

*Nabron*

# Naturally increased levels of Arsenic in the coastal provinces of the Netherlands

Nederlands Instituut voor  
Toegepaste Geowetenschappen TNO



# What is the problem

- **How to deal with naturally occurring high arsenic levels?**
  - Current regulations in the Netherlands: concentrations  $>$  intervention value  $\rightarrow$  then clean-up / remediation
- **Inventory of existing problems of policy-makers**
  - Large area with similar problems : AREA-SPECIFIC
  - Local problems: building permits/ excavations...

# Legislation Netherlands

	SOIL	GROUNDWATER
Intervention value (NL)	55 mg/kg d.s	60 ug/l
Guideline value (WHO)	29 mg/kg d.s.	10 ug/l

## Advice from National agency for the protection of soils:

- Arrive at an INTEGRATED policy to reduce the threats of naturally occurring substances to a multi-functional landuse
- How: Soil management plan (soil + groundwater)

- Steps:

- increase knowledge
- inventory of limitations of landuse with respect to As
- estimate the effects of changes in landuse
- estimate the effects of changing environmental conditions
- (monitoring)

NABRON

# NABRON Participants



- **TNO**
- **University**
- **Private Consultancy**
- **Coastal provinces**
- **National Agency**

# The NABRON project:

- **Aim:**

To support policy-makers with decision-making of the use of soil, groundwater and stream bed sediments in areas with naturally increased Arsenic concentrations

- **How:**

**SYSTEM-APPROACH and AREA SPECIFIC:**

Why is 'As' there? What are the common factors?

- **Results:**

- Risk maps
- Soil management plan
- Practical guide

# Increasing knowledge: occurrence of As in...



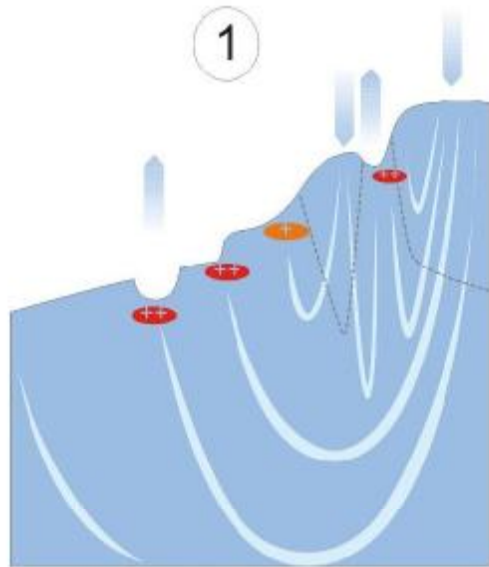
“Iron-hydroxide-type”



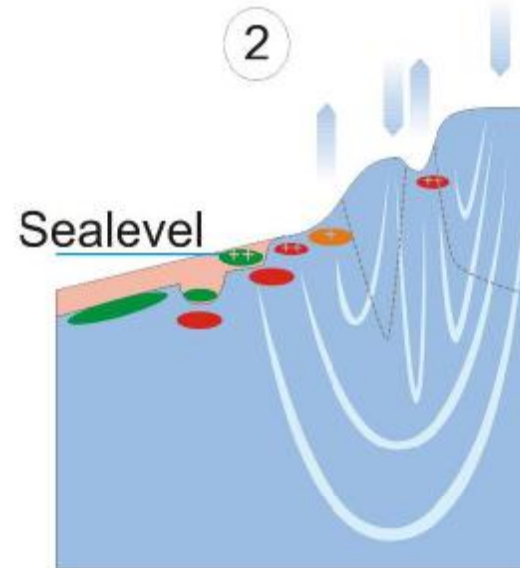
“Iron-hydroxide-type”

# Increasing knowledge: where

Late-Pleistocene



Early-Holocene



## Legend

### Accumulation of ironhydroxides

Red oval: Large amount

Orange oval: Small amount

### Accumulatio of pyrite

Green oval

Blue arrow: Precipitation

Upward blue arrow: Evaporation

Dashed line: Groundwaterflux

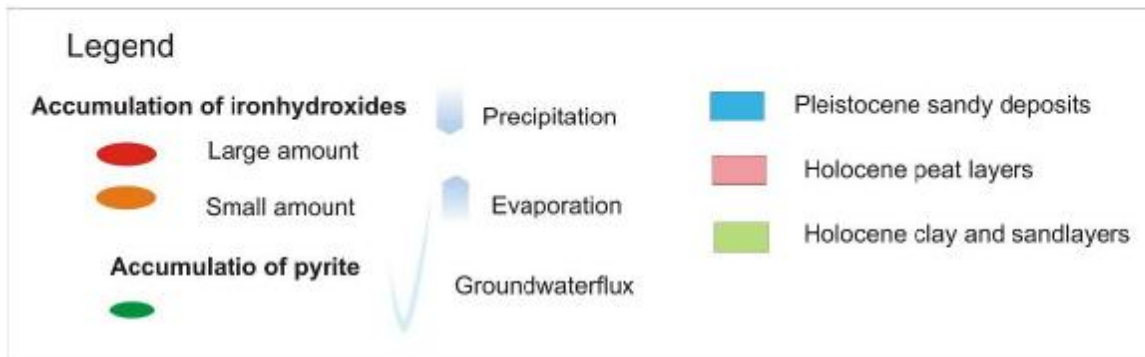
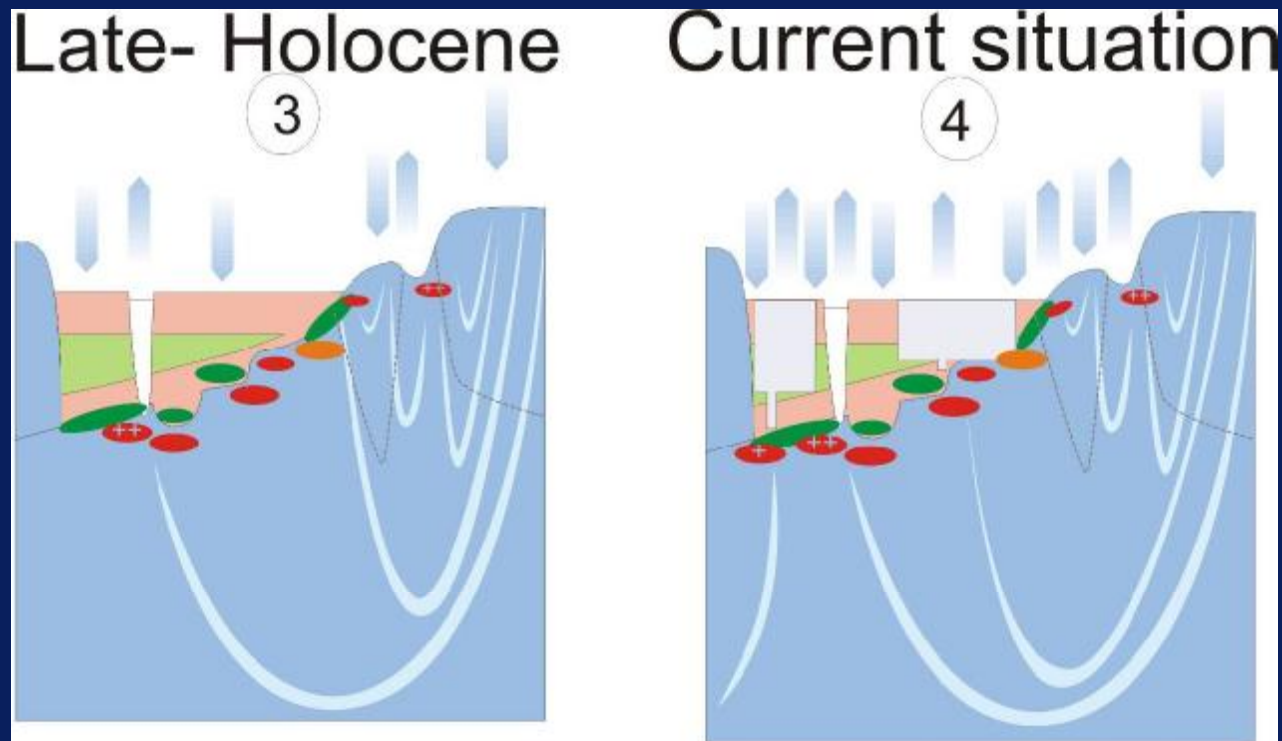
Light blue box: Pleistocene sandy deposits

Pink box: Holocene peat layers

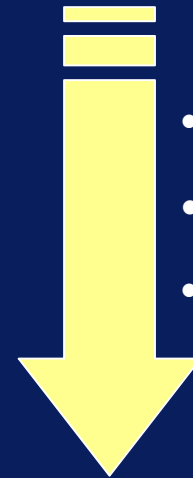
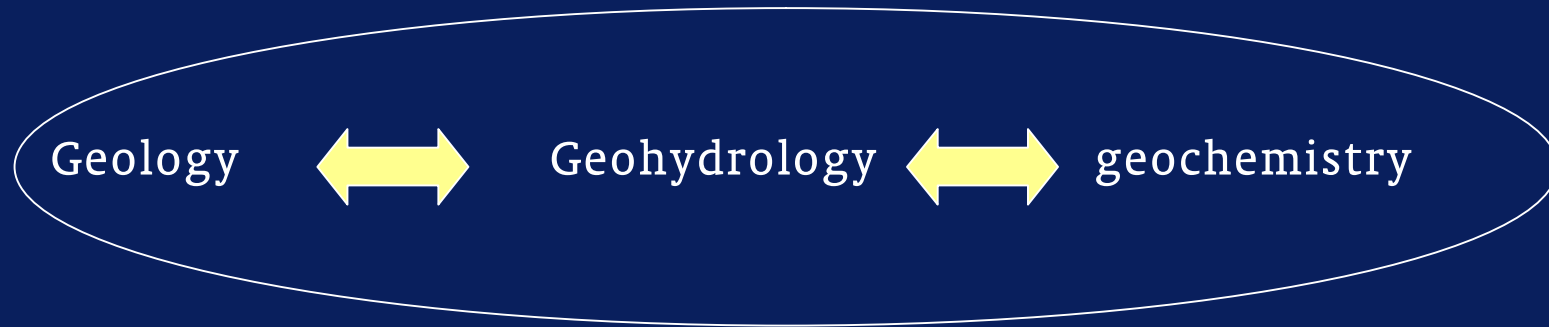
Light green box: Holocene clay and sandlayers



# Increasing knowledge: where



# Combine knowledge: Integrated approach



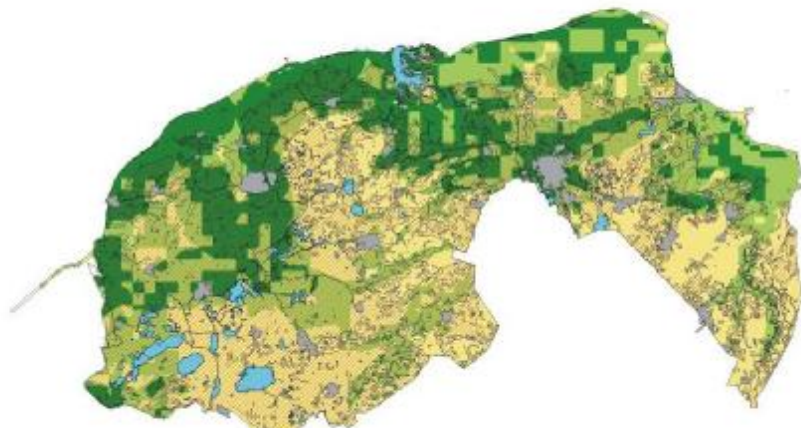
- Risk maps
- effect of environmental conditions
- effect of land use

Soil management plan

# RISK MAP:

## Possibility of increasing regulatory values

Regional pattern of high As concentration in the soil and freatic groundwater



Risk of presence of high Arseen concentrations

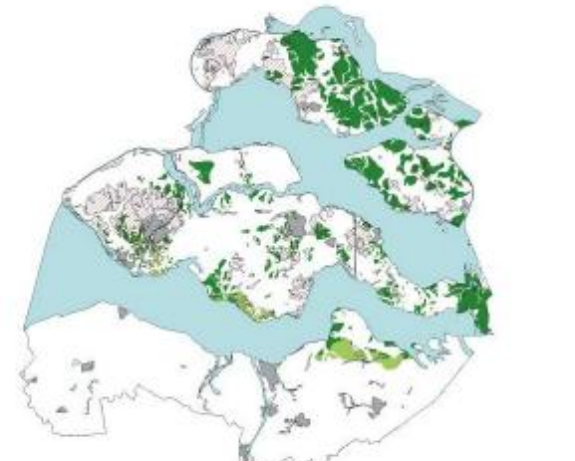
- Low risk
- Possible risk
- Higher risk
- Grondwater binnen 40 cm - mv
- Bebouwd gebied
- Water

“Fe-OOH-type”



Proefserie 300.4.1006  
Natuurlijk van nature verhoogde arseniegehaltes in de bodemprofielen  
Onderzoek naar de oorzaken van deze verhoging in de provincies Groningen, Fryslân, Noard-Hollân, Dúts-Hollân, Zeelân en Brabant

Regional pattern and depth of high As concentration in peat



Depth to basal peat

- 0 - 1 meter
- 1 - 5 meter
- > 5 meter
- Grondwater binnen 40 cm - mv
- Bebouwd gebied
- Water

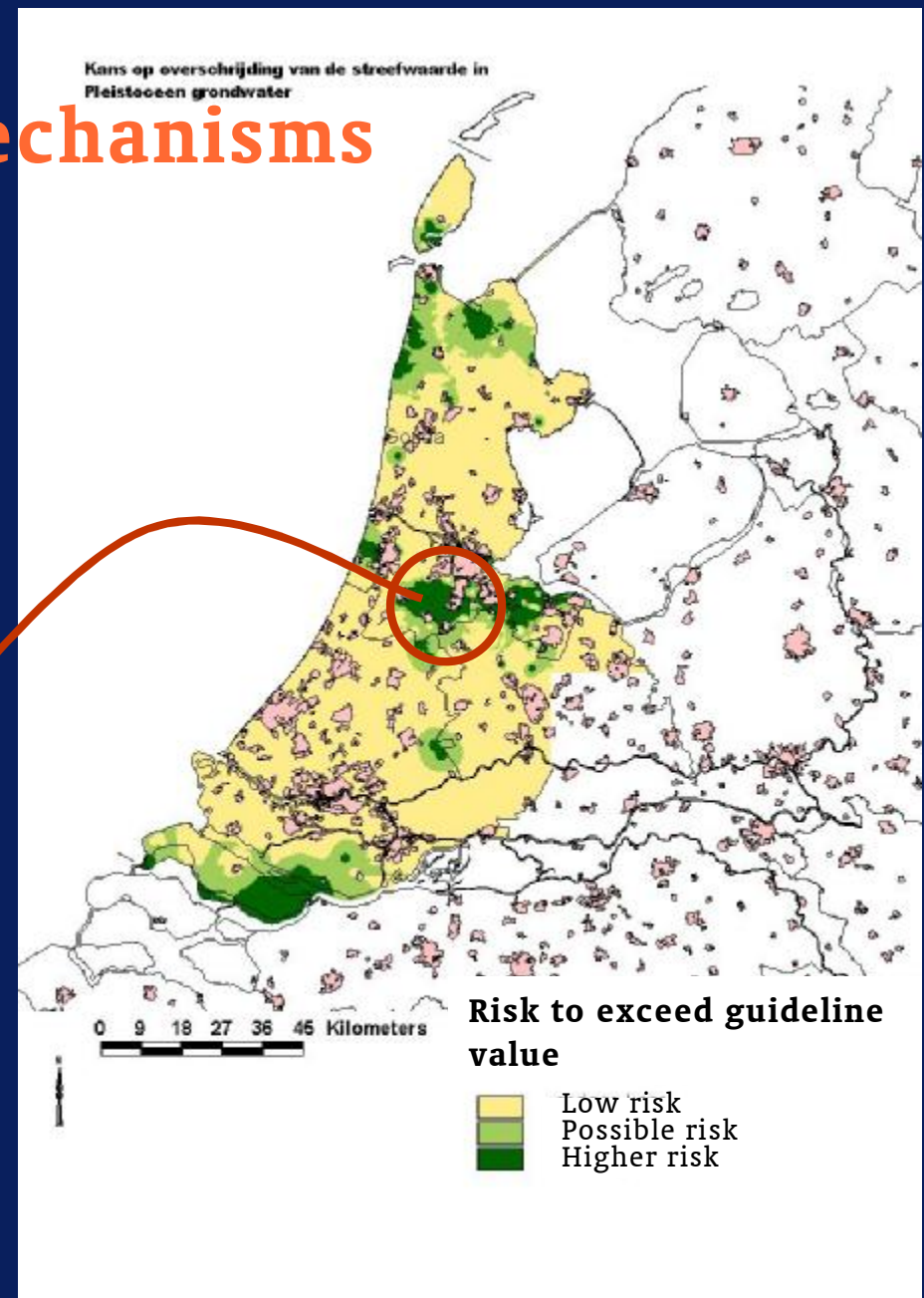
“Pyrite-type”



Proefserie 300.4.1006  
Natuurlijk van nature verhoogde arseniegehaltes in de bodemprofielen  
Onderzoek naar de oorzaken van deze verhoging in de provincies Groningen, Fryslân, Noard-Hollân, Dúts-Hollân, Zeelân en Brabant

## Understanding the mechanisms

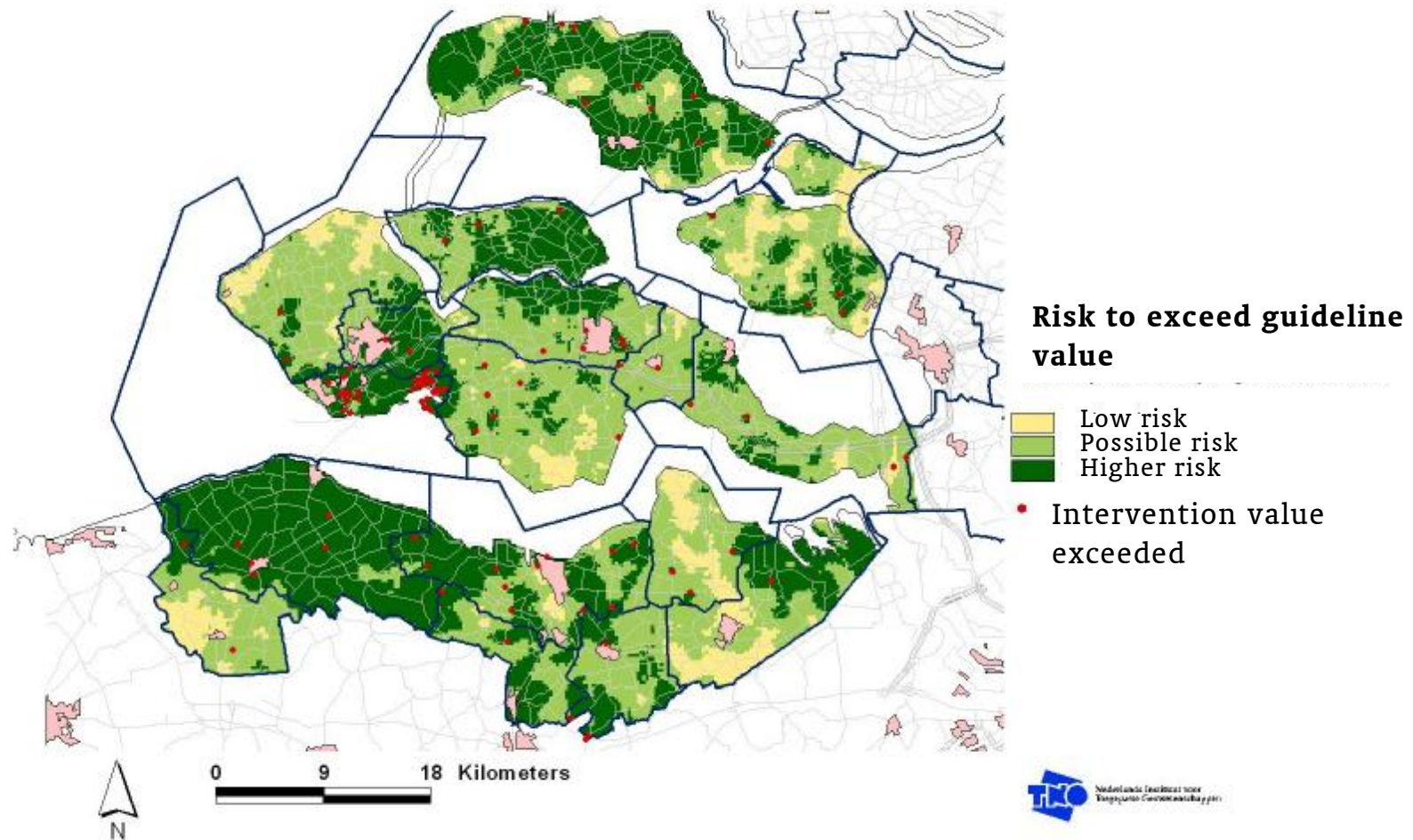
- Mechanisms explain regional patterns and predict where and at what depth high As-concentration can be expected
- Amsterdam area (ice-pushed ridges):
  - High concentrations in (deep) groundwater in restricted area
  - Area also shows high concentrations in basal peat
  - Bog iron ore at greater depth



# RISK MAP:

## Detailed mapping of increased As: Fe-OOH type

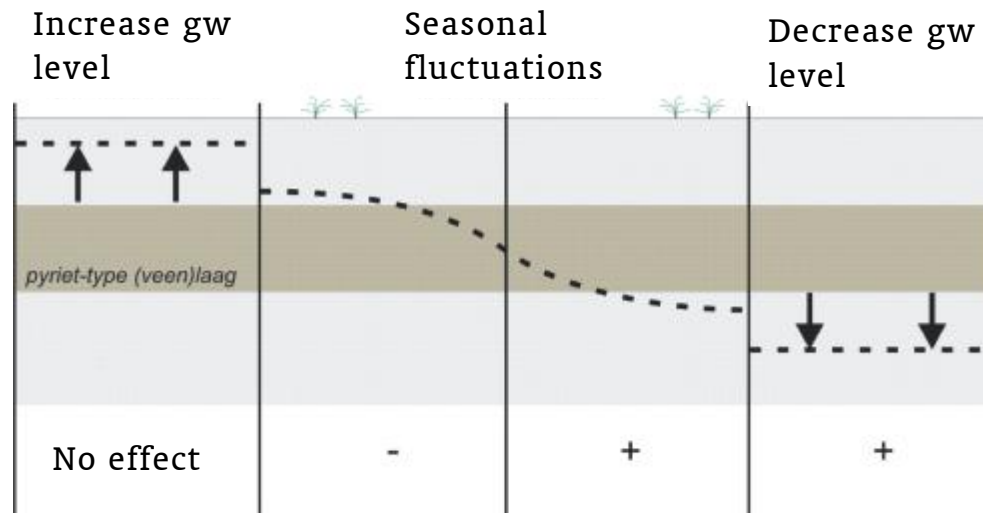
Risk of exceeding the guideline value/ intervention value of As in freatic groundwater



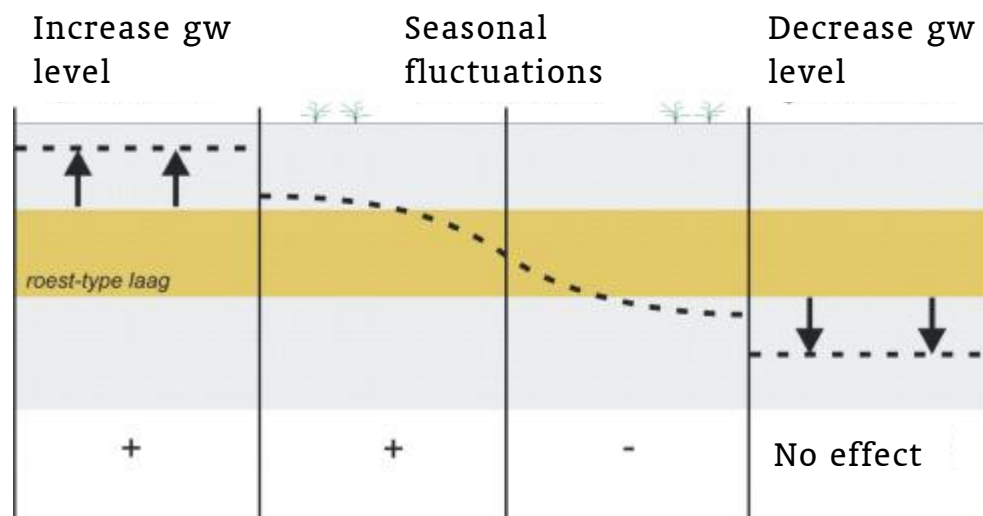


# Effect of environmental conditions (1)

“Pyrite type”

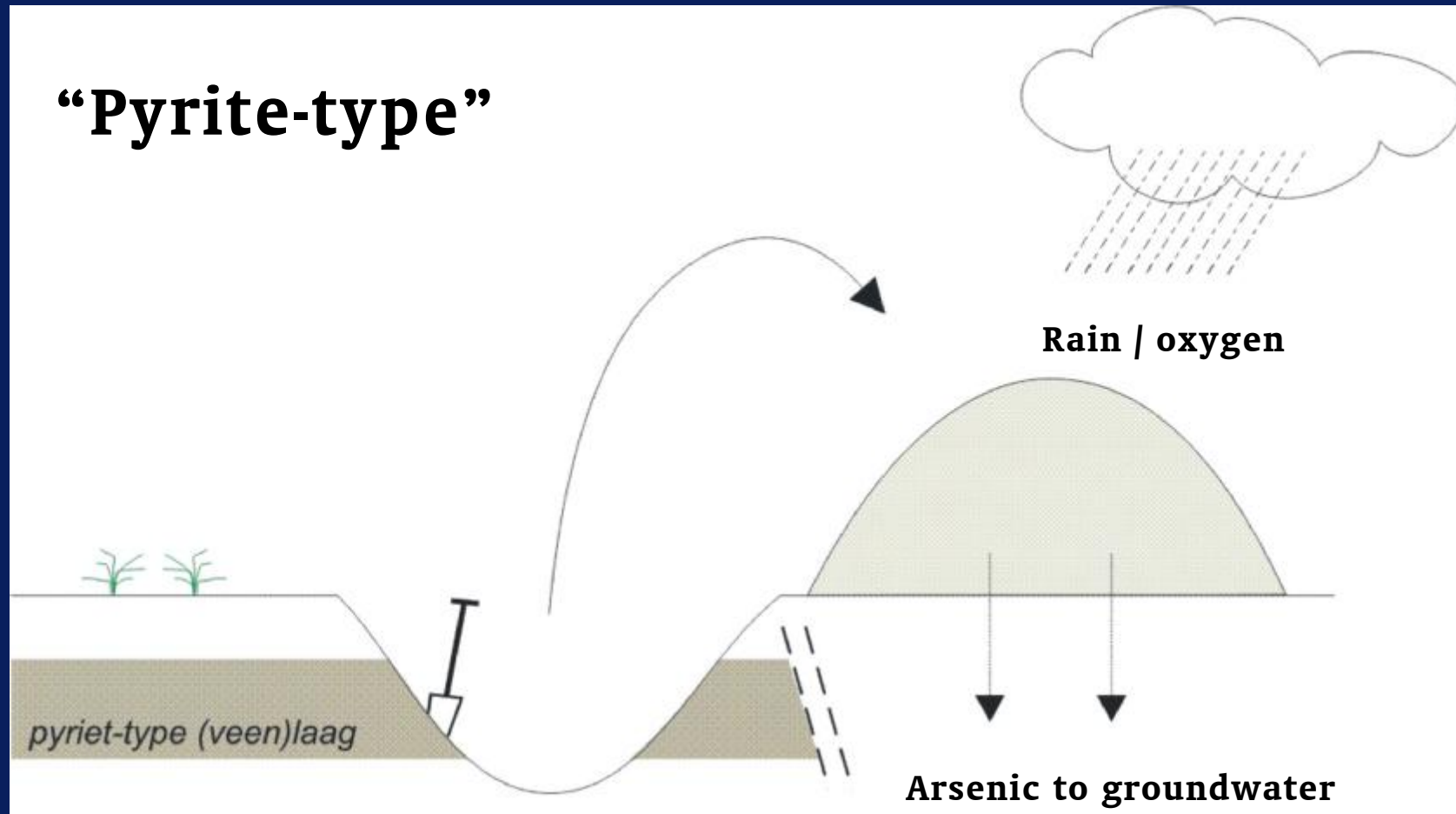


“Fe-OOH type”



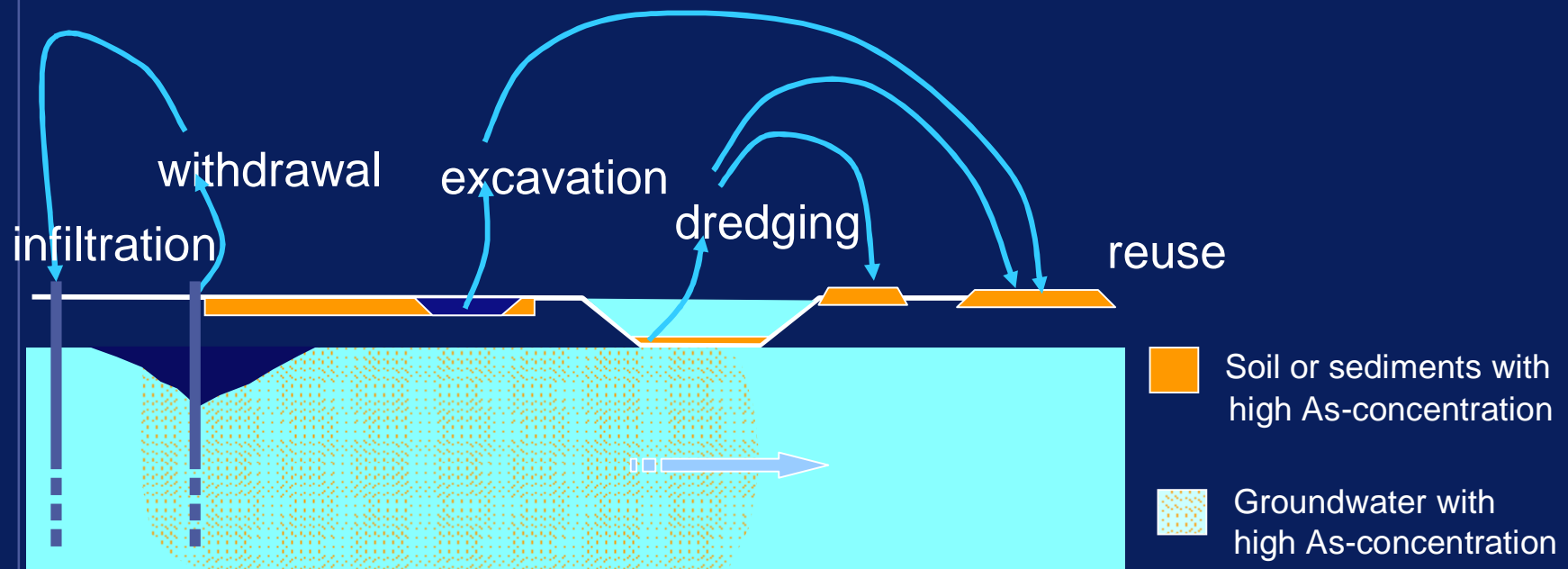
## Effect of environmental conditions (2)

### “Pyrite-type”



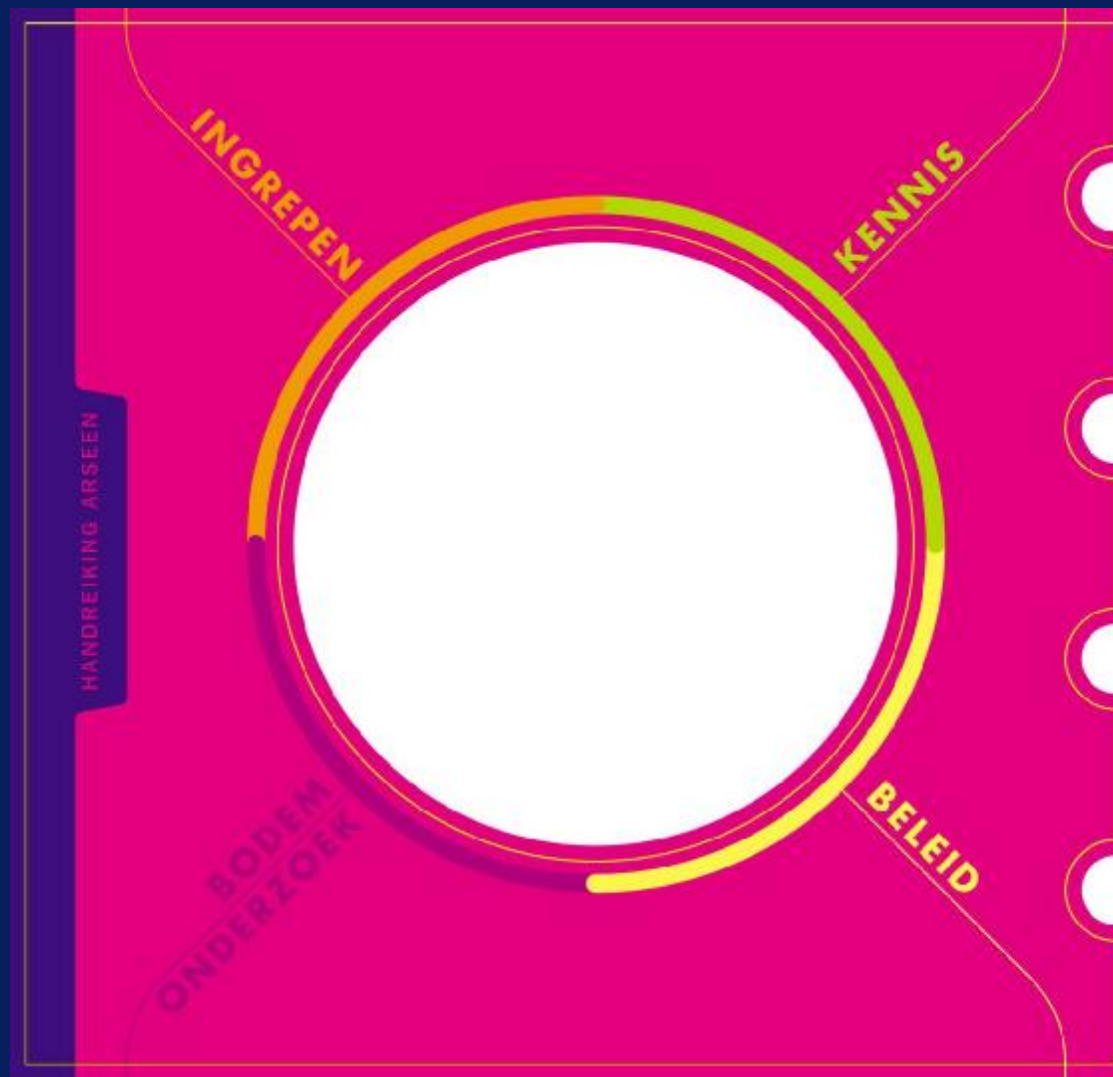
## Effect of land use

- Interventions in As-rich area can contribute to the spread or release of arsenic





# Practical guide for local authorities



## Conclusion:

- **A regional approach is needed**
  - Geographical
  - Administrative
- **National standards are not applicable for natural As**
  - AREA-specific (system)
  - As-type dependent
- **Implementation of policy:**
  - Land use based on (human) risks
  - Assess effect of changes in land use

