ort et al. 2009

Motivation

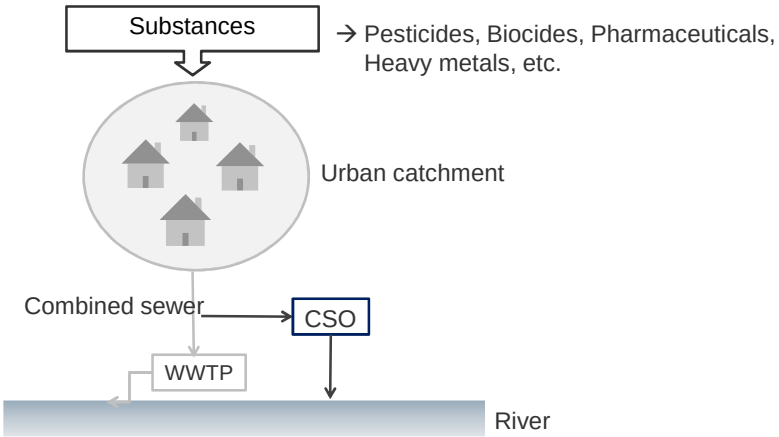
Emissions from wastewater treatment plant



Ort et al. 2009

Micropollutants in settlements

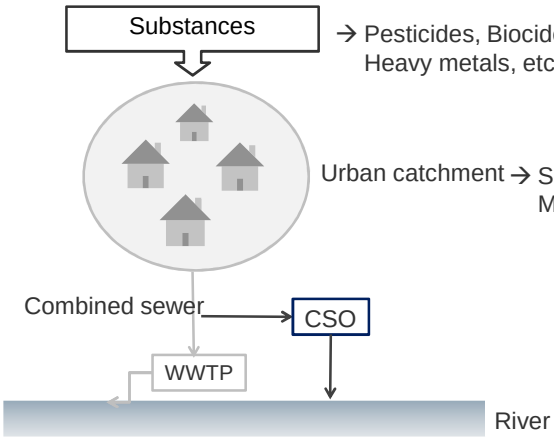
Nonpoint source (NPS-) pollution



Focus: Urban Sources, combined sewer overflows

Micropollutants in settlements

Nonpoint source (NPS-) pollution

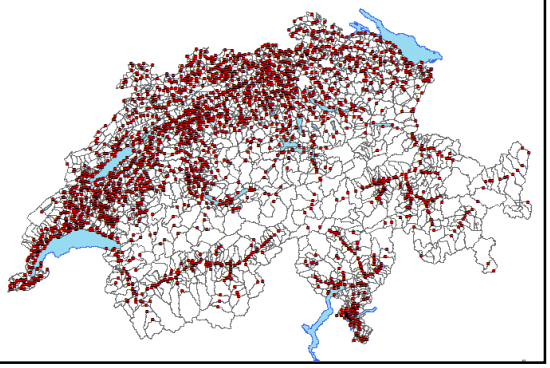


Focus: Urban Sources, combined sewer overflows

Goals

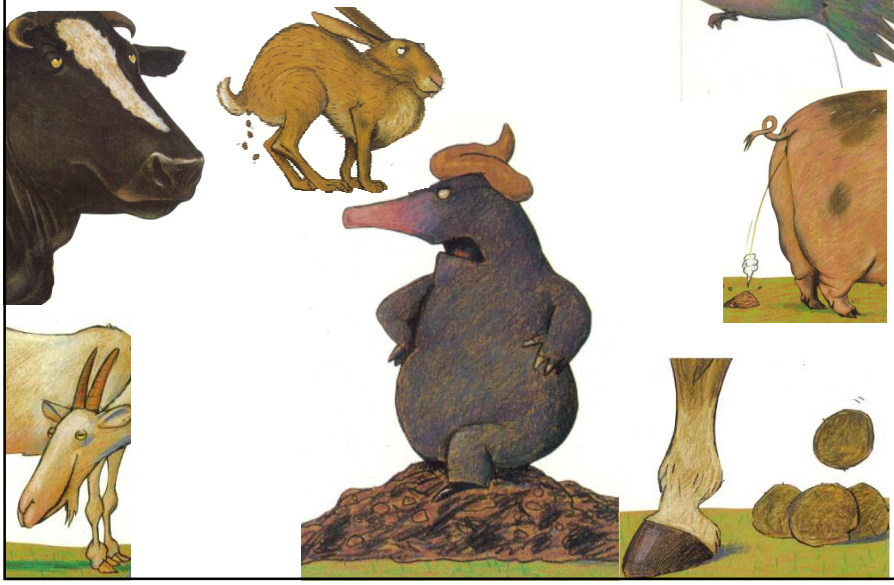
Ausgangsfragen

1) What relevancy does NPS-micropollution carry?
2) Can we indentify most critical places?



Transdisziplinäre «Literaturstudie»

Motivation



Holzwarth, W. and Erlbruch, W. (2001): Vom kleinen Maulwurf, der wissen wollte, wer ihm auf den Kopf gemacht hat, Peter Hammer Verlag

Transdisziplinäre «Literaturstudie»

Motivation

Methods

Substance flow analysis

one CSO per municipality

«dynamic» SFA

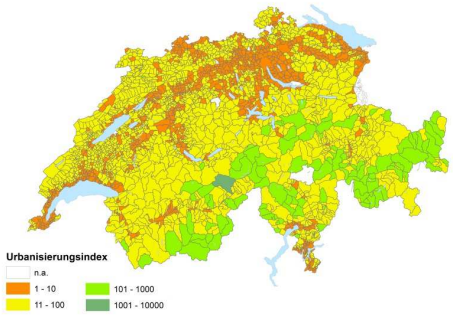
continuous simulation

entry patheways

4 substances

dynamic SFA

- load variation at the source
- seasonality of usage, e.g. pesticides
- variability in rainfall



Methods

Substance flow analysis

one CSO per municipality

«dynamic» SFA

continuous simulation

entry pathways

4 substances

1 hr resolution

Toxic unit

dynamic SFA

- annual loads
- meta-data analysis
- loss-rates

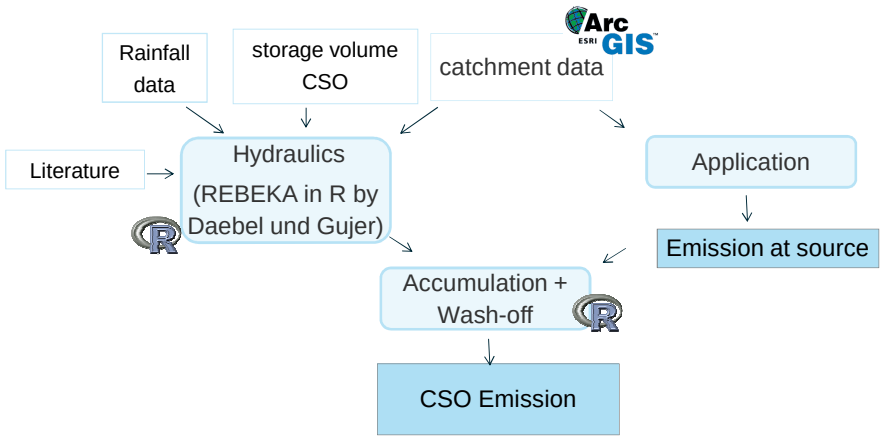
Index of urbanization

HOTSPOTS

dynamic SFA

Basis

- Basic model structure



Quellen: ArcGis Logo: http://www.lic.wisc.edu/training/CrsDesc/iag1.htm;
Logo R: http://www.r-project.org/index.html, Schweiz: Vector23@2008 swisstopo

dynamic SFA

Basis

- NPS-micropollution

Substance / Source	Triclosan	Glyphosate	Mecoprop	Copper
Household	●		●	●
Garden		●		●
Facades				●
Roofs			●	●
Streets				●

dynamic SFA

Results

- Emission from different sources (in kg/a)

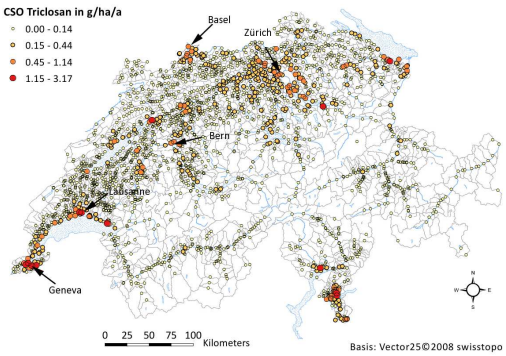
substance	house-hold	buildings	street	garden	total	rainfall-mobilized part
Triclosan	5'148				5'148	0%
Glyphosate				4'798	4'798	100%
Mecoprop	203	47		568	818	76.2%
Copper	62'140	50'542	7'043	250	119'975	49.2%

dynamic SFA

Results

- CSO - sewage

substance	Loss rates
Triclosan	**3.3**
Glyphosate	65
Mecoprop	50
Copper	34

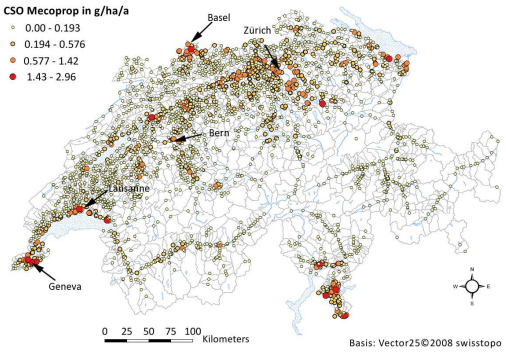


dynamic SFA

Results

- CSO: rainwater and sewage

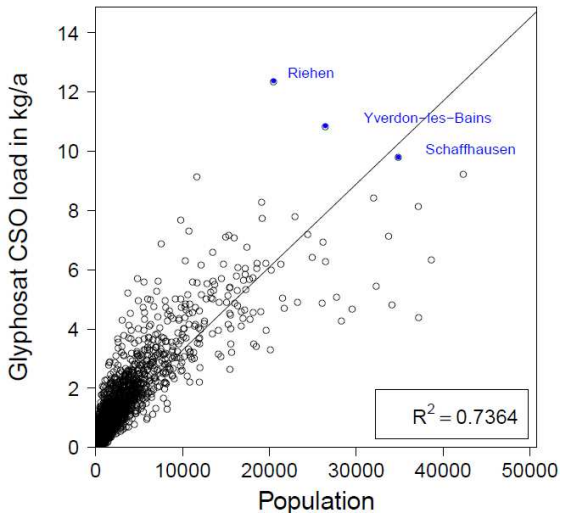
substance	Loss rates
Triclosan	3.3
Glyphosate	65
Mecoprop	**50**
Copper	34



Identification of Hotspots

Results

- Indicator: Population



Summary

Substance flow analysis

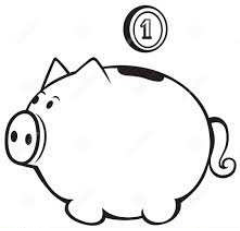
1) What relevancy does NPS-micropollution carry?

- for many wastewater-borne MP concentrations in combined sewer are lower than environmental quality standards

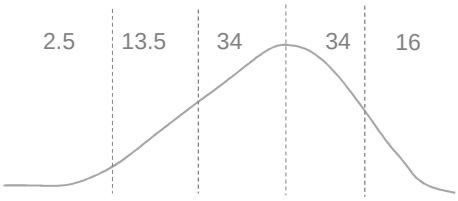
- loss-rates of rainfall-mobilized substances
  - Glyphhosate: 65%
  - Mecoprop: 50%

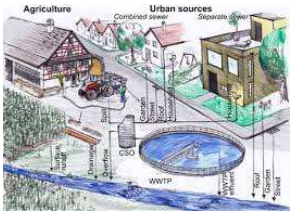
2) Can we identify most critical places?

- Even for rainfall-mobilized micropollutants population (< 50.000cap) is an good indicator for annual loads



Implementing new technologies

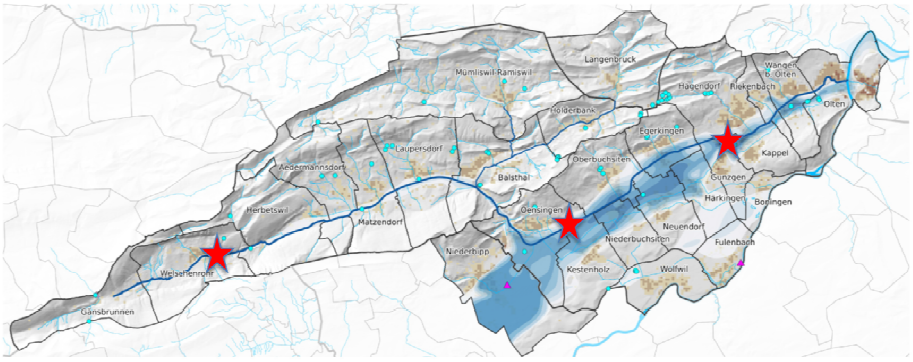




➡ cost reduction by cooperation
= not doing the work twice

the River Duennern

Overview



the River Duennern

Urban water

waste water management

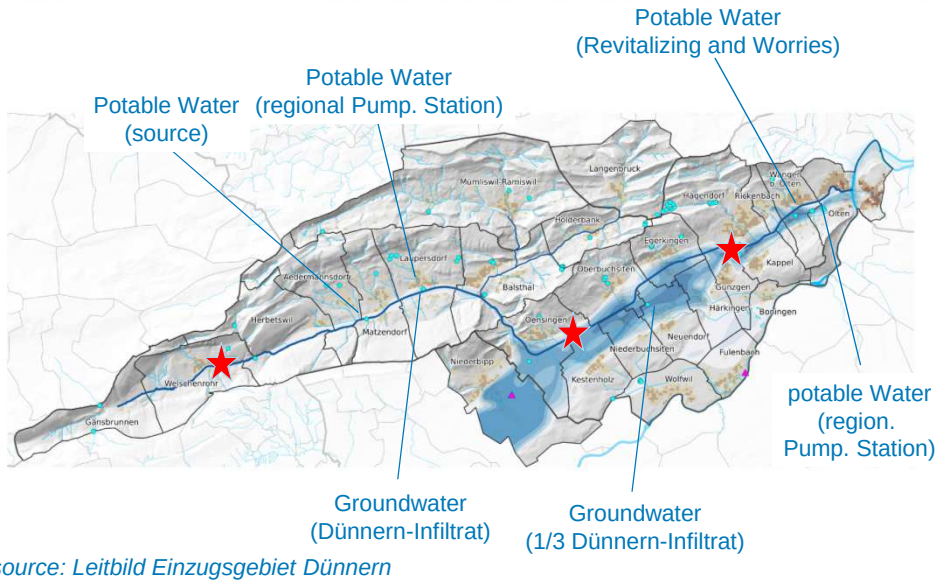
- 3 sewer treatment plants (stp) within the catchment (treated waste water in low water (Q347): 20% < R < 32%)
- Combined and separate systems
- Highway drainage
- Morphologie + Room for water courses

water ressources management

- Aquifer of gravel, one of the largest in the Canton
- restoring groundwater pollution from nitrate
- 30% Infiltration from riv. Duennern forming groundwater
- Pivot- groundwater source
  ➡ of regional importance
- preferential flow path in rock formation

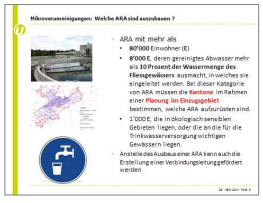
the River Duennern

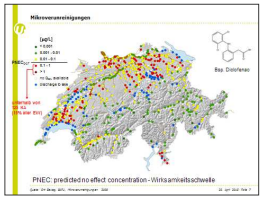
Situation



source: Leitbild Einzugsgebiet Dünnern

Objectives





Clean ground water as source for potable water

- precautios principle (PP) of 100 ng/L
- chronic criteria: 3 x PP
- arithmetic mean

Acute Effects

- time of exceedance of environmental quality standard (eqs)
- max. concentration (95%-Perzentil)

Dimensioning advanced purifiation (AP)

- Loads vs. discharge (Q)
- extranous water: infiltration and inflow (I+I)

Sources and substances

dynamic substance flow analysis

Micropollutants indicator substances (MISU)

Source	Houshold	Garden and greens	construction	traffic
Triclosan	✓			
Mecoprop	✓	✓	✓	
Glyphosat		✓		
Kupfer *	✓	✓	✓	✓

* Schwermetall, als Referenzsubstanz

Model development

From national to regionale perspective

SOURCES
land-use,
consumption data

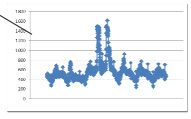
- **Substances - MISU**
  - munic. waste water (Micropoll)
  - rainfall-driven substances
    - volume-limited
    - transport-limited
  - copper (as reference)

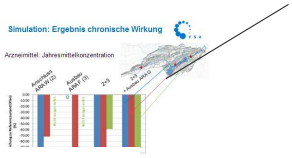
Eawag
dsfA

River Duennern
low water
network

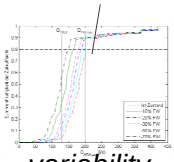
Citydrain 2.0
(hydrol. Modell)

time series





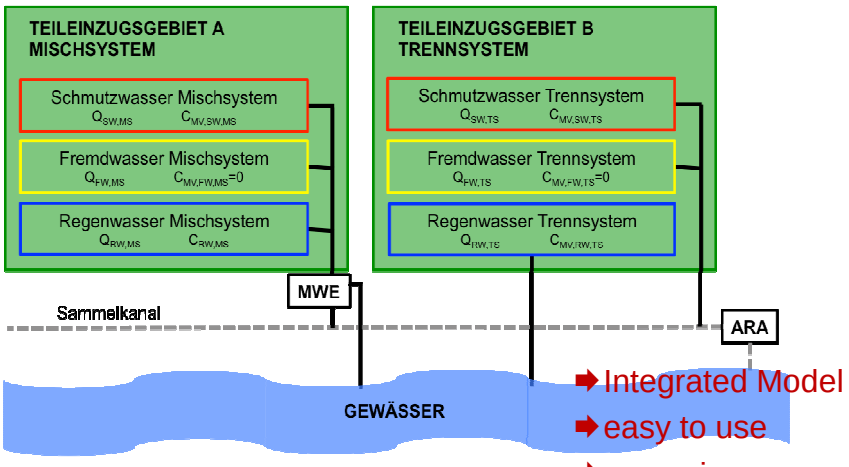
scenarios



variability

Model development

City Drain 2.0



- Integrated Model
- easy to use
- scenarios

Planning the elimination of micropollutants

Rate of elimination on stp

ARA W: conventional. waste water treatment w/o Nitrification

- substance specific, const. efficiancy for MP-elimination

ARA F & G: conventional. waste water treatment with denitrification

- substance specific, const. efficiancy for MP-elimination

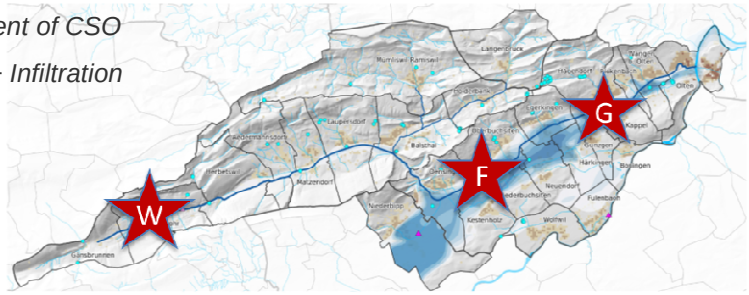
Enhanced waste water Treatment and purification

- Defined, max. discharge concentration by control loop
- min. of 80%-Elimination for all MP

Planning the elimination of micropollutants

Scenarios

1. Current state
2. Connection ARA W
3. Enhance ARA F
4. *2+3*
5. *2+3+Connection ARA G*
6. *Treatment of CSO*
7. *Inflow + Infiltration*
8. *….*

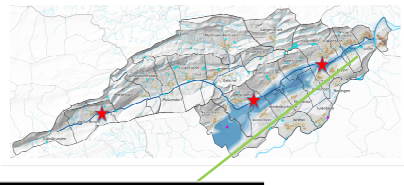


Results

Chronic effects

Pharmaceuticals + chemicals: Einhaltung Vorsorgewert

In order to reach our objectives, we have to achieve the following efficancies.

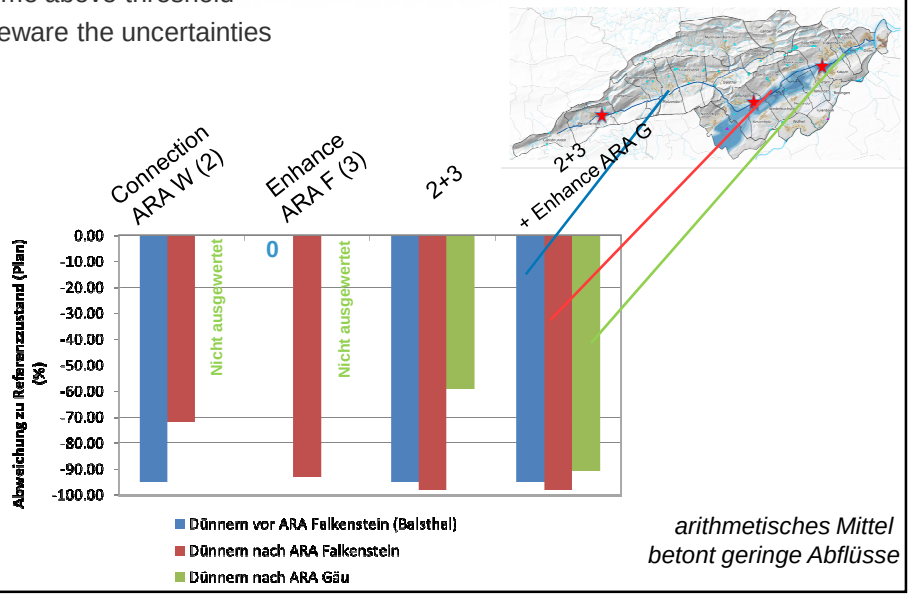


Substance		min. efficiancy
Benzotrialzol	BZT	75 %
NTA		73 %
Cabendazim	CBZ	< 300 ng / L
Triclosan	**TCS**	**48 %**
Ibuprofen	IBU	46 %

Results

Time above threshold

Beware the uncertainties

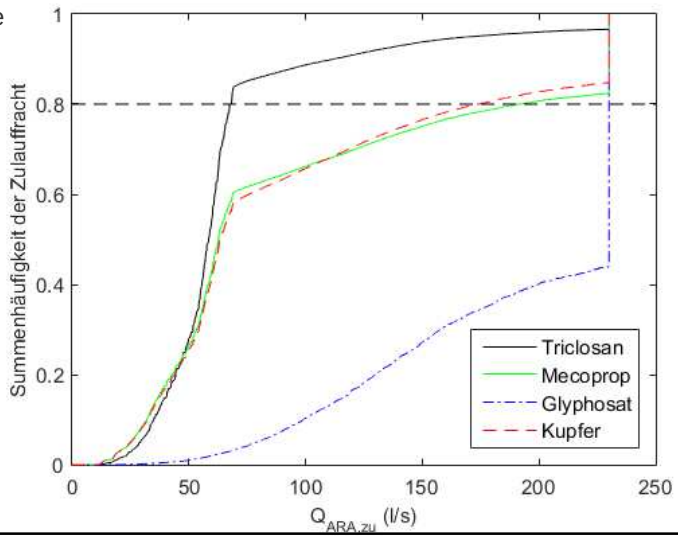


arithmetisches Mittel
betont geringe Abflüsse

Cummulative Frequencies

STP G

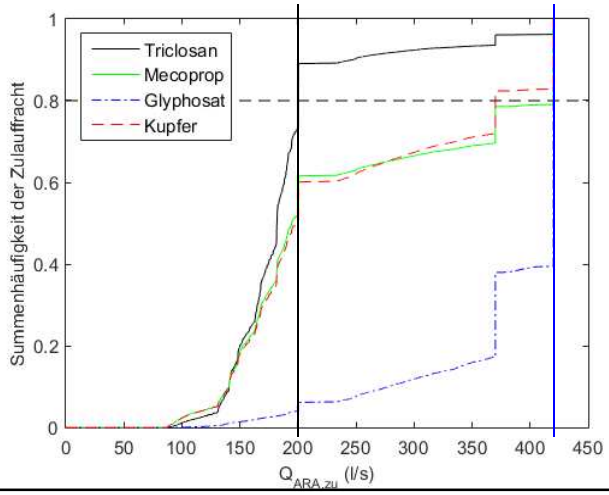
Load vs. Discharge



Cummulative Frequencies

STP F

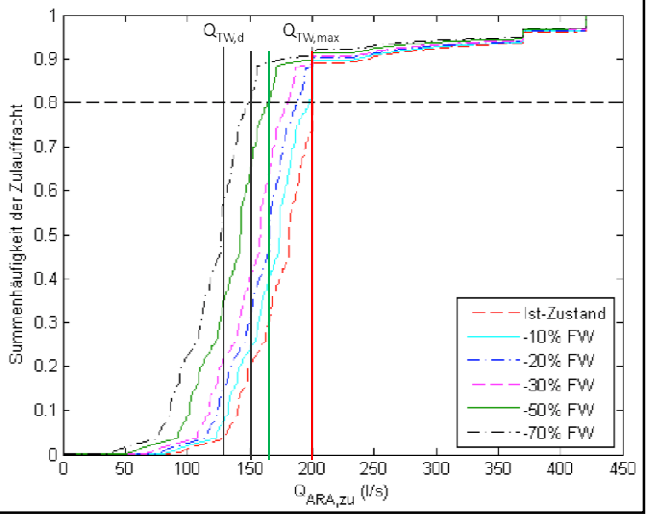
Loads vs. discharge



STP F

Infiltration and Inflow

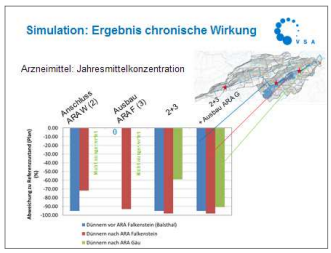
consequences
- o treatment volume
- o energy
- o low concentrations
- o O3 / PAC

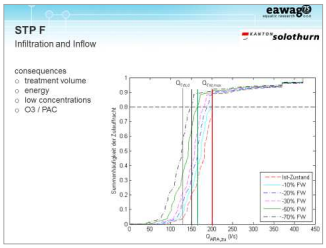


Summary

- o models
- o interaction of waste water and water ressources management
- o combining of topics

… will help in managing the catchment





- o infiltration and inflow
- o concentrating on household waste water
- o only looking at STP

… is risky.

Thank you for your attention !

ありがとう　ございます。

merci beaucoup

Vielen Dank

cum Gratiae

شكران

Blumensaat, F., P. Staufer, et al. (2012). "Water quality based assessment of urban drainage impacts in Europe – where do we stand today?" Water Science and Technology **66**(2): 304–313.

Staufer, P., L. Mutzner, et al. (2012). Dynamic Substance Flow Analysis of rainfall-mobilized Micropollutants. 9th Int. Conf. on Urban Drainage Modelling, Belgrade, Serbia.

Staufer, P. and C. Ort (2012). Schweizweite Bilanzierung der Einträge von Mikroverunreinigungen aus Mischwasserentlastungen. Aqua Urbanica T. Schmitt and I. Alves. Kaiserslautern, Schriftenreihe des Fachgebietes für Siedlungswasserwirtschaft der TU Kaiserslautern: I1 - I22.

Ort, C., J. Hollender, et al. (2009). "Model-Based Evaluation of Reduction Strategies for Micropollutants from Wastewater Treatment Plants in Complex River Networks." Environmental Science & Technology 43(9): 3214-3220.

•Grundlagen

1. STAUFER, PH. & ORT, CH. 2013. Faktenblatt: Mikroverunreinigungen aus diffusen Quellen - Diffuse Mikroverunreinigungs-Emissionen aus Siedlungen (DIMES). Eawag, Dübendorf.
2. OEKOTOXZENTRUM. 2014. Vorschläge für akute und chronische Qualitätskriterien für ausgewählte schweizrelevante Substanzen. Schweizerisches Zentrum für angewandte Oekotoxikologie, Dübendorf.
3. VSA. 2015. Zu behandelnde Abwassermenge und Redundanz von Reinigungsstufen zur Entfernung von Mikroverunreinigungen – Empfehlung, Vernehmlassungsvorlage vom 15. Juli. 2015, Glattbrugg.
4. HBT/Holinger (2015). Dimensionierungswassermenge und Redundanzen von Stufen zur Elimination von Mikroverunreinigungen, Schlussbericht im Auftrag des VSA, Holinger, Hunziker Betatech, Bern, Winterthur.
5. STAUFER, PH. et al. 2012. Dynamic Substance Flow Analysis of rain driven micropultants, Int. Conf. Urban Drainage Modelling, Proceedings on CD.

Staufer, Ph.; Zehnder, S. (2016). Integrale Betrachtungen von Mikroverunreinigungsemissionen, Aqua&Gas (1): 44-53.

Knüsel, P. (2016). Diffuse Bedrohung für das Trinkwasser, Tec21,

Staufer, Ph.; Ort, Ch. (2012). Diffuse Einträge aus Siedlungen, Ergebnisse einer Situationsanalyse. Aqua & Gas, (11): 2–11.

HBT (in Vorbereitung). ARA-Ausbaukonzept zur Elimination von Mikroverunreinigungen im Kanton Solothurn, Bericht, Im Auftrag des Amtes für Umwelt Solothurn, Bern.