



Will our traditions for groundwater sampling in agricultural settings survive the 21st century?

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Sampling for the Dutch agricultural water quality monitoring program (LMM), operated by RIVM.





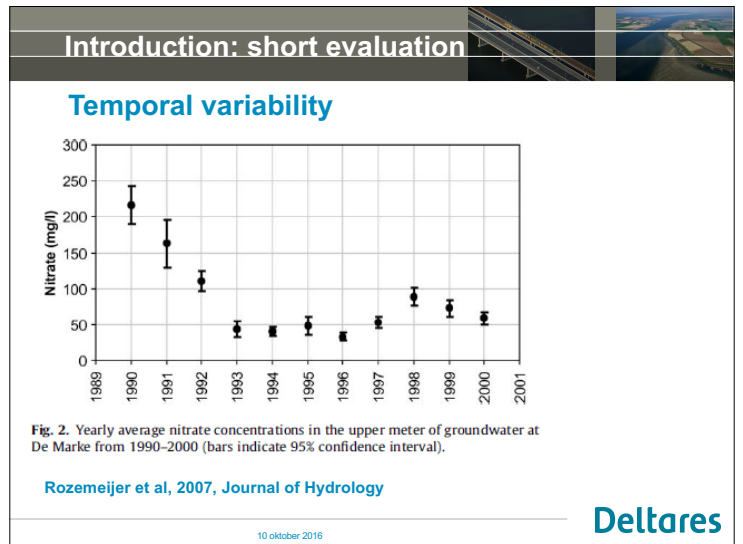
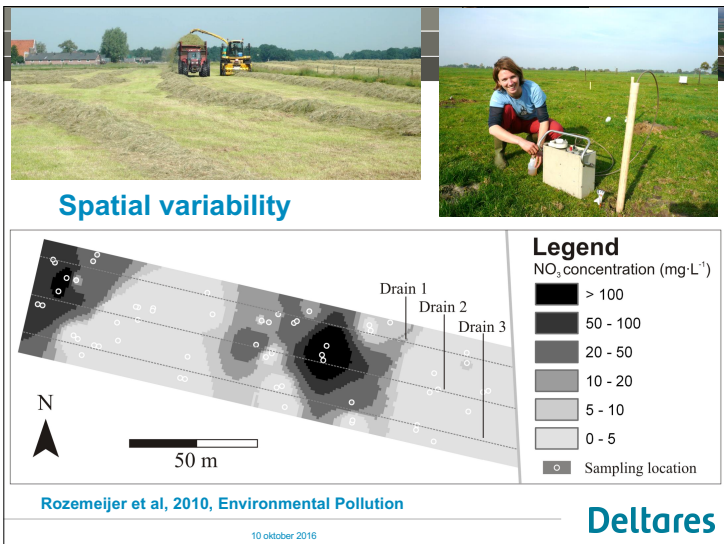
Introduction: short evaluation

Short evaluation of current groundwater monitoring practice:

- Expensive
- Heavy work
- Many steps
- Sensitive to errors
- Slow

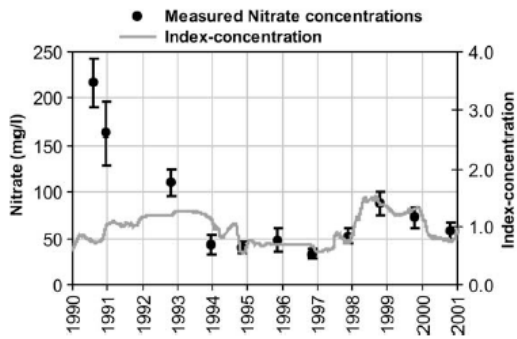
And does it provide it the information that we need?

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Introduction: short evaluation

Temporal variability



Boumans et al., 2001, Netherlands Journal of Agricultural Science
Rozemeijer et al, 2007, Journal of Hydrology

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Information issues:

- Spatial variability
- Temporal variability
- What water are we sampling?

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Introduction: short evaluation

Short evaluation of current groundwater monitoring practice:

- Expensive
- Heavy work
- Many steps
- Sensitive to errors
- Slow
- **And it does not always provide it the information that we need**

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Introduction: short evaluation

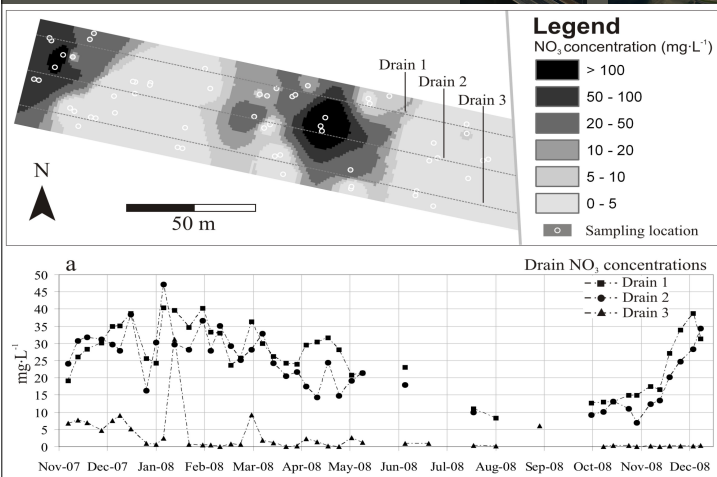
Some potential improvements:

- Choosing the sampling domain
- Average concentration measurements
- Distributed Chemical Sensing
- In situ smartphone based measurements

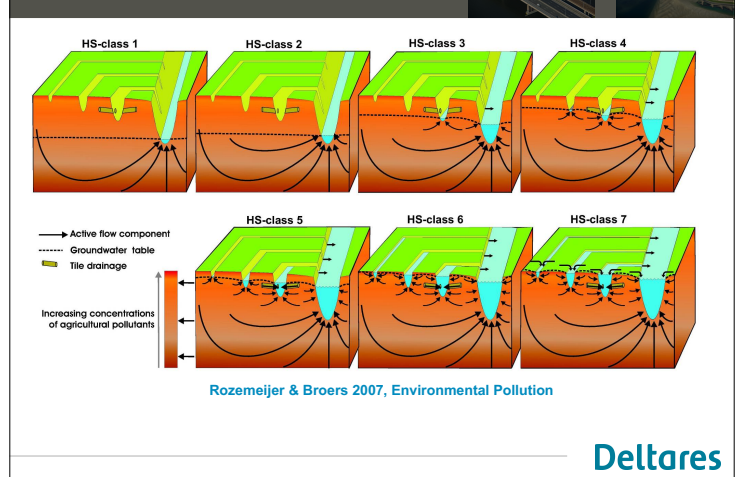
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Choosing the sampling domain

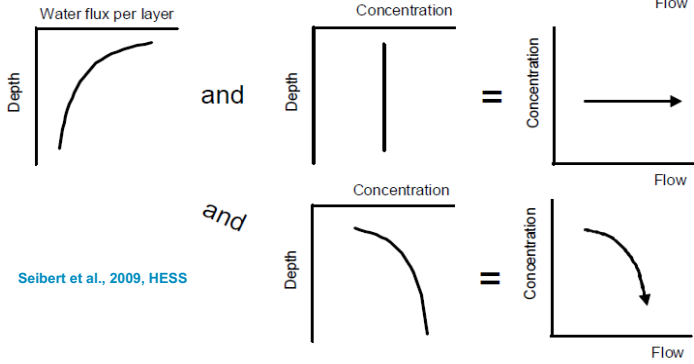


Choosing the sampling domain



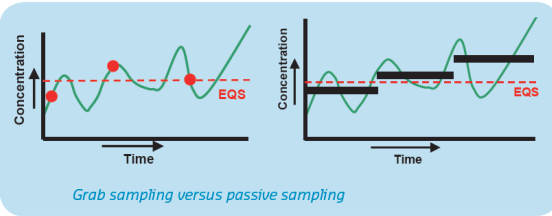
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Riparian profile flow-concentration Integration Model (RIM)

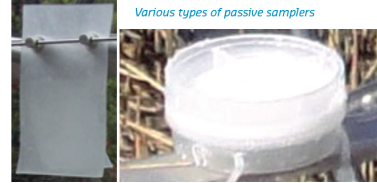


Seibert et al., 2009, HESS

Average concentration measurements

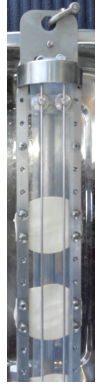


Grab sampling versus passive sampling



Silicone rubber Speedisk

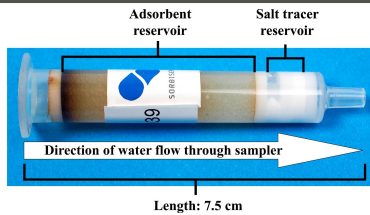
Vrana et al., 2016, TrAC



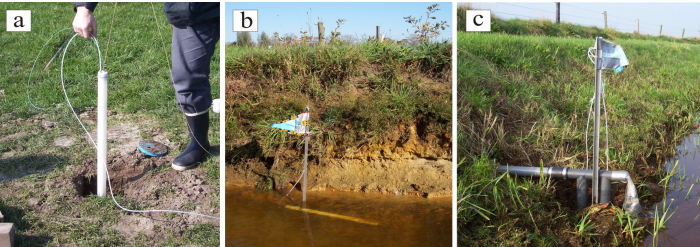
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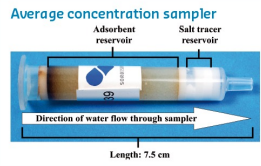
Average concentration measurements



De Jonge & Rothenberg, 2005, ES&T
Rozemeijer et al., 2010, ES&T



Basic concept



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Installation with Suro-outlet for flow proportional sampling



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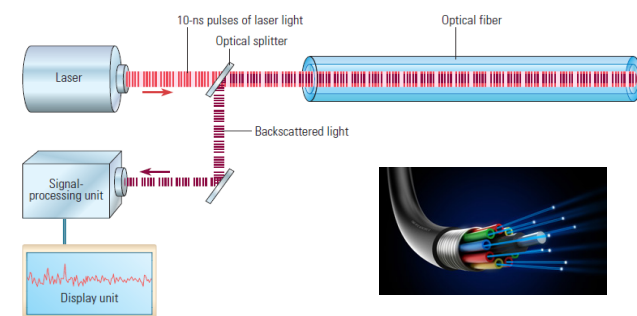
Low-tech measurements of flux average concentrations and loads from drains



Vendelboe et al, 2016, EMA

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Distributed Temperature Sensors



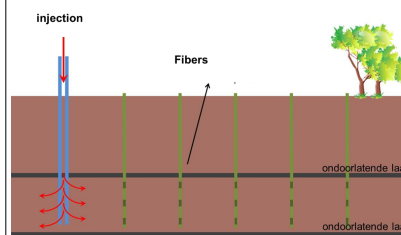
^ DTS process. The DTS laser shoots bursts of light down the length of the optical fiber. Some light returns in the form of backscatter. The backscattered light is split from the incident pulses and filtered into discrete wavelengths. Because the speed of light is constant, a log of the backscattered light can be generated for each meter of the fiber.

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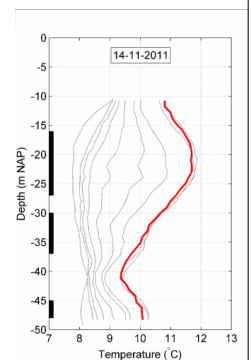
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Distributed Temperature Sensors

Example of current application:
Monitoring Aquifer Thermal Energy Storage (ATES)



De Kleine et al., 2016, SAGEEP conference



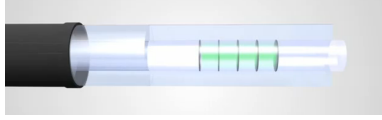
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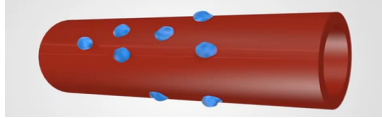
Distributed Chemical Sensors

From DTS to DCS (distributed chemical sensors)

Fiber Bragg Grating sensors (FBG's):
Optical sensors sensitive to strain



Responsive coatings:
Respond to chemical conditions or concentration levels

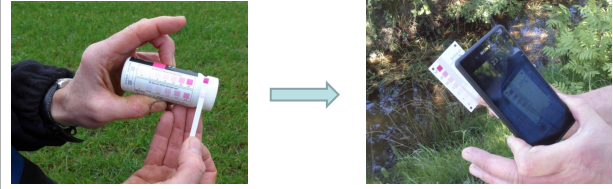


Van der Kuil et al., 2016 (TNO/Deltares report in prep.)

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Nitrate App

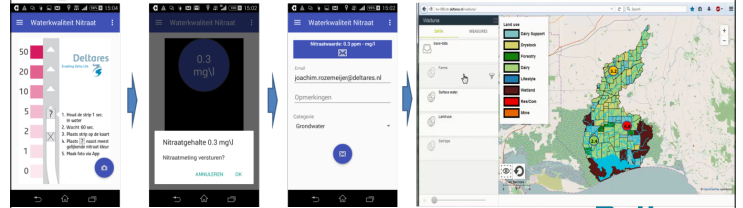


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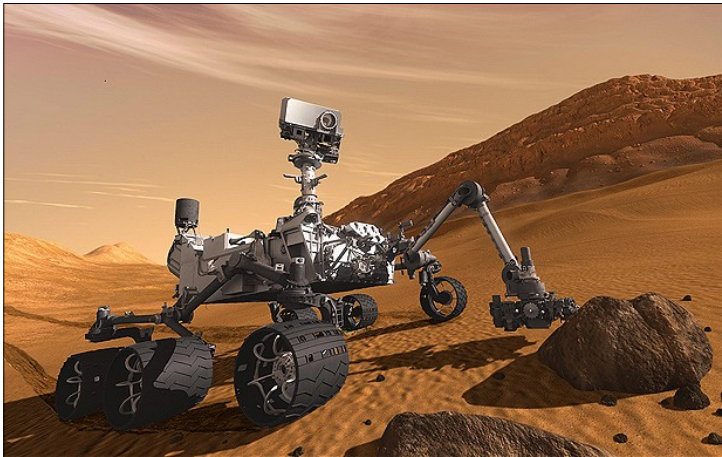
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Nasa's Mars Science Laboratory Curiosity rover, a mobile robot for investigating Mars' past or present ability to sustain microbial life.

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Conclusion

Will our traditions for groundwater sampling in agricultural settings survive the 21st century?



Hopefully not!

Thanks. Questions?

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