Experiences with ATES and ERD in NL
&
LCA of ATES-ERD

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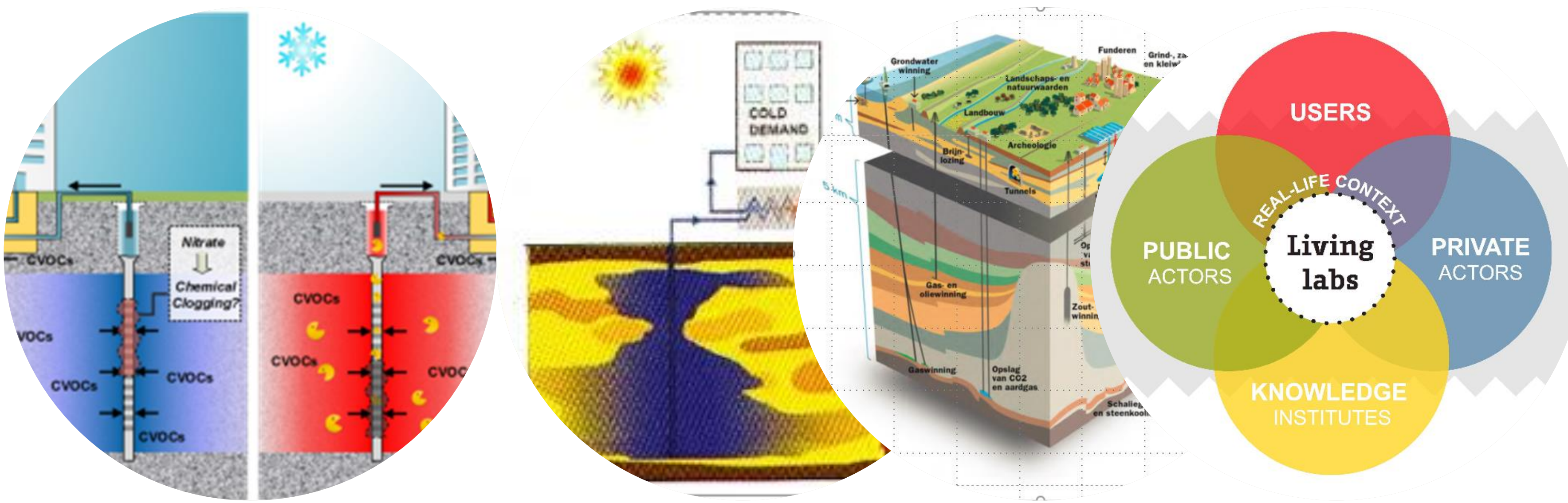

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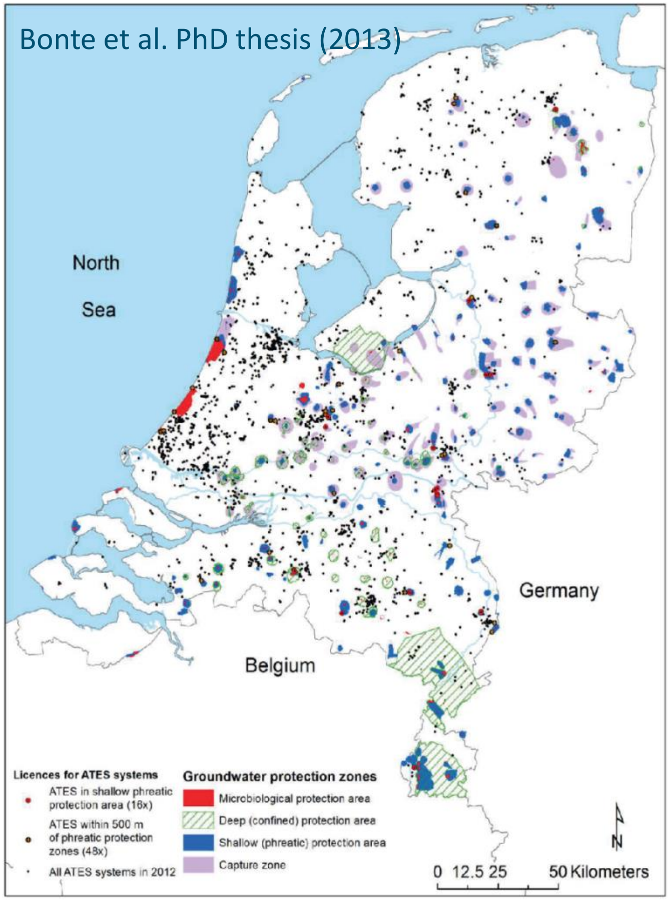
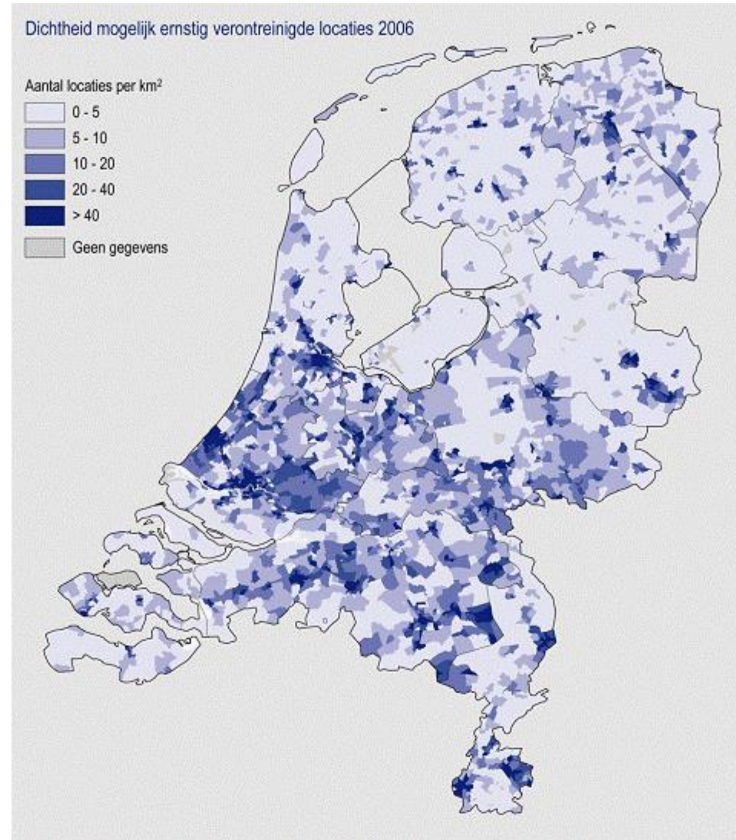
On-line møde i ATV Jord og Grundvand om Muligheder i udnyttelse af undergrunden i klimaperspektiv 25 May 2021

Stadswende

Context of the ATES–ERD concept





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2019: 2 Pilot studies finalized

- Sports center Welgelegen Utrecht, NL (2017-2018)
  - Low concentrations VOCl around Central Station
  - Extension existing ATES monowell by injection DHC biomass

- Hammerbakken, Birkerød, DK (2018-2019)
  - High concentration VOCl in industrial area
  - ATES recirculation system, Electron donor addition and injection DHC biomass

Utrecht Pilot
(Sportscenter Welgelegen, Utrecht)

Installation Biomass injection well

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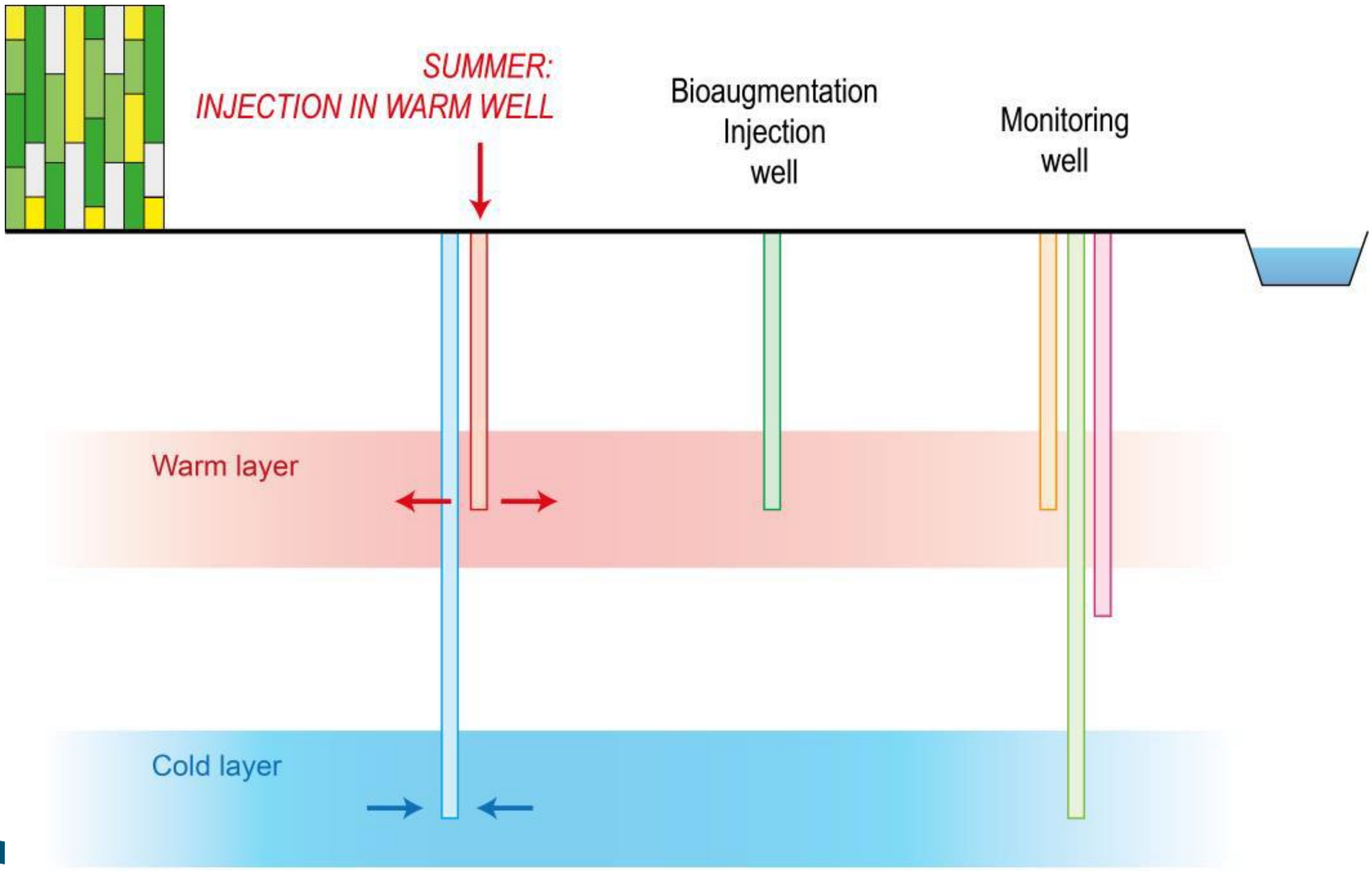
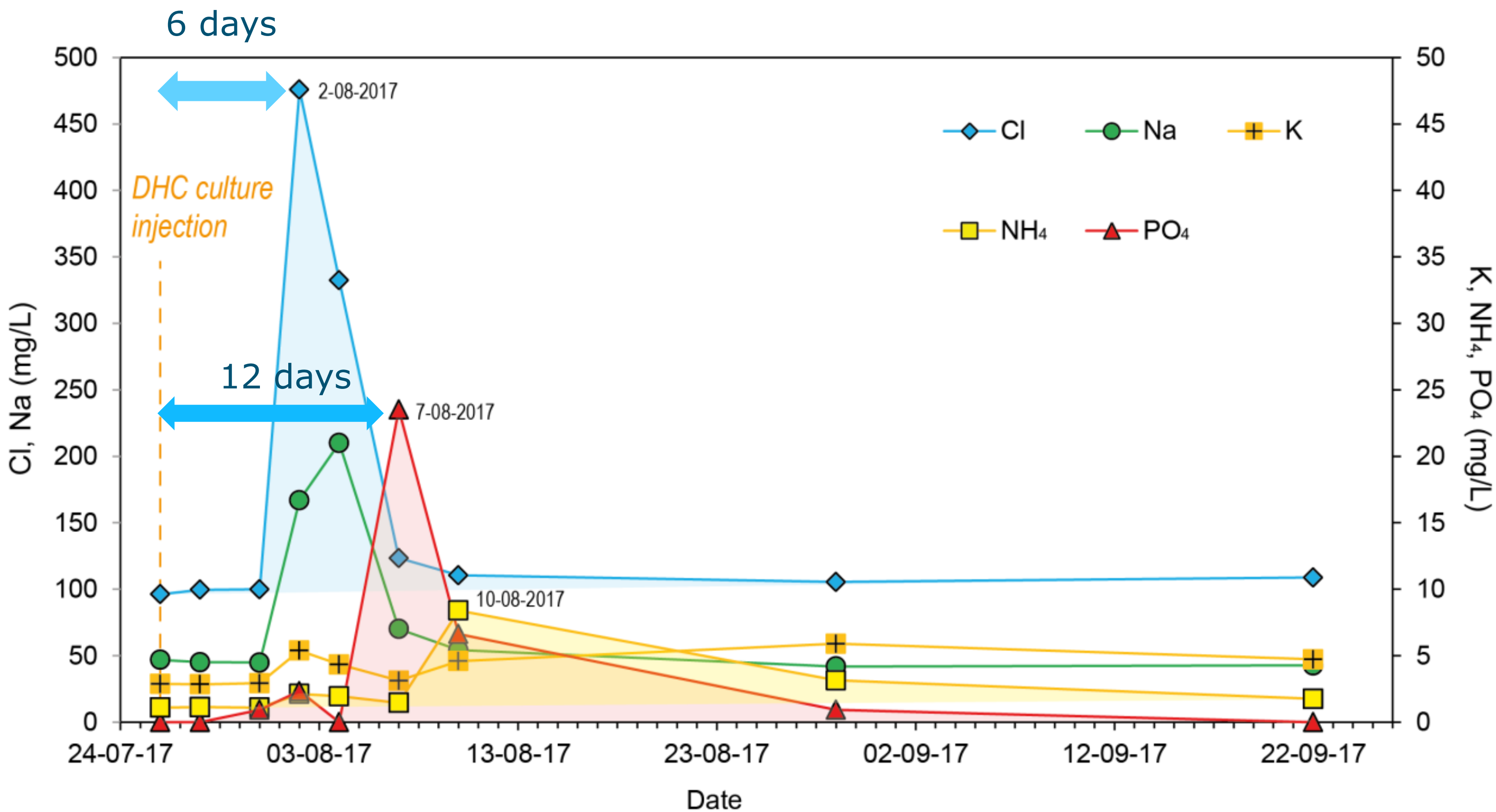
ATES 3 well Monowell (summer)

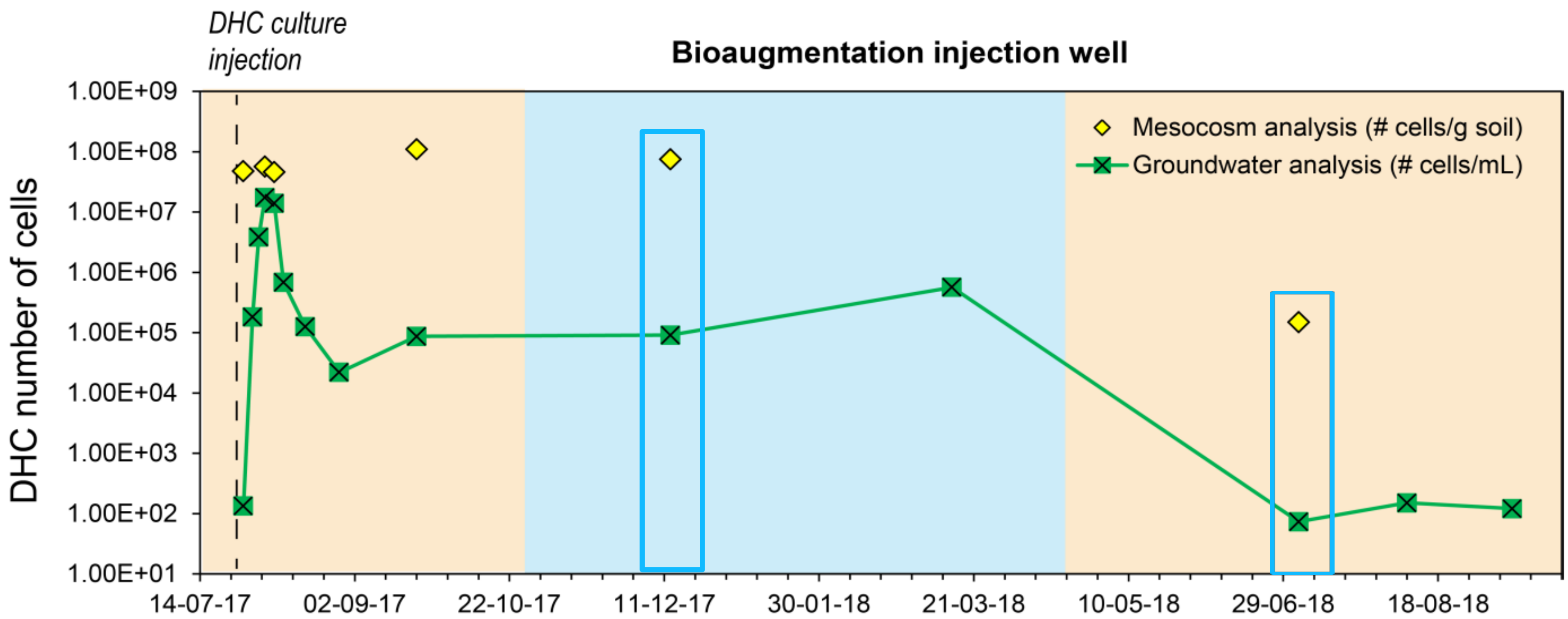


Mobile compound transport (tracer tests) (after 4 m^3 inoculation *Dehalococcoides*)



Monitoring well 27-31m blg (shallow well)

Dehalococcoides sorbed versus supended (in biomass injection well)



10^8 DHC sorbed versus 10^5 in groundwater after 5 months
10^5 DHC sorbed versus 10^2 in groundwater after 12 months

➔ Sorption seems to be preferred

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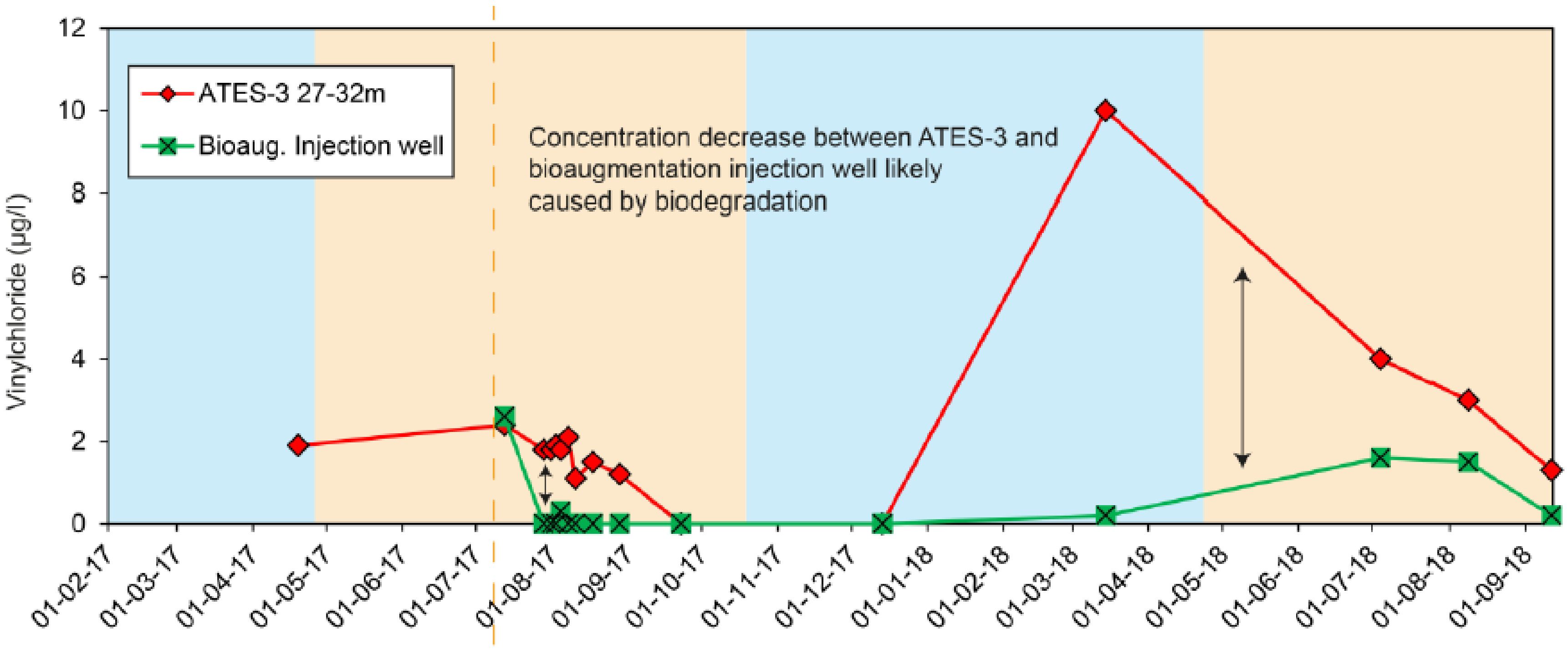
Vinylchloride concentrations in warm well and Biomass injection well



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Conclusions Utrecht Pilot

- Biomass injection did not lead to clogging
- DHC bacteria were attached to matrix in injection well and monitoring well
- Vinylchloride biodegradation seems to occur after biomass injection (also ethene formation, results not shown)

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LCA study ATES-ISB versus CHC-ISB (based on case in Shanghai)

Parameters investigated:

1.	primary energy demand	PED	(MJ)
2.	abiotic depletion potential	ADP	(kg Sb eq)
3.	water use	WU	(kg)
4.	global warming potential	GWP	(kg CO_2 eq)
5.	ozone depletion potential	ODP	(kg CFC^{-11} eq)
6.	acidification potential	AP	kg SO_2 eq)
7.	respiratory inorganics	RI	(kg PM2.5 eq),
8.	photochemical ozone formation potential	POFP	(kg NMVOC eq)
9.	eutrophication potential	EP	(kg $PO_4{}^{3-}$ eq)
10.	ecotoxicity	ET	(CTUe)
11.	human toxicity	HT	(CTUh)

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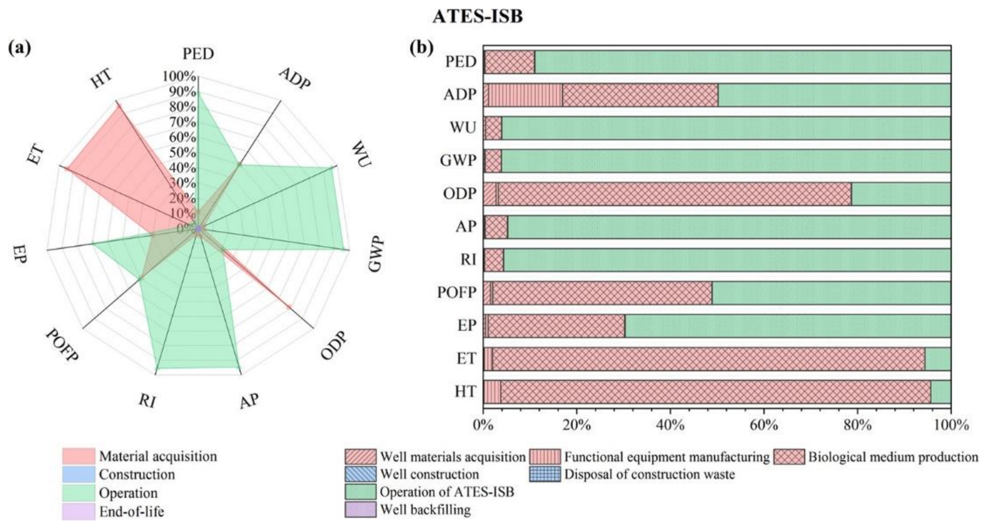
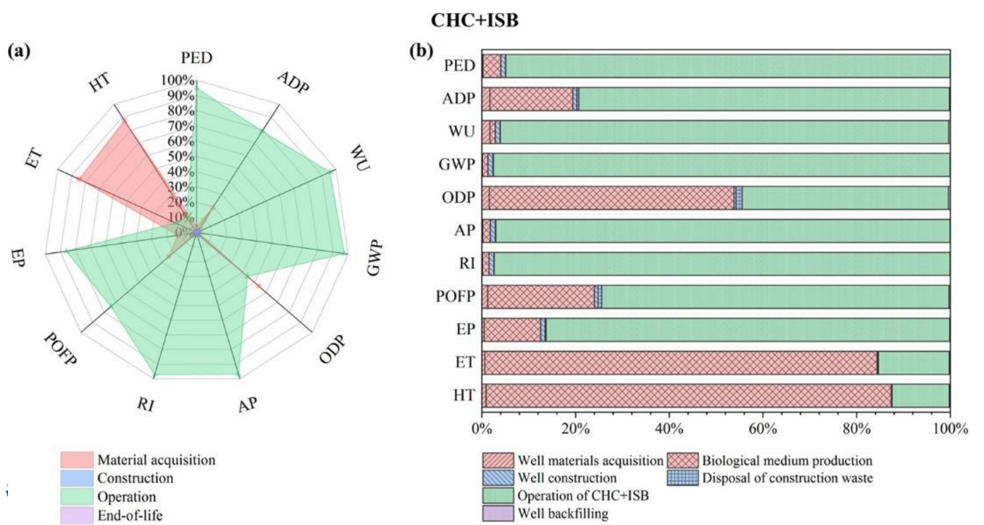
Contribution different % LCA parameters and subordinate activities: ATES-ISB versus CHC-ISB (Conventional Heating and Cooling)





Results:
electricity use is responsible
> 95% of:

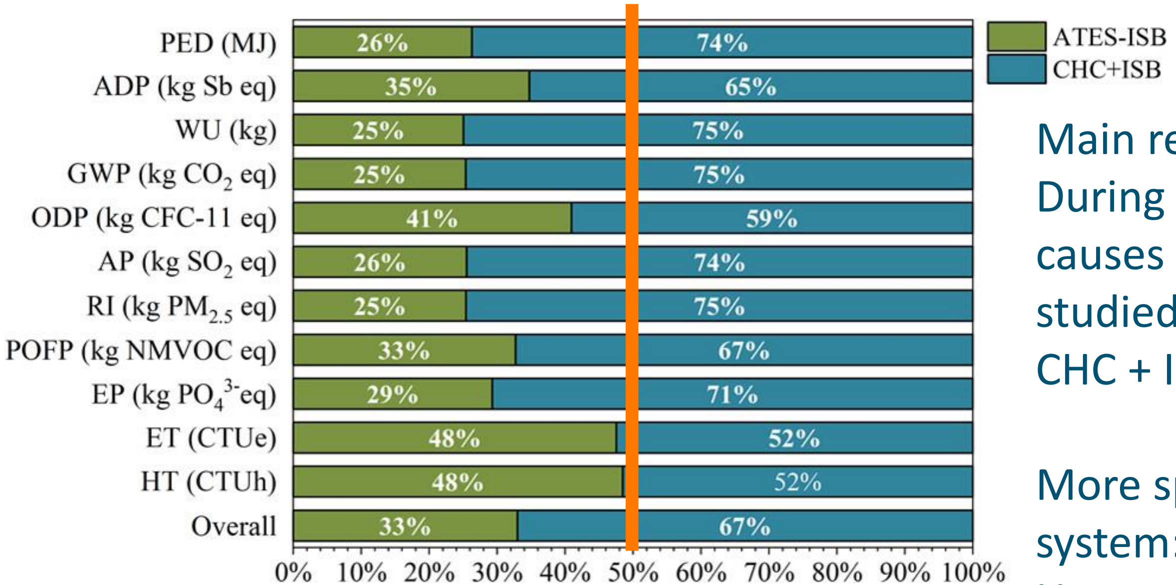
WU, GWP, AP, and RI
in both cases

production of electron donor is responsible > 85% of:

the toxicity impact (ET and HT) in both cases

DOI: (10.1021/acs.est.9b07020)

Comparison of the environmental impacts: ATES–ISB versus CHC + ISB



Main result:
During whole life cycle: ATES–ISB causes smaller impacts on all of the studied categories compared to CHC + ISB.

More specifically, the ATES–ISB system:
Uses:
50% less energy and
50% less water,

Releases:
50% less CO_2, SO_2, and $PM_{2.5}$

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Aspects (first) full scale application at location Houttuin in Woerden (NL)

Overview of the site:

Redevelopment area for sustainable apartments

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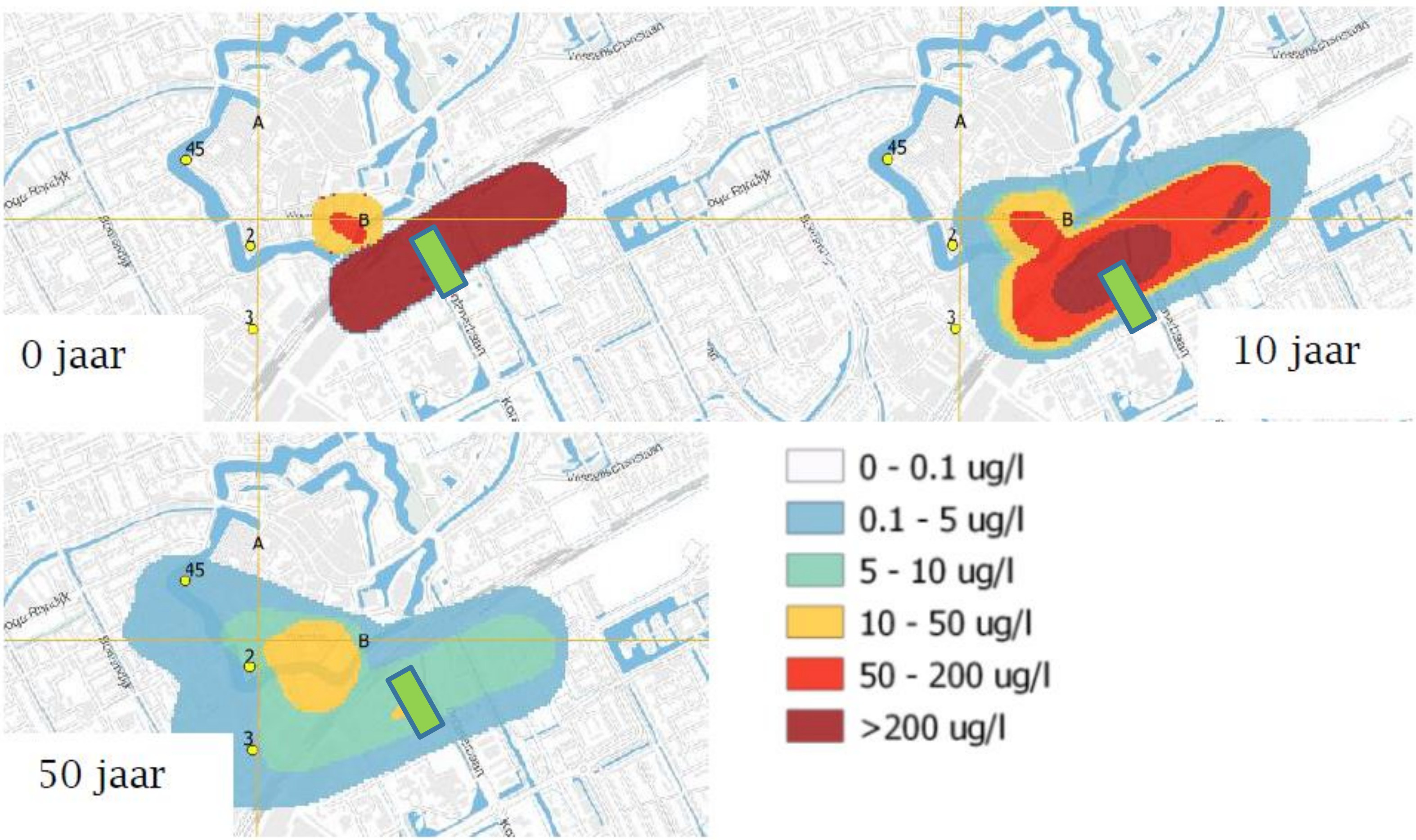
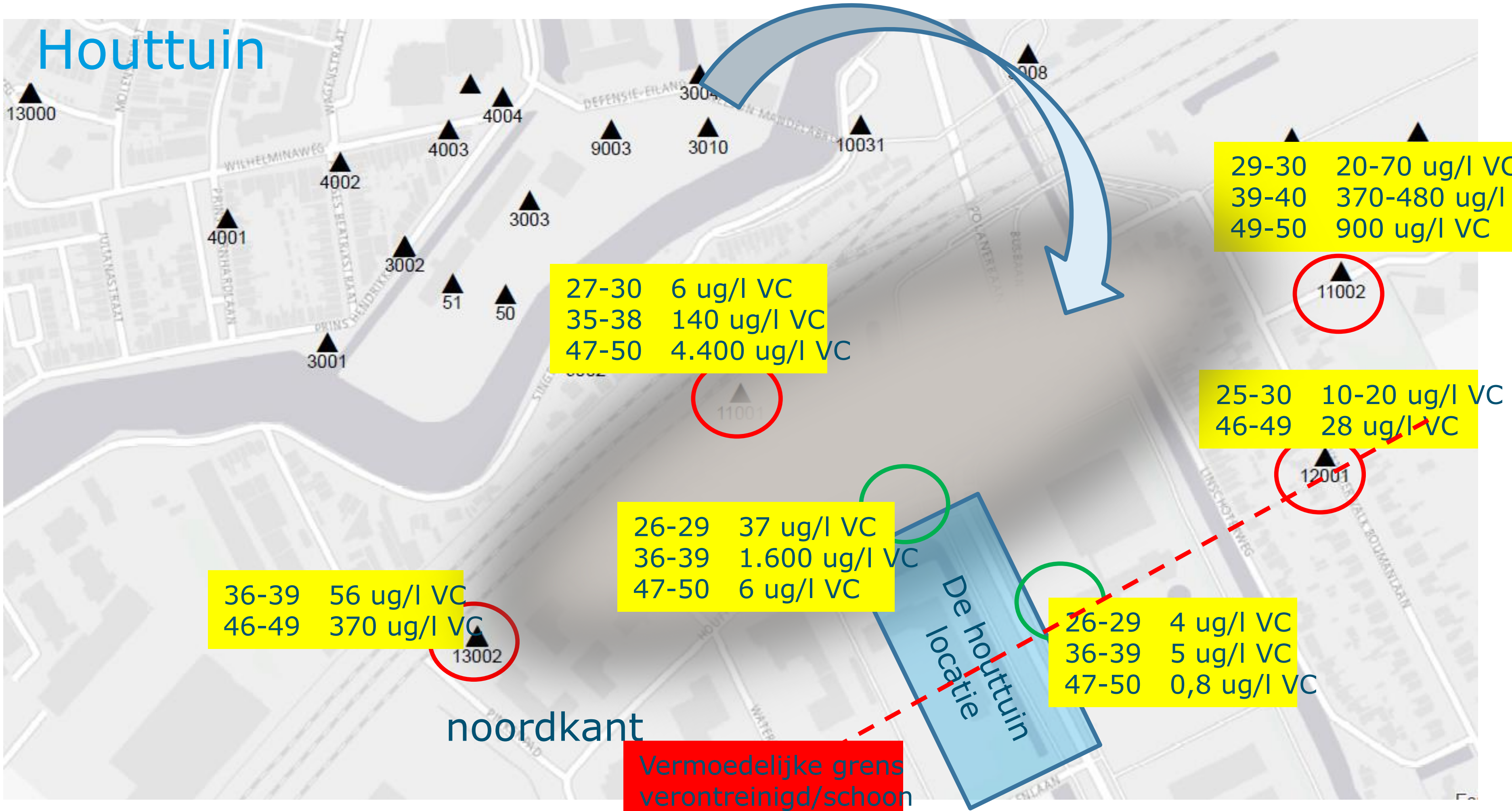
Expected plume develeopment: Scenario C (conservative, low biodegradation)



Figuur 25: Scenario C -berekende VC-concentraties voor modellaag 10 (41-56 m diep).

Present situation groundwater location Houttuin



gemeente WOERDEN

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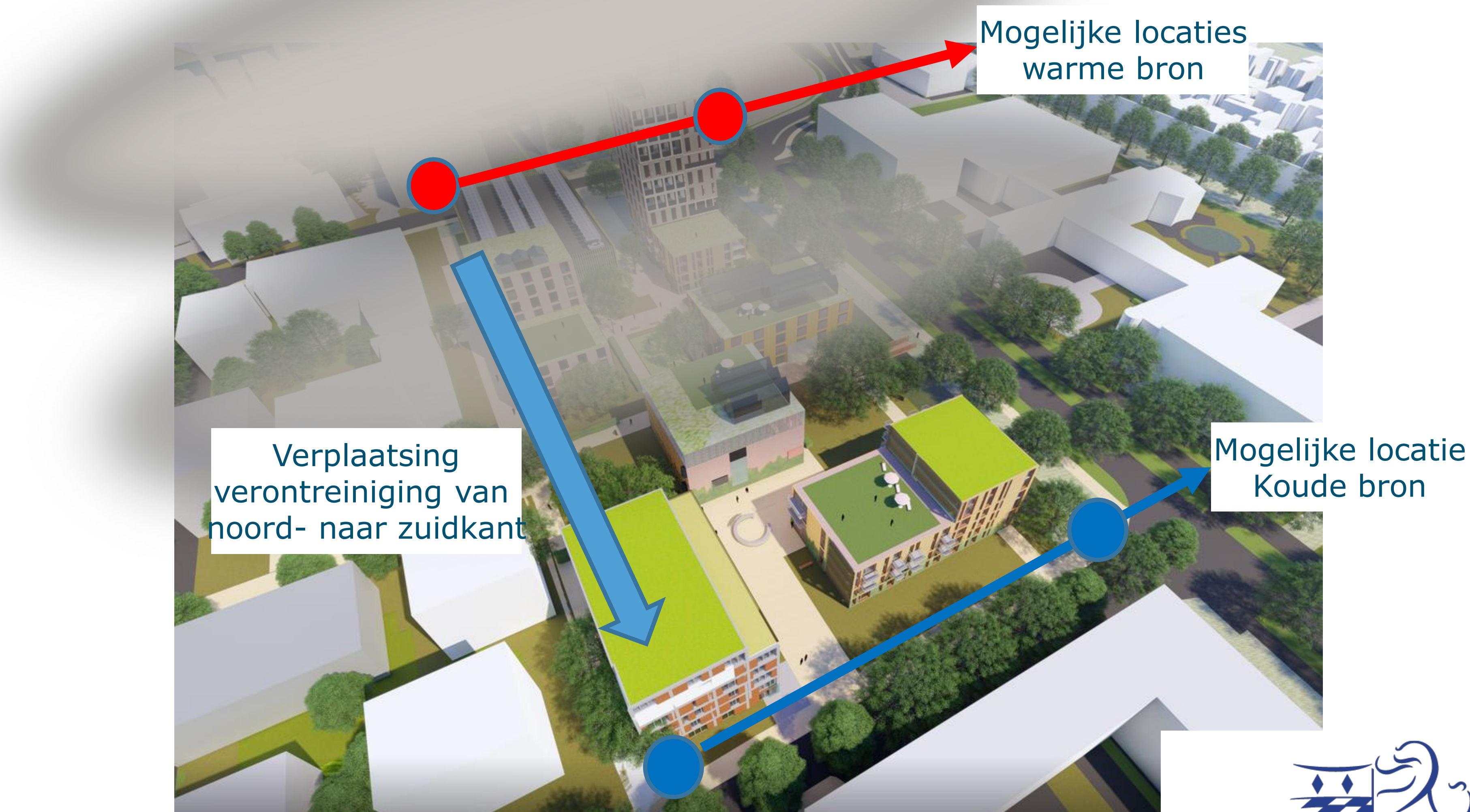
Points of attention with ATES in 1st aquifer



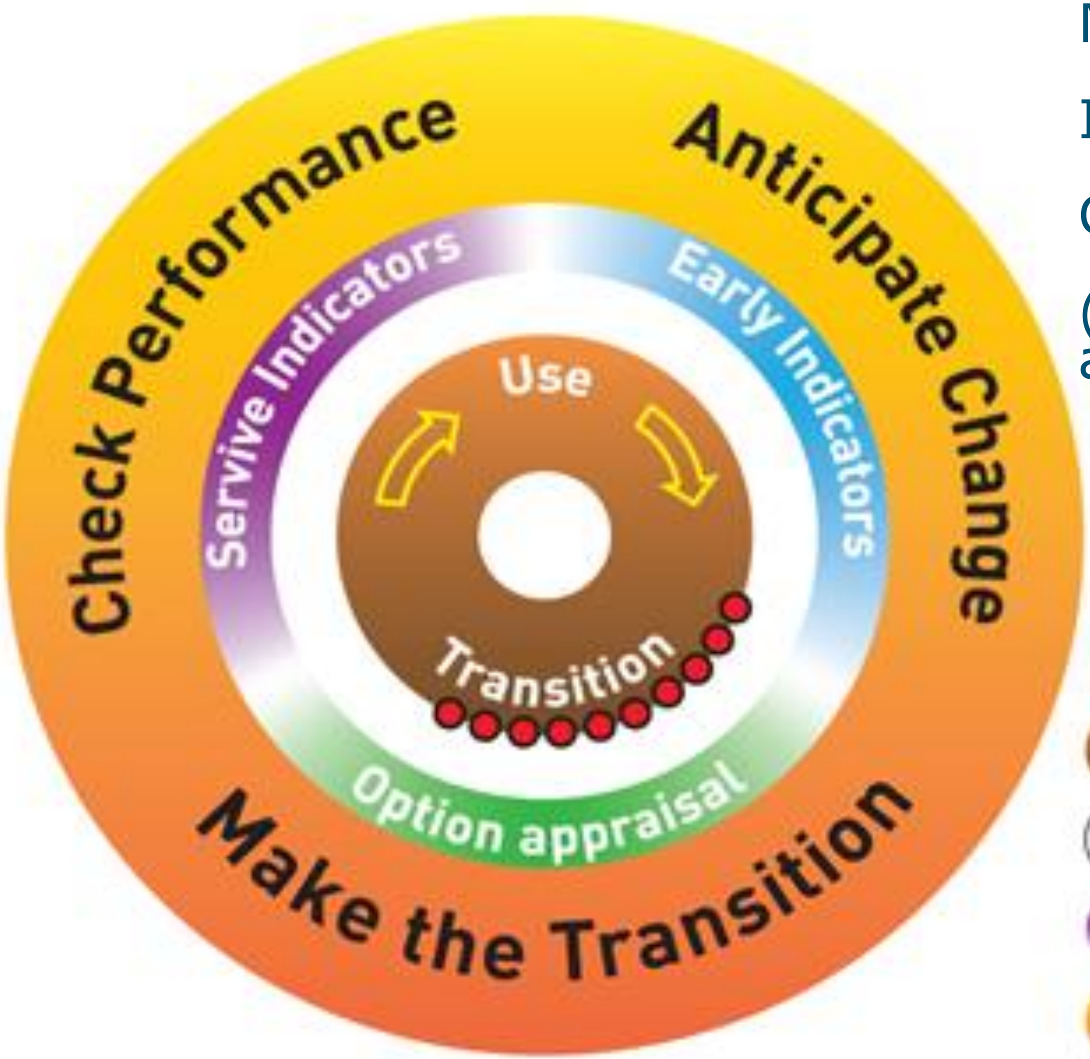
Apects to be solved yet:

- Modelling is in progress to determine impact of ATES (without IBS) to study the south border of the contamination in case ATES will be applied (result expected in June)
- Large imbalance in heat and cold demand by the apartments
- Concerns by non-bioremediation specialists:
  - How to be sure contamination will not spread in downflow direction?
  - How can clogging be controlled?
- Most probable design (according to Maurice Henssen):

Recirculation system similar as Hammerbakken

Land Use cycle as link to circular economy

Land Use cycle as link to circular economy



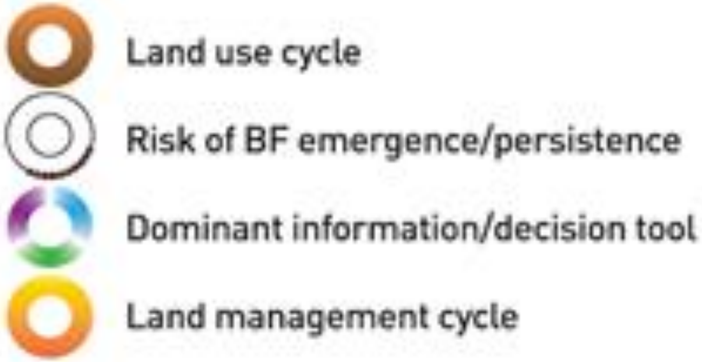
New developments:

Nature Based Solutions

Improve Spatial environment

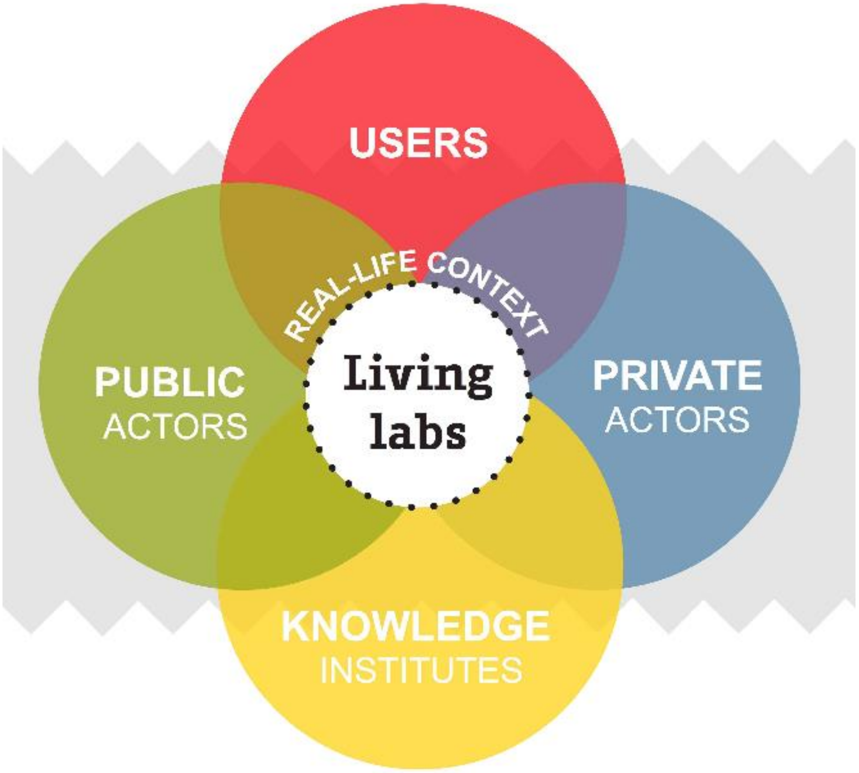
Combinations of functions

(eg. sustainable energy & accelerated bioremediation



Natural science in a broader perspective

The Living Lab Approach



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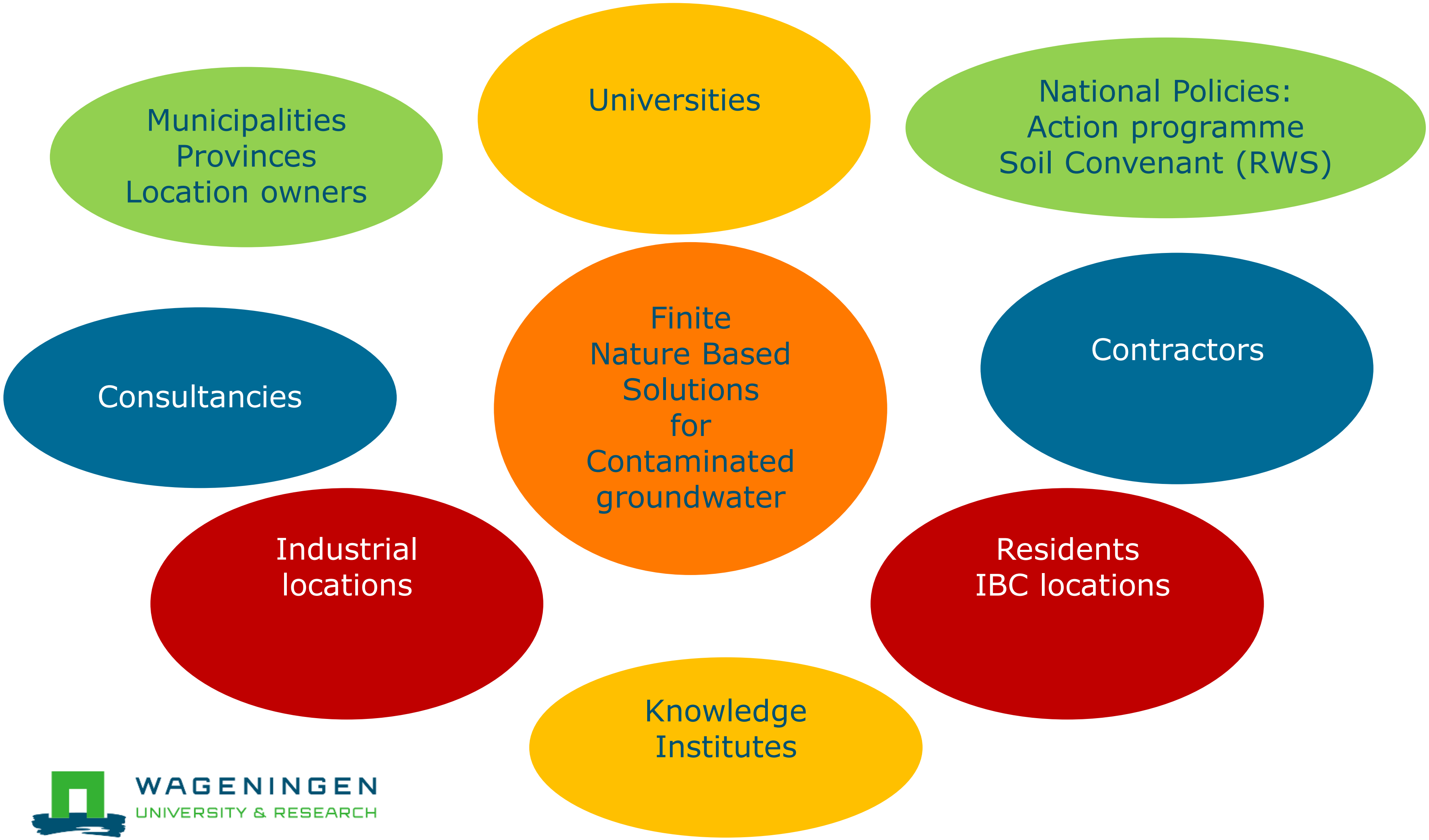
Nature Based Solutions for Redevelopment of contaminated sites in the sustainable urban environment



Core questions in Living Lab Approach

1. What will be the future use of a site?

2. What problems hamper the future use of the site?

3. What technology is needed to tackle the problems?

4. How will the redevelopment be organized?

5. How should the measures be financed?

Thanks to:

Zhuobiao Ni (Sun Yat-sen University, Guangzhou)

LCA aspects ATES-IBS

Sun Yat-sen University

Peter Rood (Municipality Woerden):

Project Houttuin in Woerden

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Maurice Henssen (Bioclear earth):

Latest info on progress Project Houttuin

bioclear earth