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# Predicting the evolution of a pesticide metabolite in spring water combining laboratory experiments, field sampling and numerical simulations


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# The situation

**Drinking water in Luxembourg**

•½ of the raw water comes from one aquifer, the Luxembourg Sandstone

•the aquifer is drained by numerous contact springs➔provides cheap groundwater to local communities and to the capital city

•bimodal landuse in recharge areas: woodland (~ 2/3) and cropland (~ 1/3)

**Chronology**

**2005**

•atrazine banned in Luxembourg

•s-metolachlor becomes a prominent replacement product for corn cultures. A major degradation products is metolachlor-ESA (m-ESA)

**2010**

•numerous cases of contamination (up to 10 times the legal limits) by m-ESA are reported

**2014**

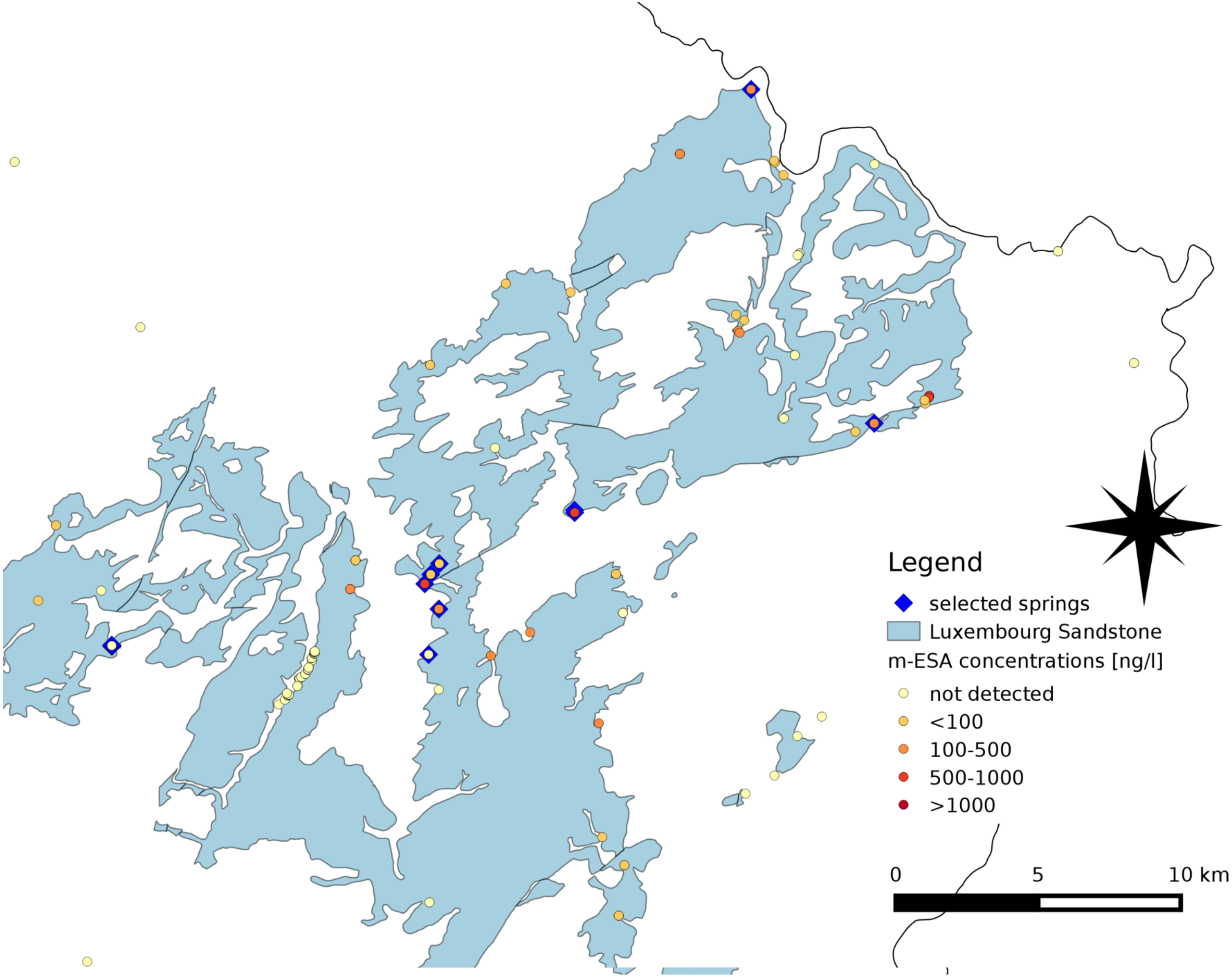
•s-metolachlor banned

**Questions**

•is m-ESA transported by fast flow or slow flow (or both) ?

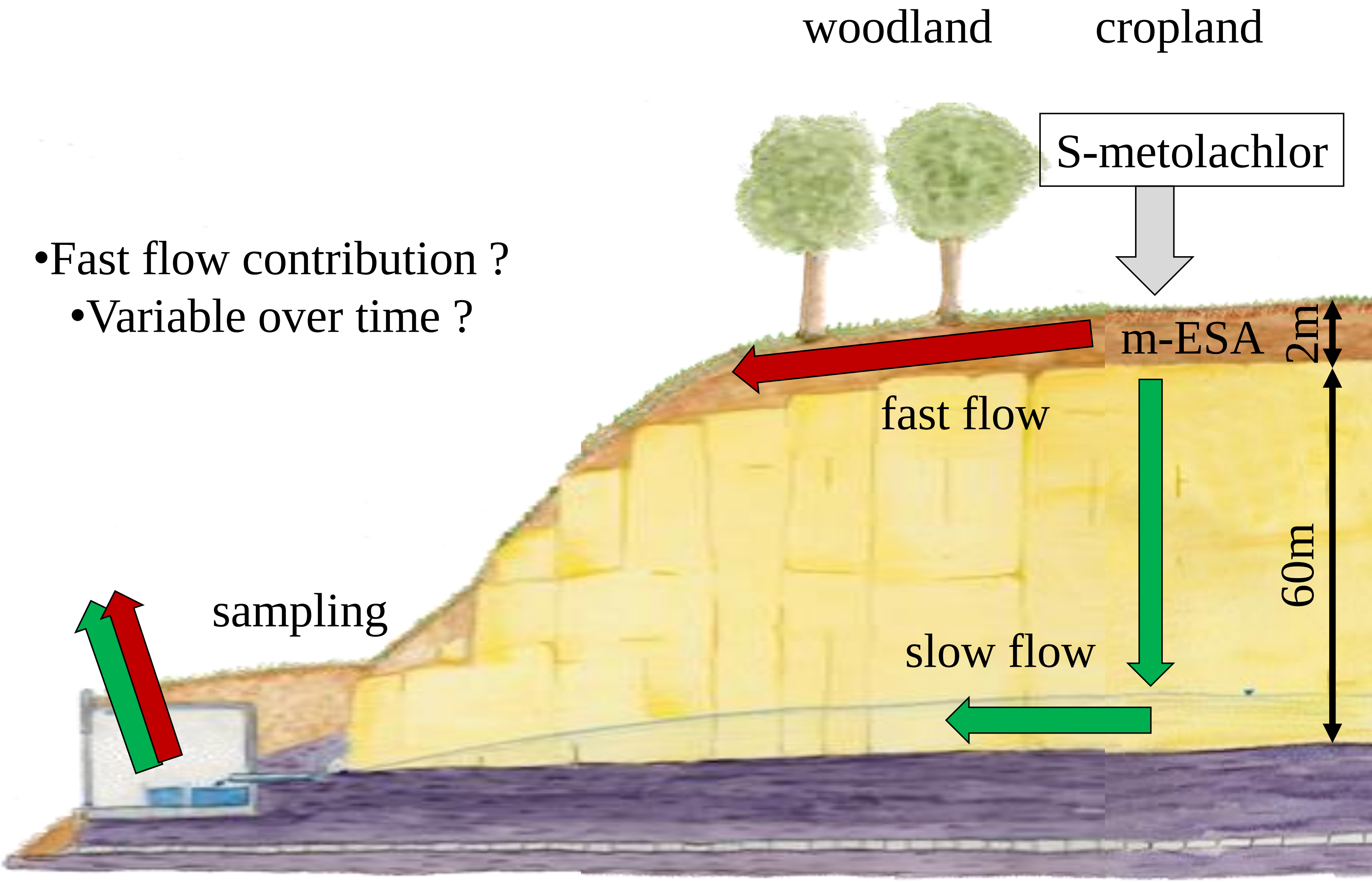
•can the time to trend reversal be estimated ?

# Overview of the contamination



# Conceptual model

•Fast flow contribution ?
•Variable over time ?



# Structure of the study

**Field sampling**

•weekly grab samples

➔m-ESA dynamics

➔aquifer response to changed boundary conditions

**Laboratory experiments**

•microcosm experiments

➔transformation rates

**Numerical simulations**

•pesticide leaching with the code PEARL

➔dynamics of the release of m-ESA from the soil

**Predictions/inverse modeling**

•m-ESA transport pathway(s)

•evolution of m-ESA concentrations after the ban

# Field data

**Available data**

•cropland

•crop rotation

➔corn frequency

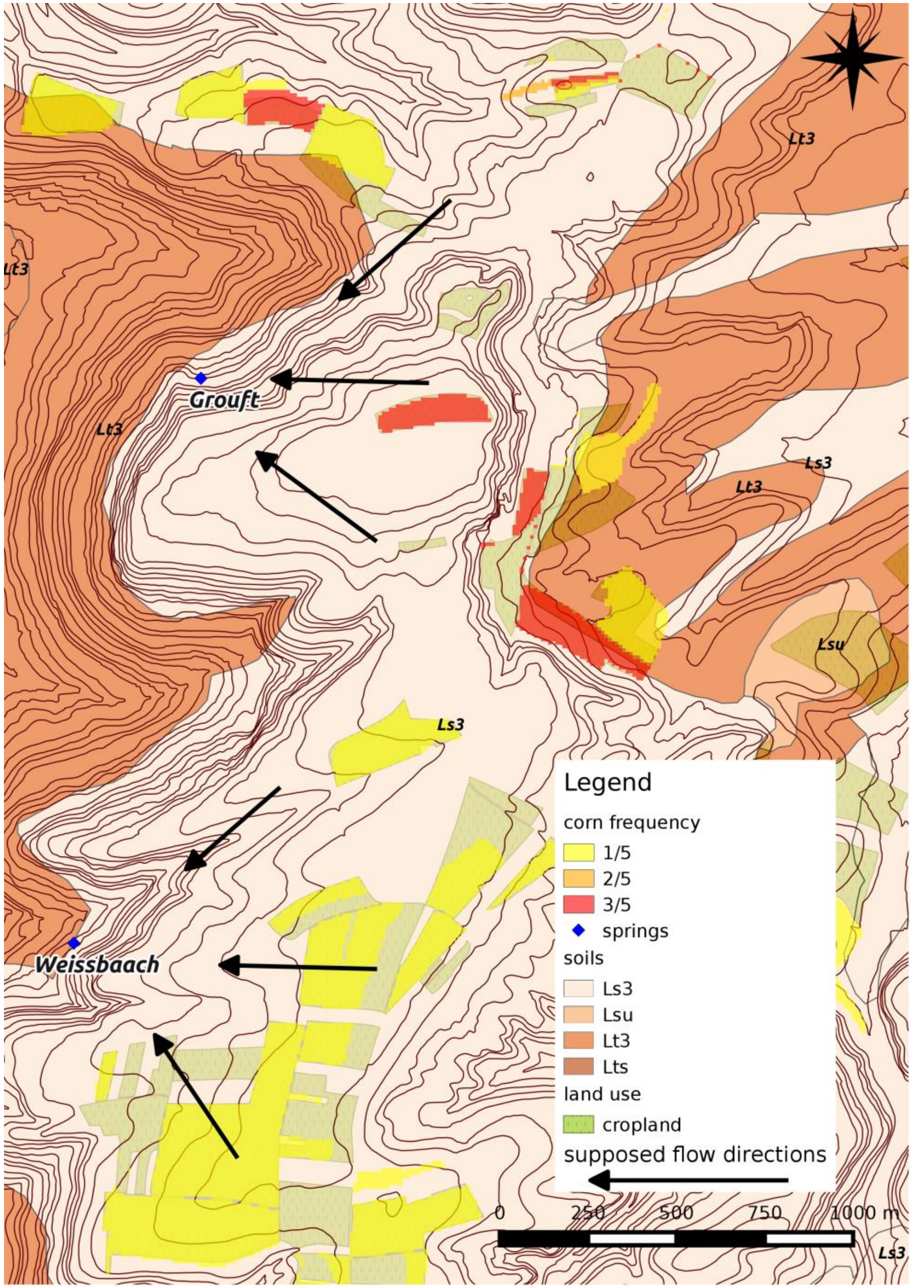
•applied s-metolachlor mass /ha

•groundwater dating for some sites

**Unknowns**

•recharge area of the capture zones

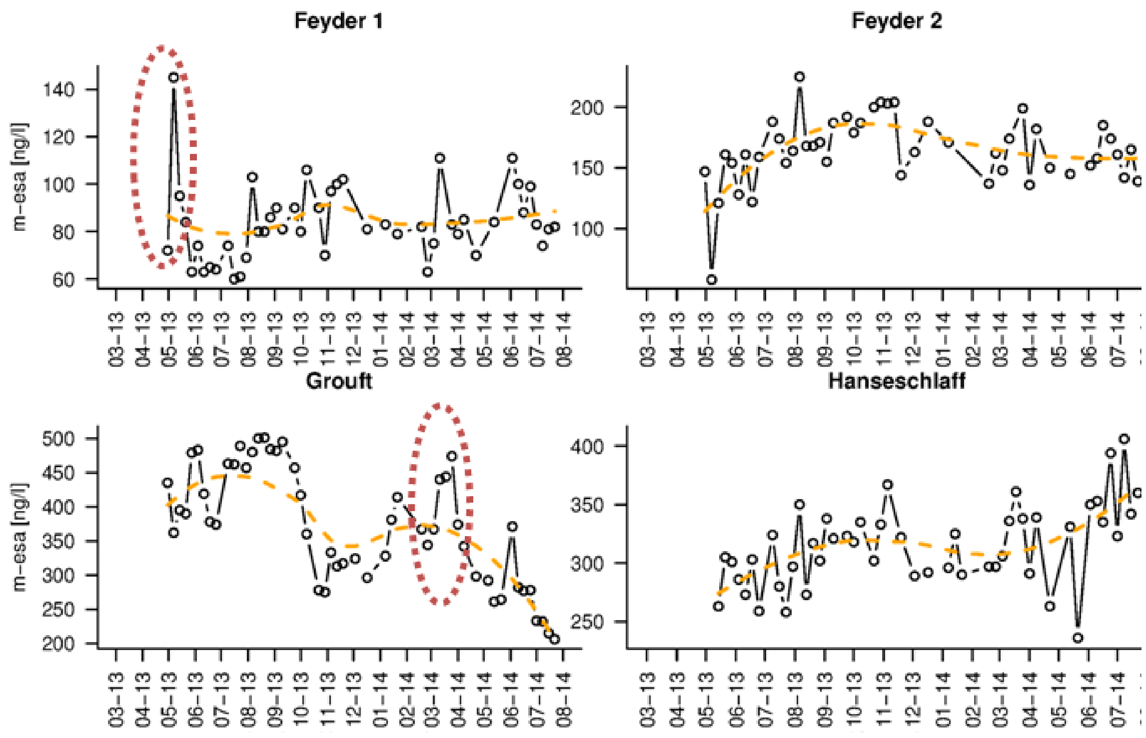
•boundaries of the capture zones



# Field sampling

**Program**

•twelve springs sampled weekly (May 2013-July 2014)




**Results**

•high m-ESA concentration all year round

•some breakthroughs observed as well

•some seasonal fluctuations (not always!)

•no clear-cut correlation with discharge or other solutes

➔local hydrogeological/pedological situation variable

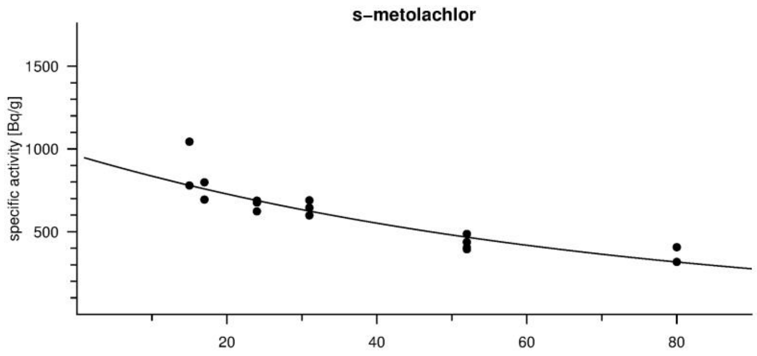
# Laboratory experiments

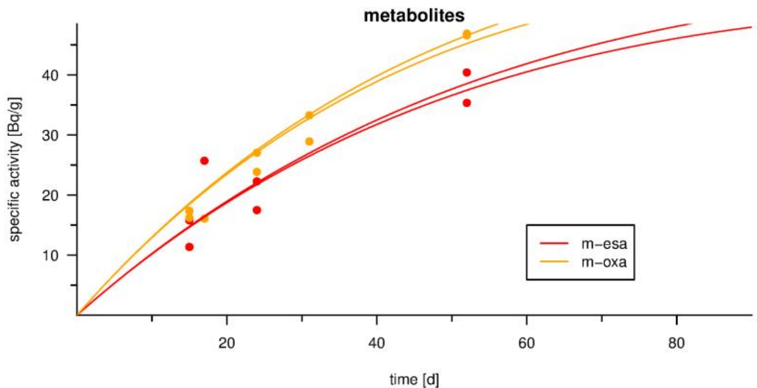
**Experimental setup**

•microcosm experiments over 12 weeks with a radiolabelled precursor
•NO sorption experiments (literature values for Koc and freundlich exponent)

**Results**

•longer half-life for s-metolachlor than previously reported (50 days vs. ~10 days)
•shorter half-life for m-ESA than previously reported (50 days vs. ~100 days)



# Numerical simulations

**Code setup**

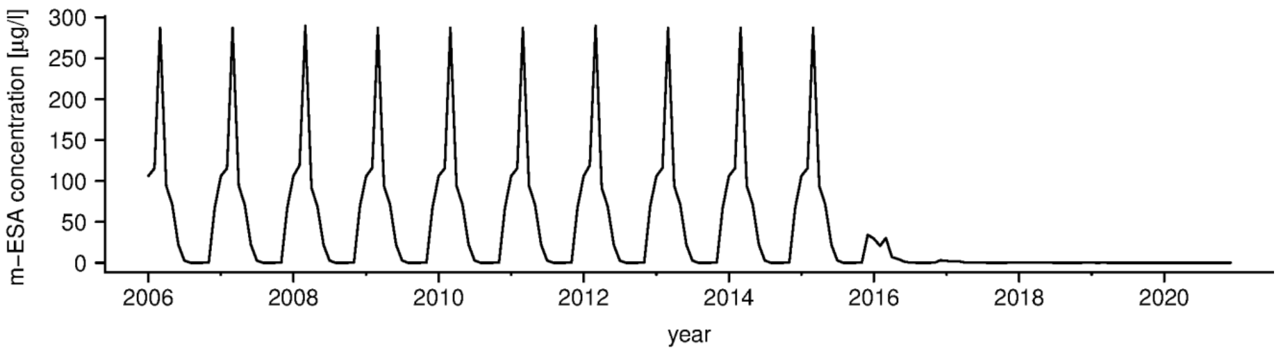
•PEARL is 1-D

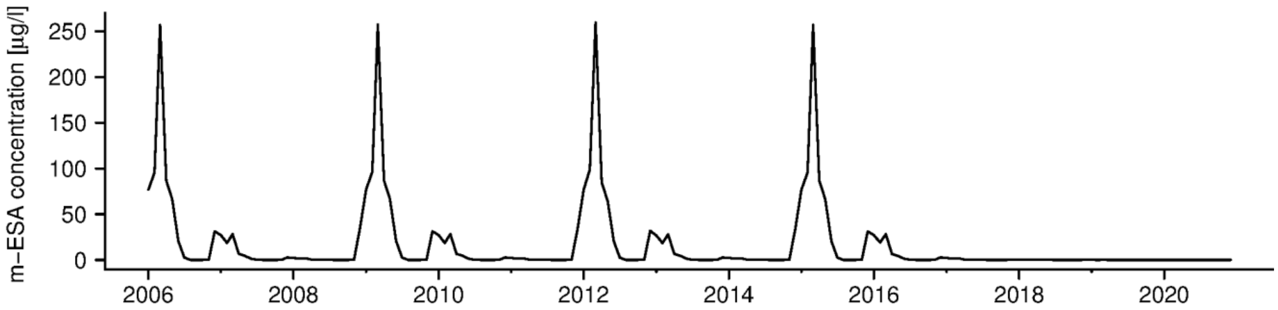
•integrated crop growth library

•soil hydraulic parameters from pedotransfer function (HYPRES)

•pesticide parameters from laboratory results (half-lives) and literature (sorption isotherm)

➔dynamics of the release of m-ESA from the soil




**Results**

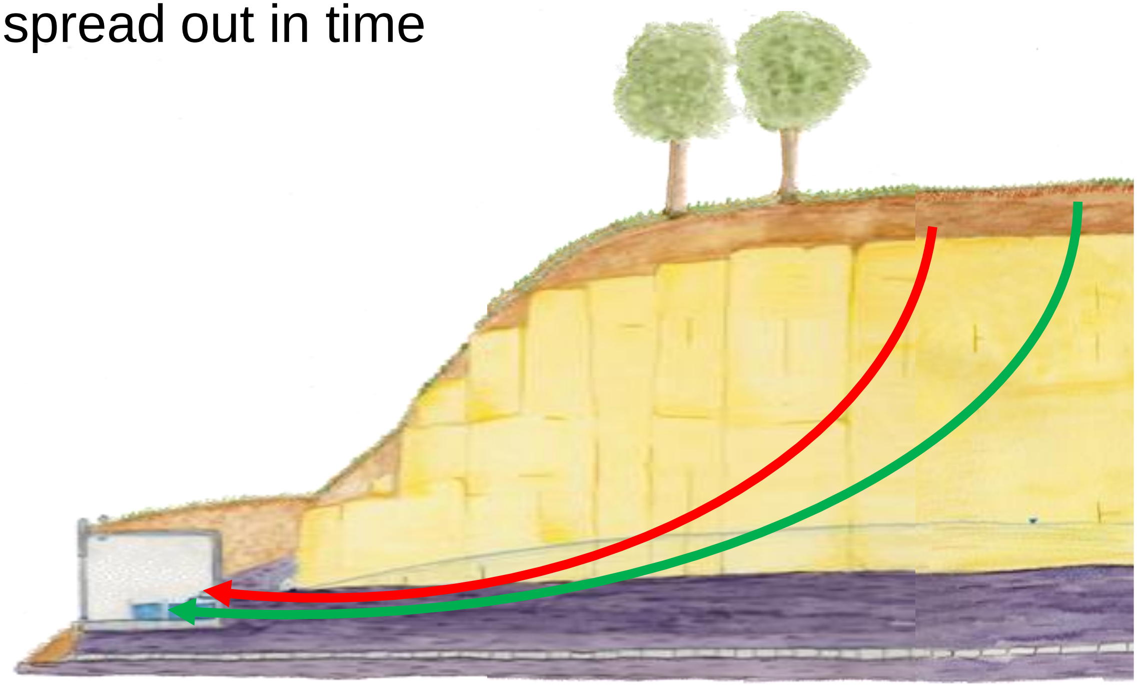
•m-ESA is released from the **soil** in pulses➔some storage in the **rock** is necessary to explain the high baseline concentrations in spring water

# Predictions: transit time distribution

**Convolution**

- distributes a pulse over flow lines with different transit times

➔even before dilution with pesticide-free water, concentration peaks in the leachate are spread out in time



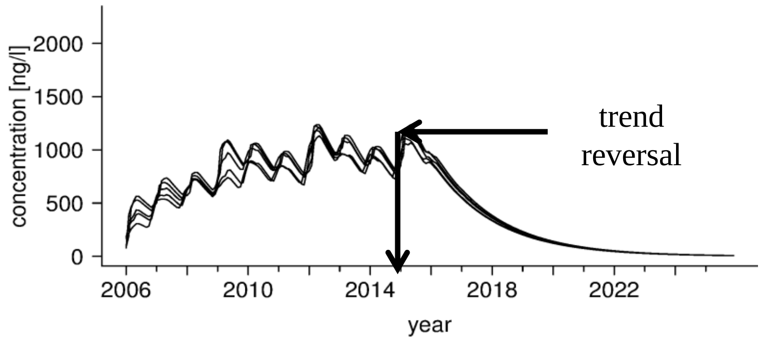
**m-ESA spring** ← **transfer function** ← **m-ESA soil**

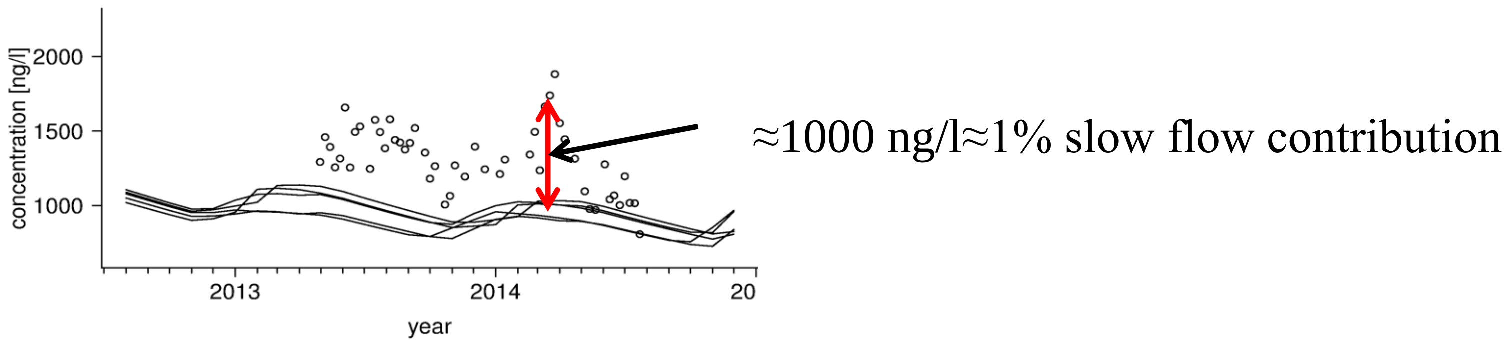
- Parameters of the transfer function➔tritium+stable isotopes

# Predictions

## Method

1. convolution
2. estimation of the surface area of the capture zone
3. corn fields surface area and rotation frequency in the capture zone
4. weighting concentration by the ratio of corn fields to total recharge area



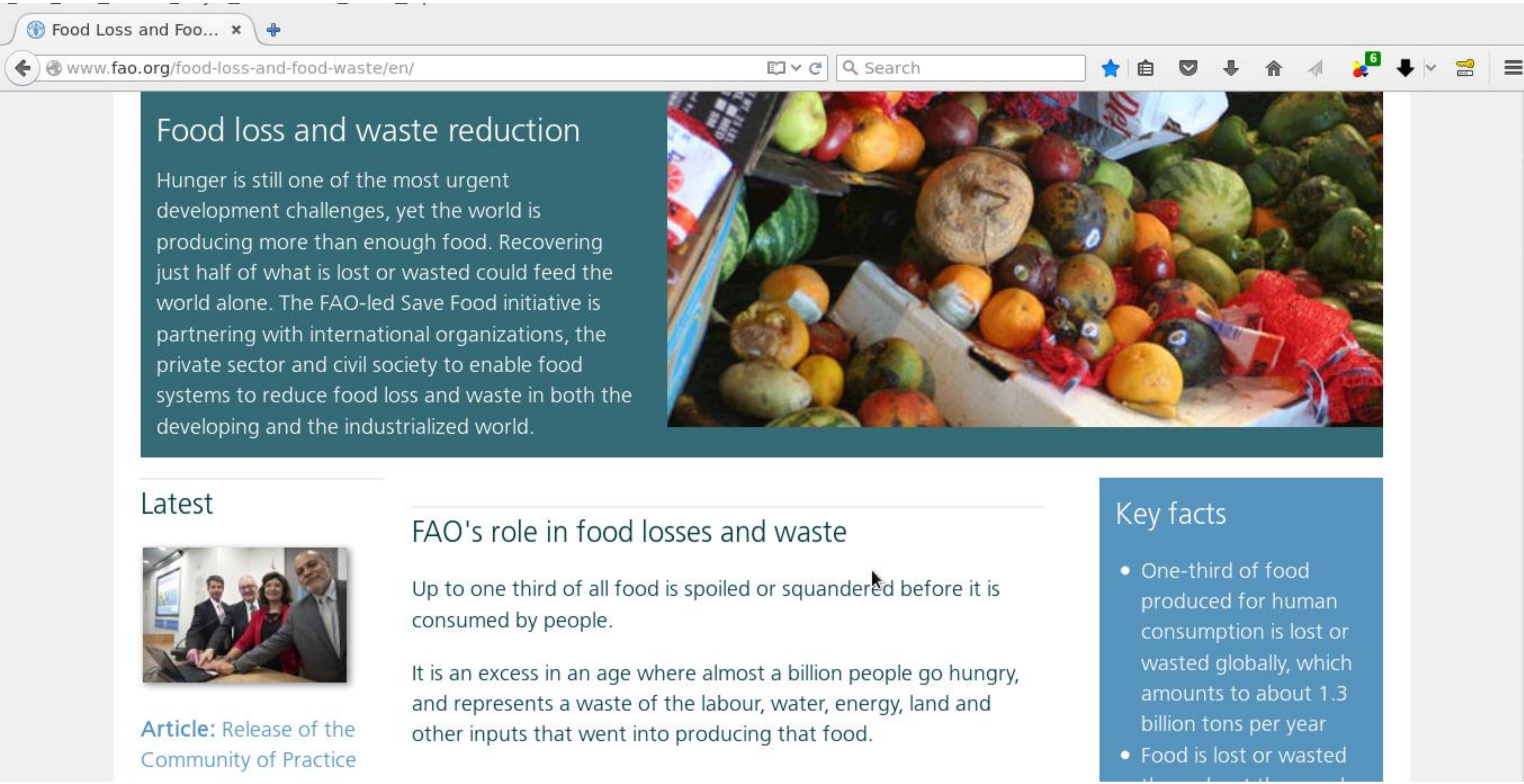




## Results

- ➢baseline concentrations can be explained (for some springs!) by the slow flow contribution
- ➢model residuals ➔fast flow contribution (≈1% discharge)
- ➢time to trend reversal: soil lag negligible compared to aquifer response time

# Conclusions

1. combining methods is essential and adds robustness to the results
2. knowing crop rotation is useful
3. very small fast flow contribution sufficient to produce peaks of 1000 ng/l
4. post-audit is around the corner (trend reversal predicted for 2015 for some springs)…


Food Loss and Foo... ×

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# Food loss and waste reduction

Hunger is still one of the most urgent development challenges, yet the world is producing more than enough food. Recovering just half of what is lost or wasted could feed the world alone. The FAO-led Save Food initiative is partnering with international organizations, the private sector and civil society to enable food systems to reduce food loss and waste in both the developing and the industrialized world.

## Latest

**Article:** Release of the Community of Practice

## FAO's role in food losses and waste

Up to one third of all food is spoiled or squandered before it is consumed by people.

It is an excess in an age where almost a billion people go hungry, and represents a waste of the labour, water, energy, land and other inputs that went into producing that food.

## Key facts

- One-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year
- Food is lost or wasted