Technical University of Denmark

Determining the importance of groundwater pathways for pesticide impacts on streams

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with

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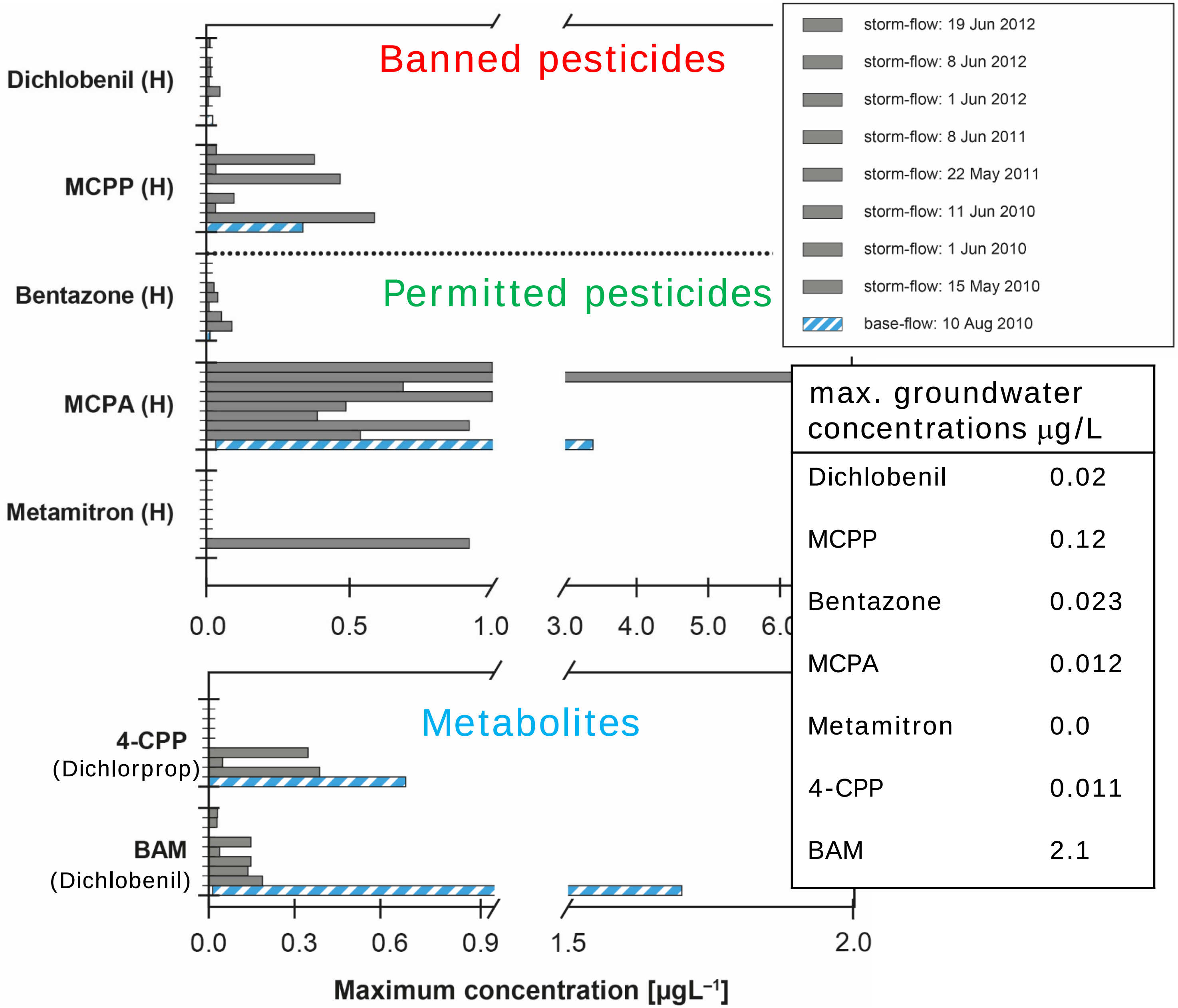
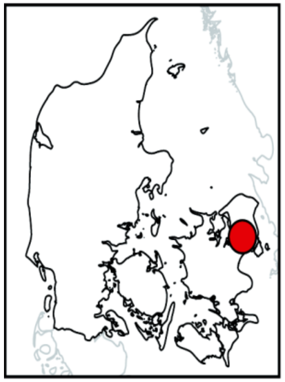
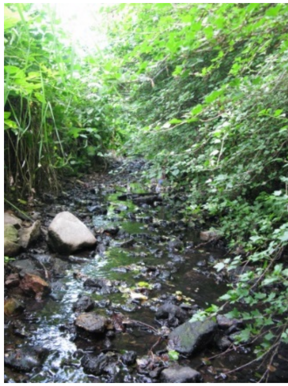
Pesticide in streams



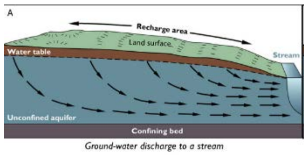
max. groundwater concentrations μg/L	
Dichlobenil	0.02
MCPP	0.12
Bentazone	0.023
MCPA	0.012
Metamitron	0.0
4-CPP	0.011
BAM	2.1



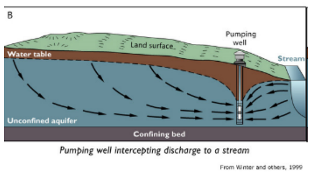


McKnight, U. S., J. J. Rasmussen, B. Kronvang, P. J. Binning, and P. L. Bjerg (2015), Sources, occurrence and predicted aquatic impact of legacy and contemporary pesticides in streams, *Environmental Pollution, 200, 64-76.*

Introduction



Groundwater pesticides impact streams

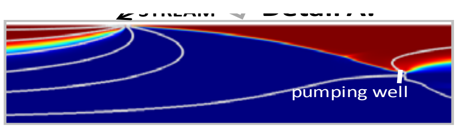


Stream pesticides impact groundwater

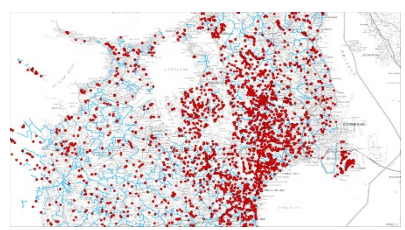
It goes both ways

Tools

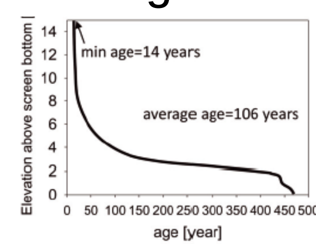
Models



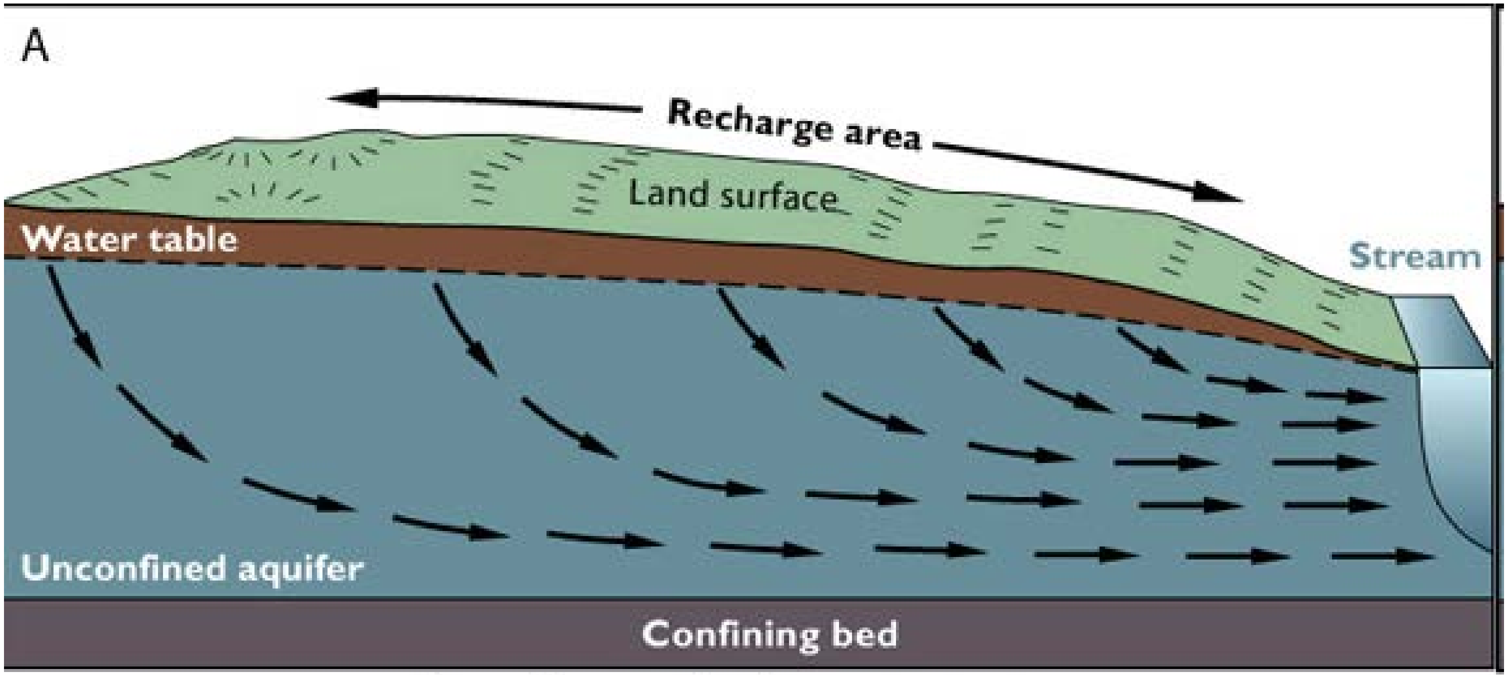
Statistics



Age



Groundwater pesticides impact streams

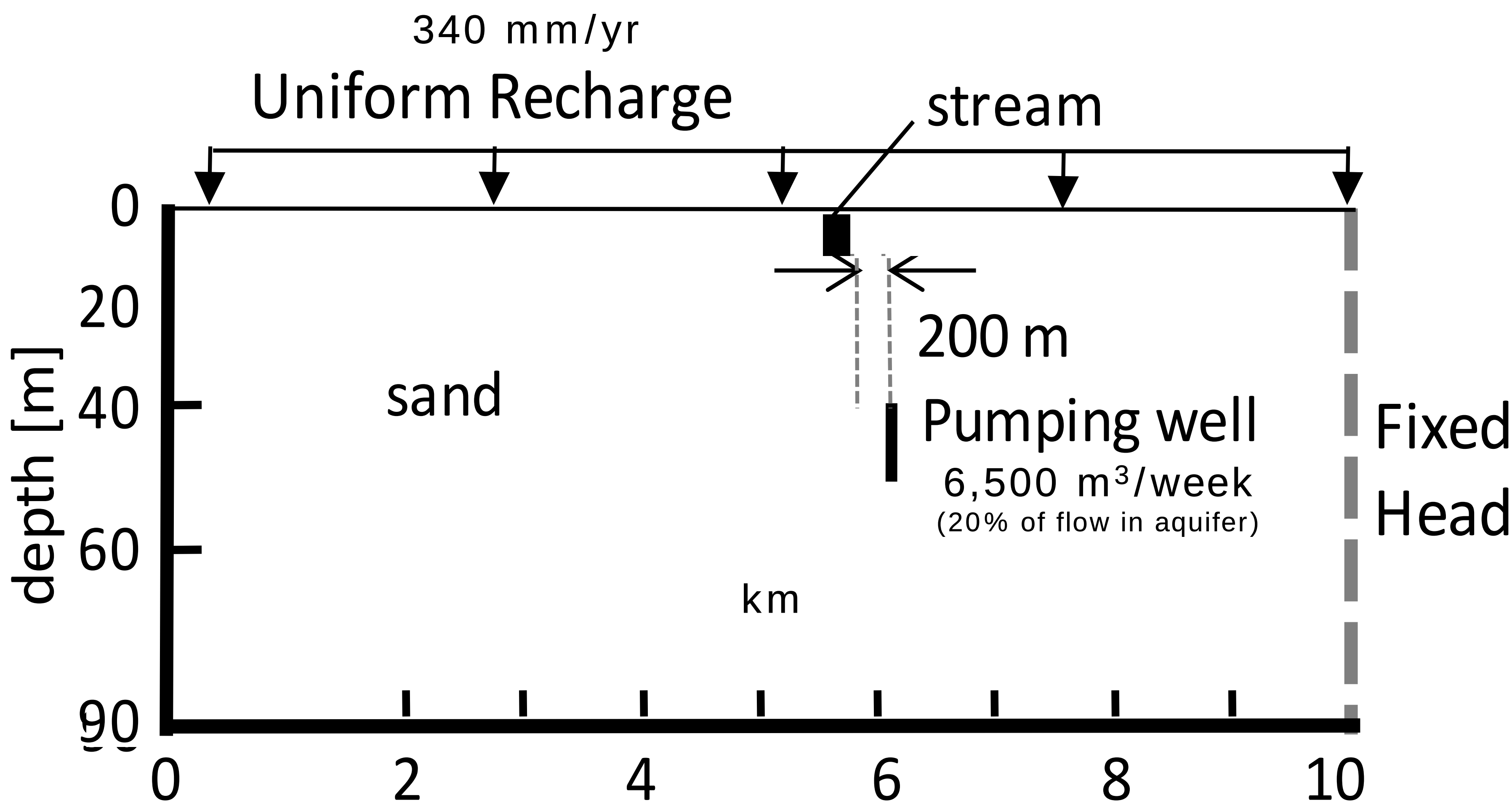


Ground-water discharge to a stream

DTU Environment
Department of Environmental Engineering

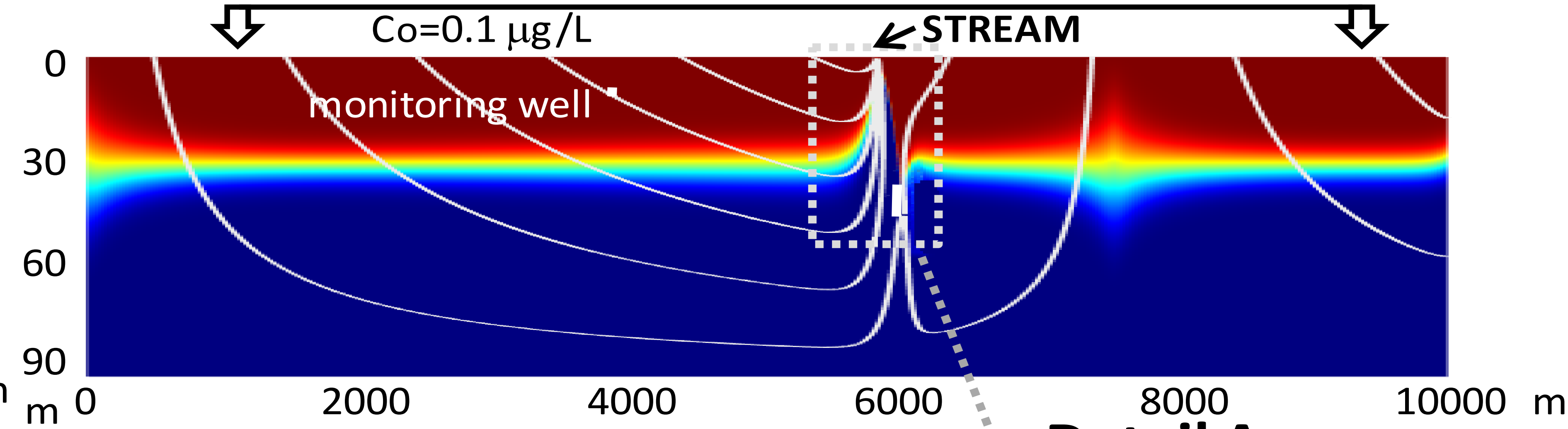
Winter, T. C., J. W. Harvey, O. L. Franke, and W. M. Alley (1998), Ground Water and Surface Water A Single Resource, U.S. Geological Survey Circular 1139*, Denver, Colorado.*

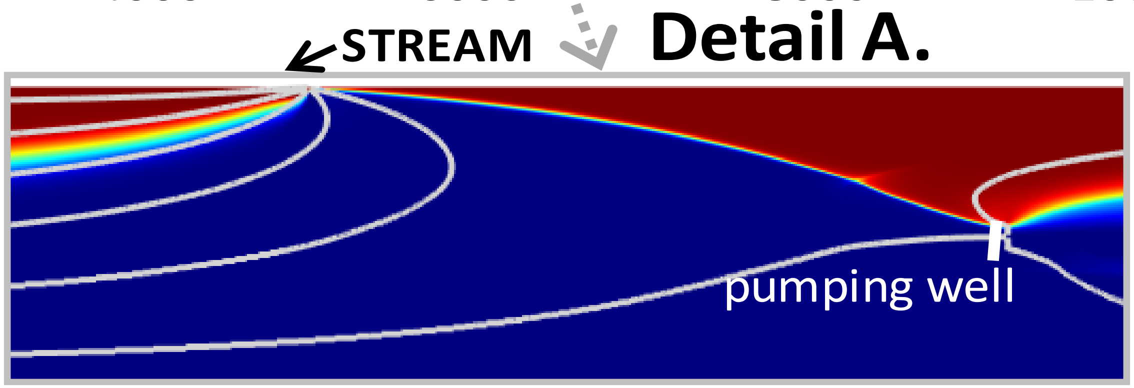
Groundwater impacts streams



Aisopou, A., P. J. Binning, J. Chambon, and P. L. Bjerg (2012), Pesticide breakthrough at monitoring and pumping wells generated from diffuse and point source application: Appendix M3, *Miljøprojekt nr. 1502, 2013, Miljøstyrelsen.*

1975-present, Bentazone

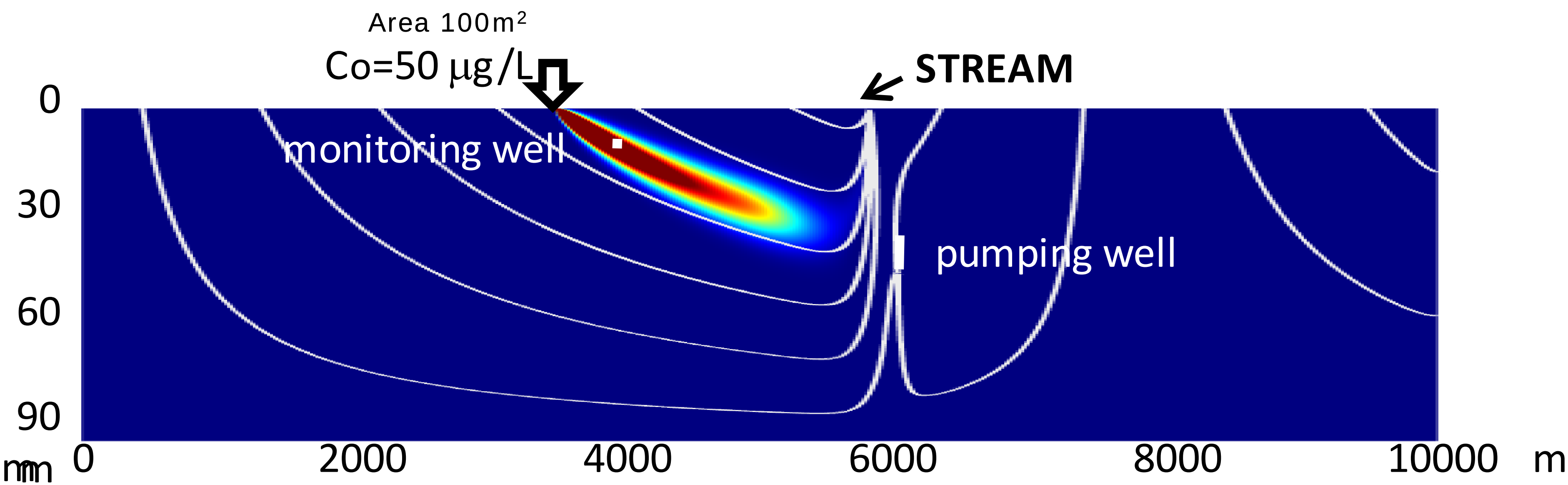




Input concentrations typical of values at the water table

Aisopou, A., P. J. Binning, J. Chambon, and P. L. Bjerg (2012), Pesticide breakthrough at monitoring and pumping wells generated from diffuse and point source application: Appendix M3, *Miljøprojekt nr. 1502, 2013, Miljøstyrelsen.*

1980-present, Bentazone



Input concentrations
typical of values at
bentazone point sources

Aisopou, A., P. J. Binning, J. Chambon, and P. L. Bjerg (2012), Pesticide breakthrough at monitoring and pumping wells generated from diffuse and point source application: Appendix M3*, Miljøprojekt nr. 1502, 2013, Miljøstyrelsen.*

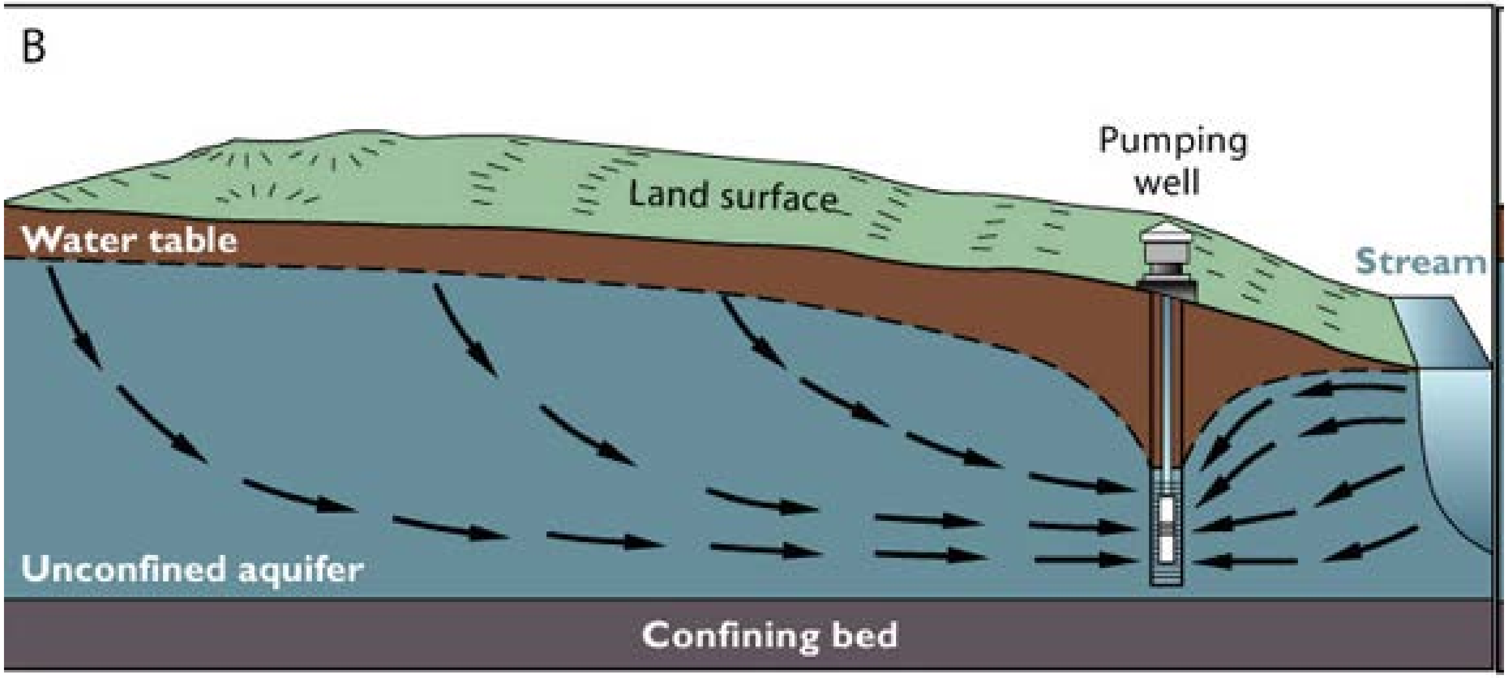
Pesticide properties matter

	Neither sorbed or degraded	Weakly sorbed Degraded $t_{\frac{1}{2}} > 35\,\text{days}$	Strongly sorbed Degraded $t_{\frac{1}{2}} = 231\,\text{days}$
Property	Bentazone	MCPP	Glyphosate
K_d (clay) (L/kg)	0	0,5 [d]	300[a] or 100
k_1 (clay) day^{-1}	0	0,02 or 0,002 or 0,0002 or 0	0,003 [a]
K_d (sand) (L/kg)	0	0,1 [d]	150[a] or 5
k_1 (sand) day^{-1}	0 [c]	0,02 or 0,002 or 0,0002 or 0	0,003 [b]
K_d (chalk) (L/kg)	0	0	0

[a] (Vereecken 2005), [b] (de Lipthay et al. 2007), [c](van der Pas et al. 1998), [d] (Madsen et al. 2000)

Aisopou, A., P. J. Binning, J. Chambon, and P. L. Bjerg (2012), Pesticide breakthrough at monitoring and pumping wells generated from diffuse and point source application: Appendix M3, *Miljøprojekt nr. 1502, 2013, Miljøstyrelsen.*

Streams impact groundwater

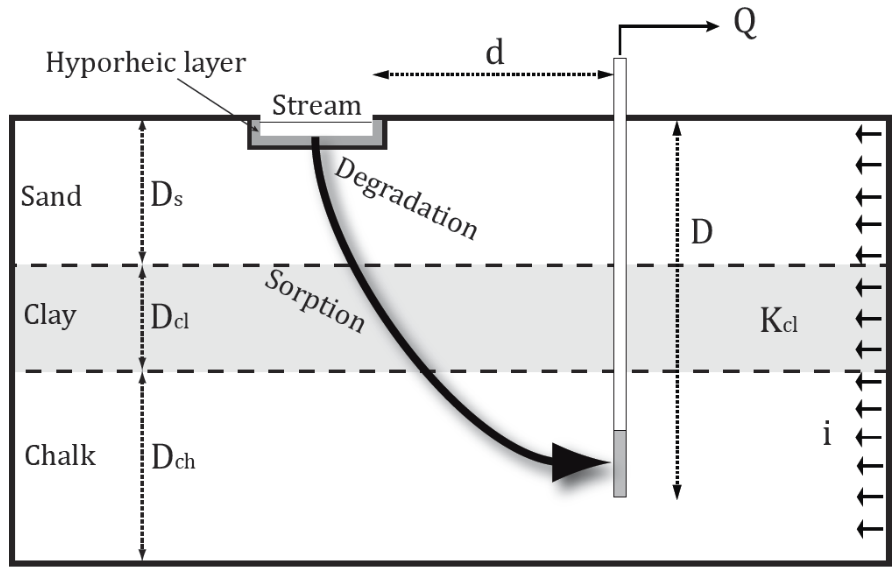


Pumping well intercepting discharge to a stream

From Winter and others, 1999

Winter, T. C., J. W. Harvey, O. L. Franke, and W. M. Alley (1998), Ground Water and Surface Water A Single Resource, U.S. Geological Survey Circular 1139*, Denver, Colorado.*

Streams impact groundwater



Confined aquifer

Concentrations up to 7% of stream

Unconfined aquifer

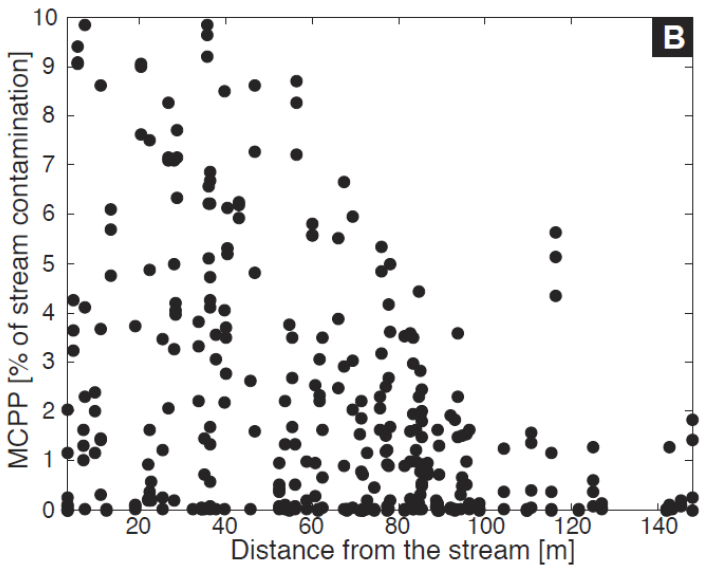
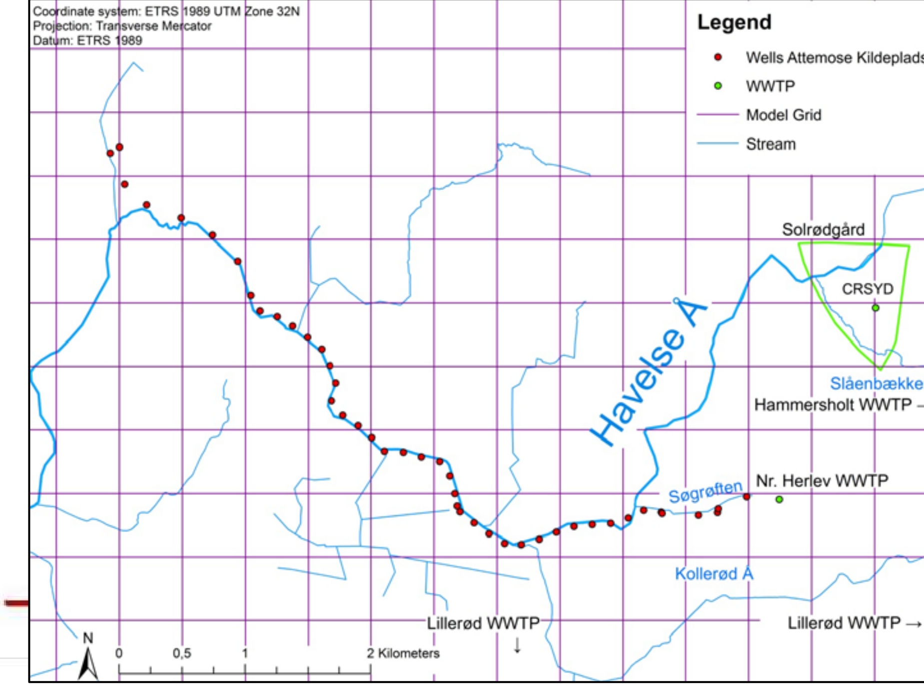


Table 2
Parameters intervals used for sensitivity analysis.

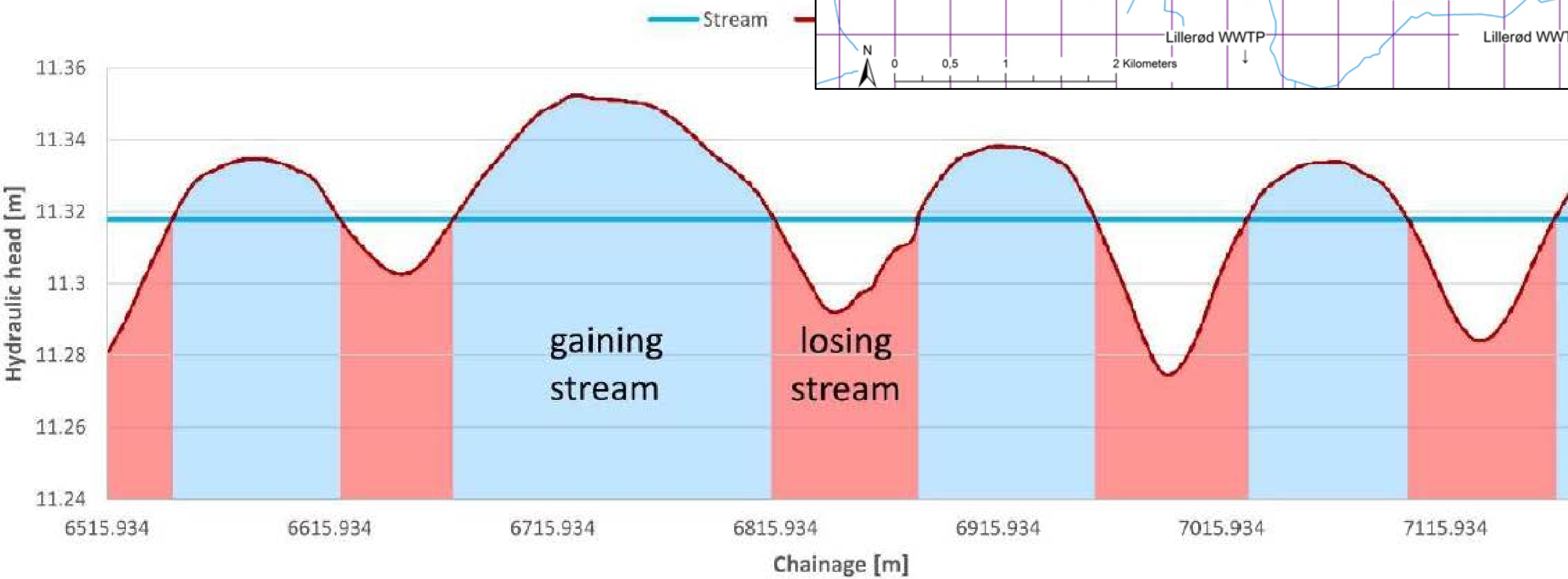
Parameter	Symbol	Unit	Range
Sand aquifer thickness	D_s	m	1–30
Clay layer thickness	D_{cl}	m	0–30
Chalk aquifer thickness	D_{ch}	m	1–100
Distance from the stream	d	m	3–150
Well depth	D	m	8–100
Aerobic hypoheric zone	O_2	–	Yes/no
Abstraction rate	Q	m^3/h	1–100
Natural hydraulic gradient	i	m/m	−1% to +1%
Clay hydraulic conductivity	K_{cl}	m/s	3e−7–1e−8

Malaguerra, F., H.-J. Albrechtsen, and P. J. Binning (2013), Assessment of the contamination of drinking water supply wells by pesticides from surface water resources using a finite element reactive transport model and global sensitivity analysis techniques, *Journal of Hydrology, 476, 321–331.*

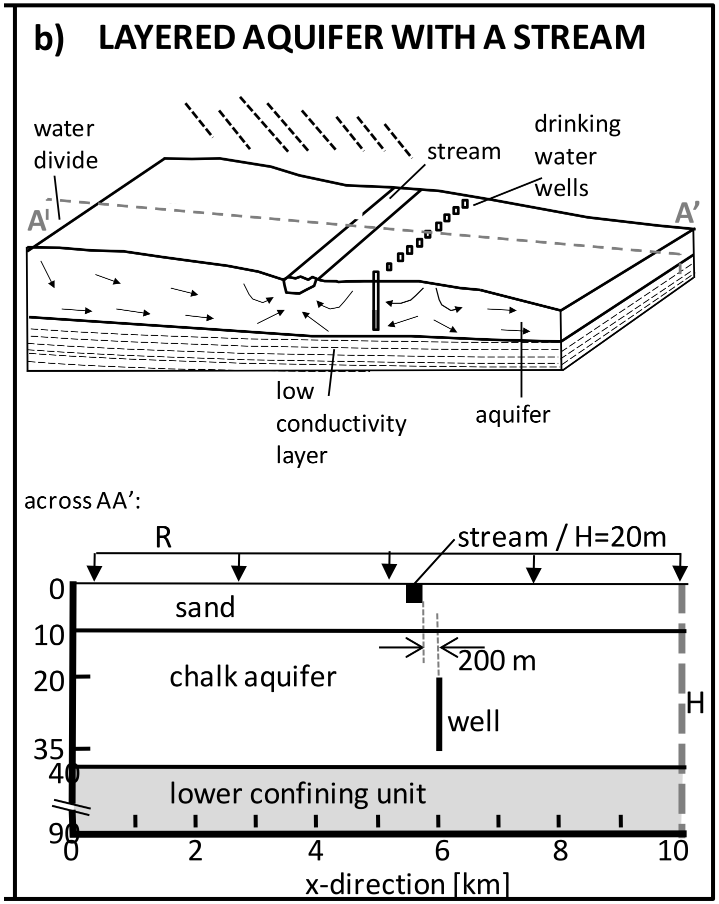
It goes both ways

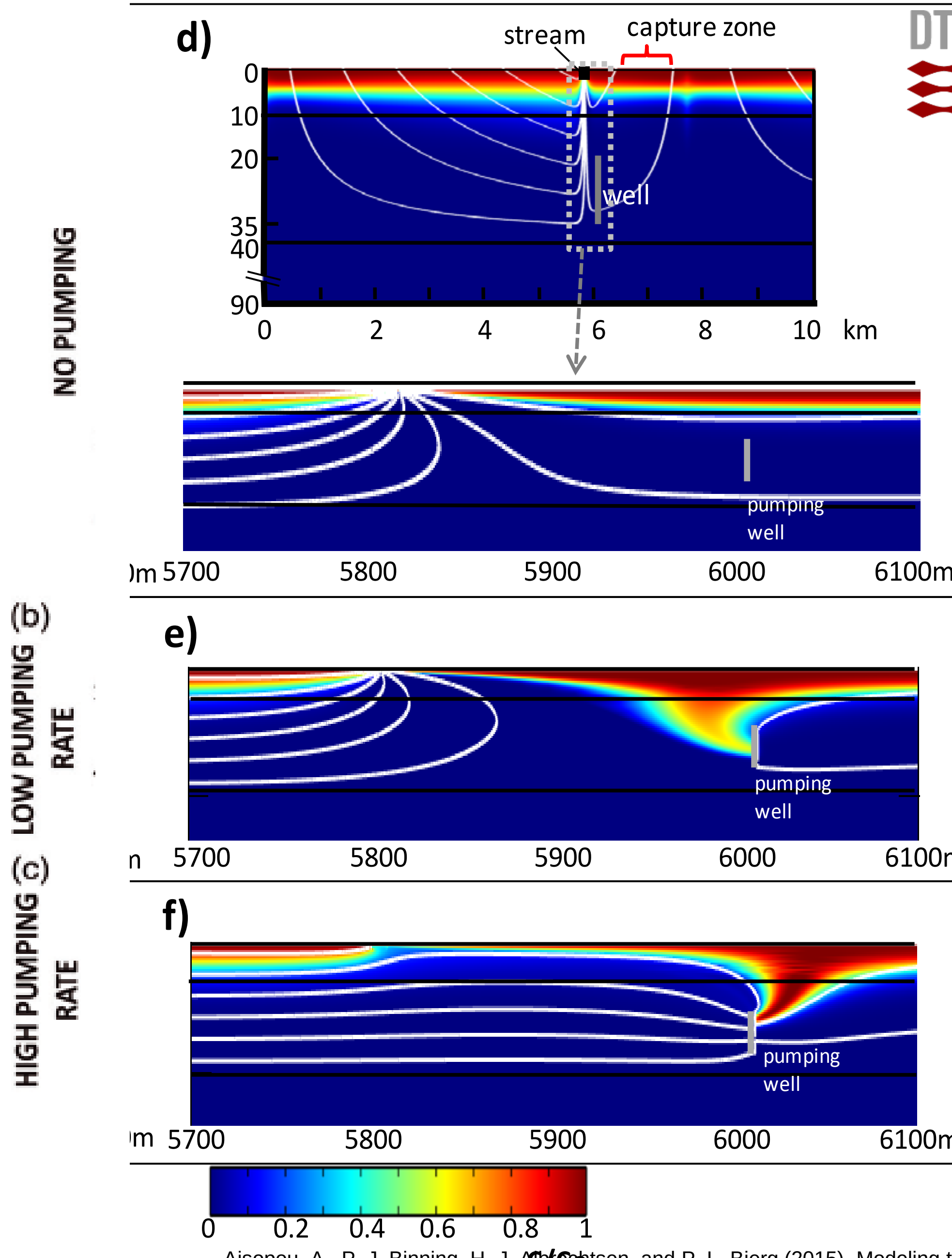


Havelse Å: a gaining stream



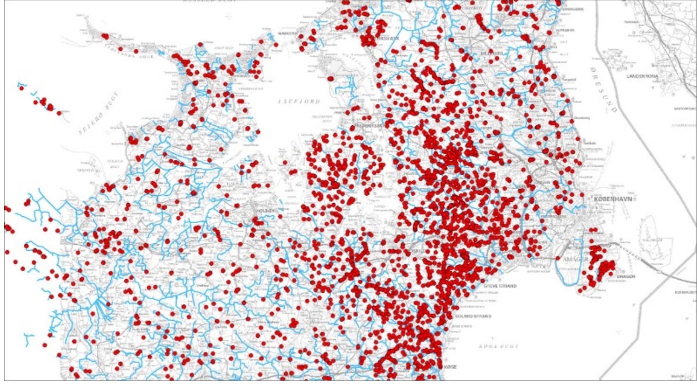
Tobias Lorenz, MSc thesis

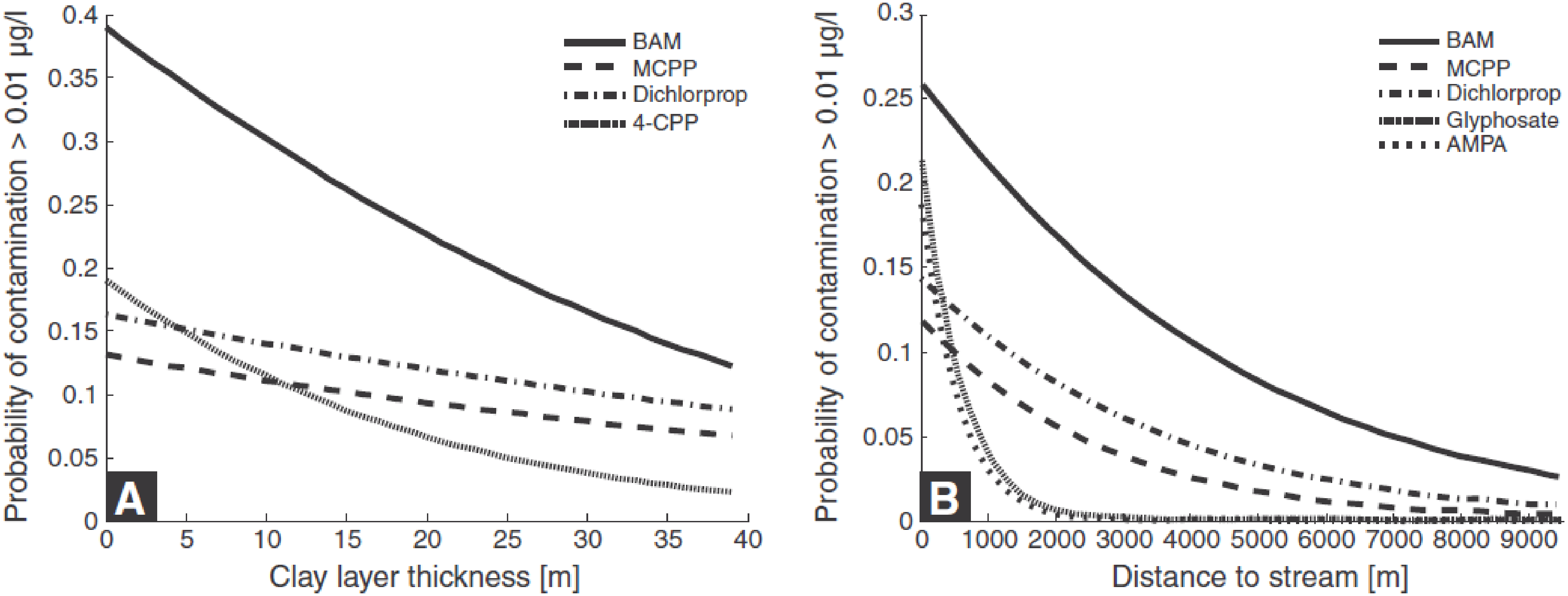




Aisopou, A., P. J. Binning, H.-J. Albrechtsen, and P. L. Bjerg (2015), Modeling the Factors Impacting Pesticide Concentrations in Groundwater Wells, *Groundwater, doi: 10.1111/gwat.12264.*

Usually when we analyze pesticide occurrence we focus on soil type

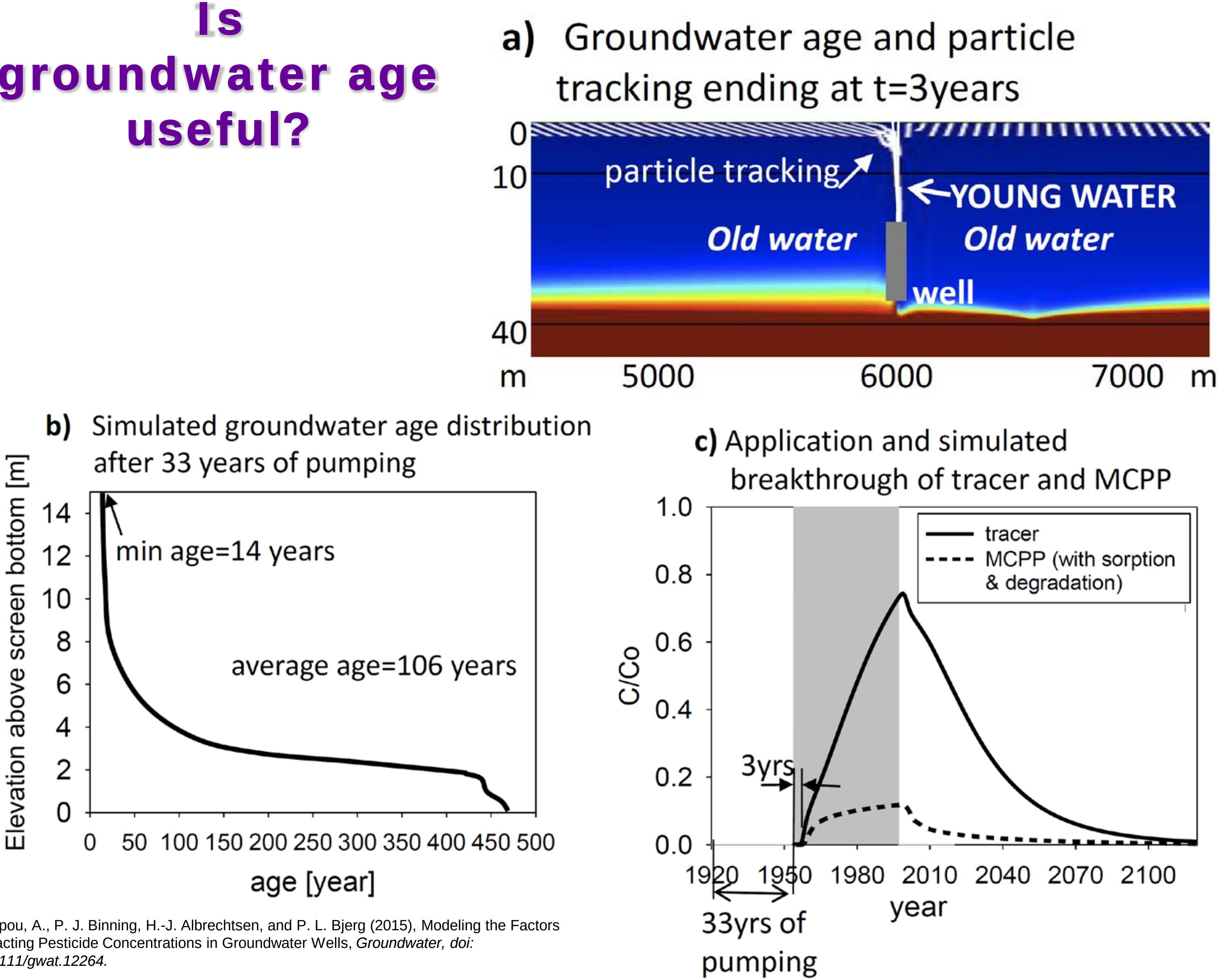




But the relationship to surface water is just as important!

Malaguerra, F., H.-J. Albrechtsen, L. Thorling, and P. J. Binning (2012), Pesticides in water supply wells in Zealand, Denmark: A statistical analysis, *Science of the Total Environment, 414, 433-444.*

Is groundwater age useful?



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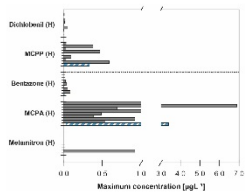
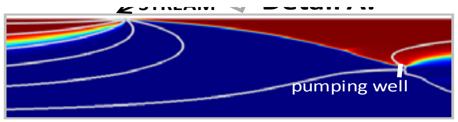
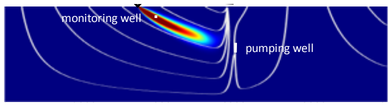
Conclusions



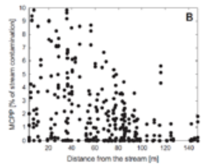
We observe groundwater pesticides in streams



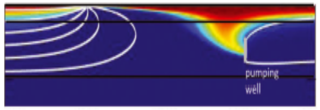
Diffuse sources impact streams today



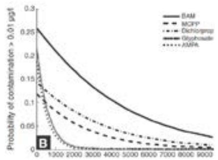
Point source impact depends on many factors



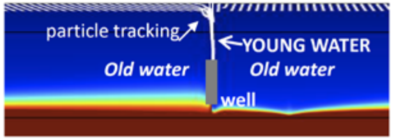
Streams are likely to impact groundwater



Pumping affects stream interaction



Surface water is as important as soil type



Groundwater age must be used very carefully