

# ***Risk assessment of abandoned mine sites***



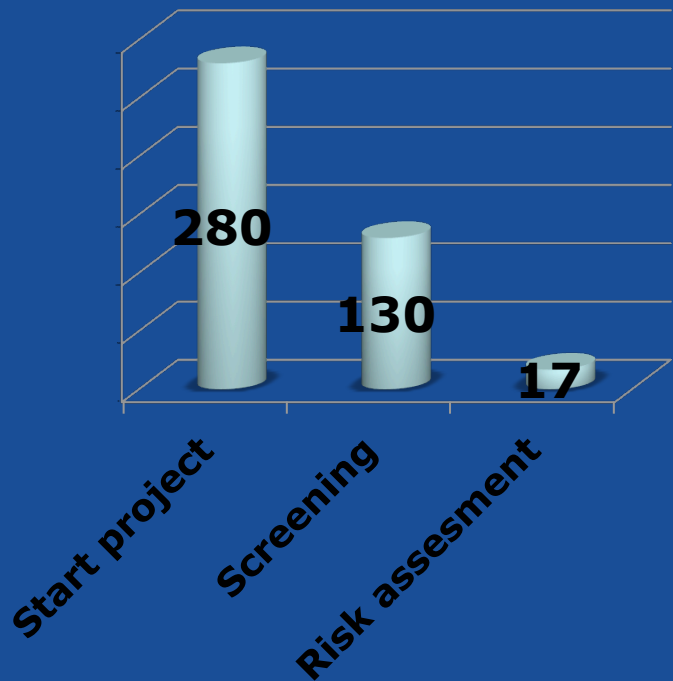
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# Content

## Estimated costs m€



### Problem

- Historical mine tailings can be a large treat to the environment, risk of leaching.
- Sites are so large, that remediation seems impossible due to large costs involved
- Detailed site investigation is far to expensive to start projects

### Our innovation

- Method for site investigation
- Approach for risk assessment

### Result

- Size of problem largely reduced
- Cost estimate from 280 mEU -> 17 mEU
- Remediation becomes feasible

# Zinc Slag as mine tailing



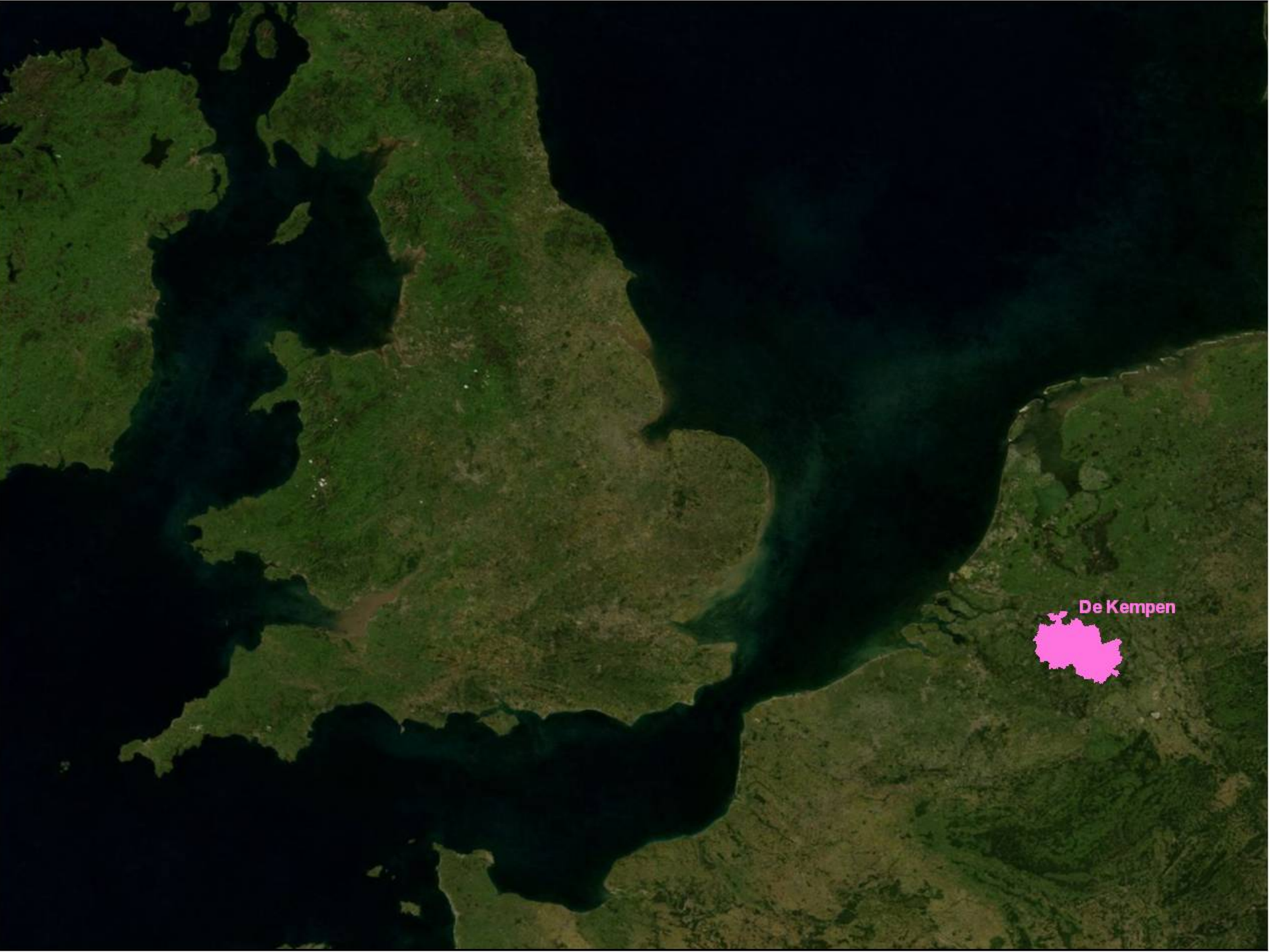
## Zinc slag

- Zinc was produced between 1892 and 1973 in “De Kempen” in the Netherlands and Belgium
- Zinc slags were spread to improve public and private roads.
- Potential ecological risk asks for remediation.

## Challenge

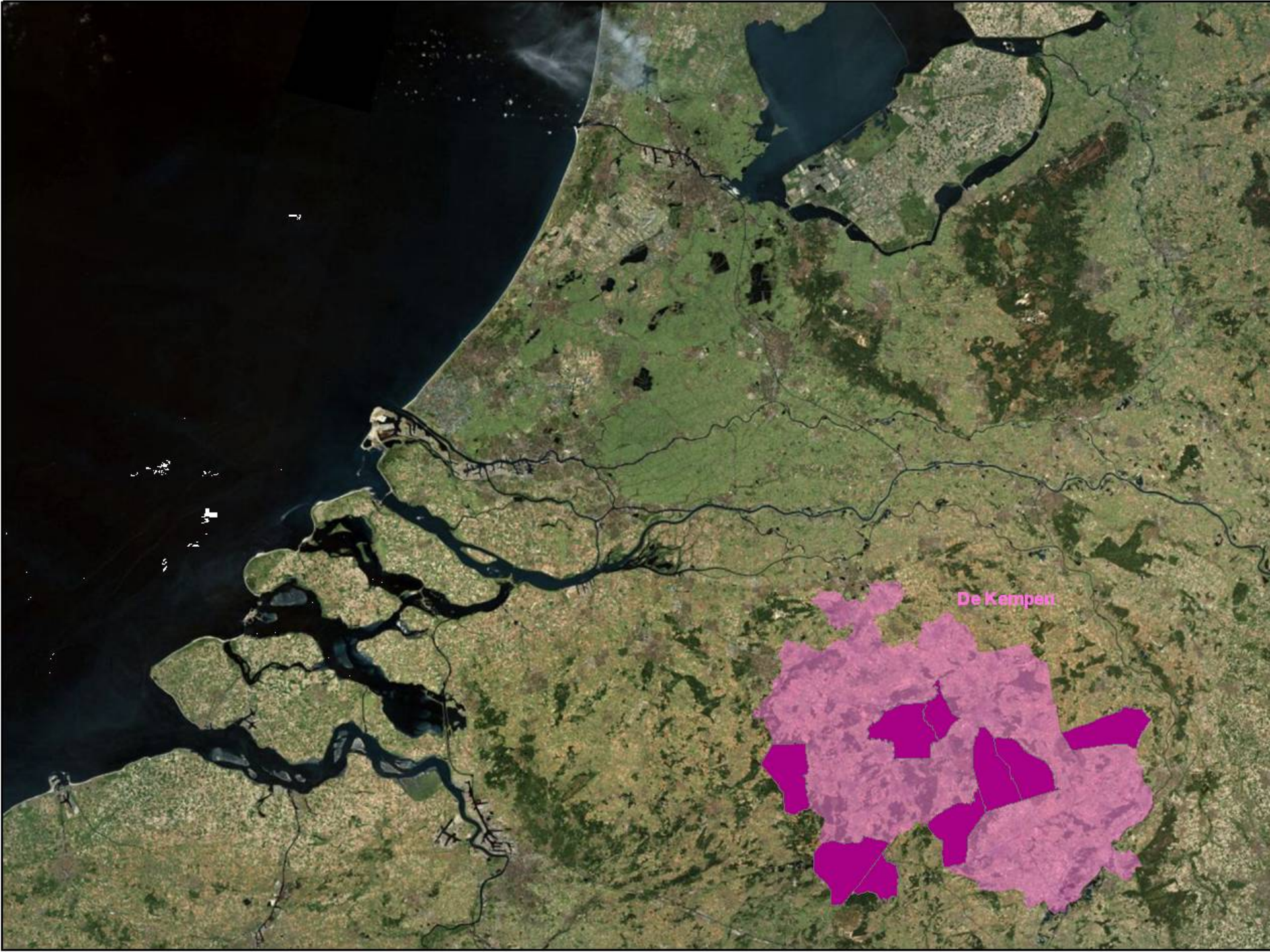
- Estimated polluted area=2600 km<sup>2</sup>, but actual distribution not known
- Need for a rapid, synoptic method to locate the slags.





De Kempen





De Kempen



## Project

1100 km of road potentially polluted

De Kerpen



The image is an aerial photograph of a rural landscape with green fields and some buildings. Overlaid on the map is a network of roads. A large, irregular area in the center is shaded in a light pink color. Within this pink area, a complex network of roads is highlighted in a darker blue color. The roads are shown as thin lines, some solid and some dashed. The label 'De Kerpen' is written in pink text above the main road network. In the top right corner, there is a white box containing the text 'Project' and '1100 km of road potentially polluted'.



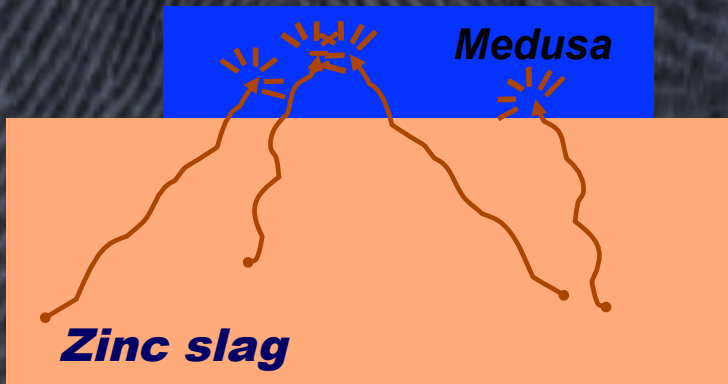
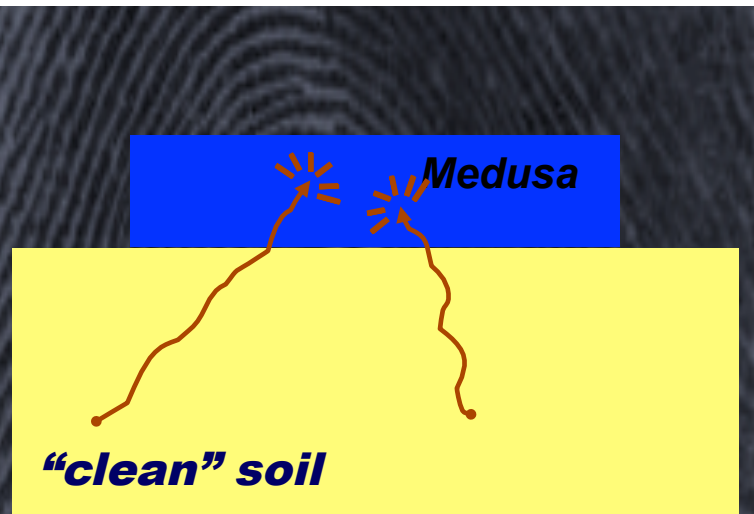
# Mapping zinc slags in roads



- No methods available for direct mapping zinc slag other than coring
- Use geophysical and geochemical tools for indirect mapping zinc slag
- Use pathfinder elements



# Pathfinder elements: radioactivity



## The concept:

- Zinc slag contains suite of radioactive elements that differs from normal soil
- Radioactive elements can be measured easily in the field and in the laboratory

## Fingerprint:

- Quantitative relation between zinc slag and radioactive elements
- Results give value of zinc slag content

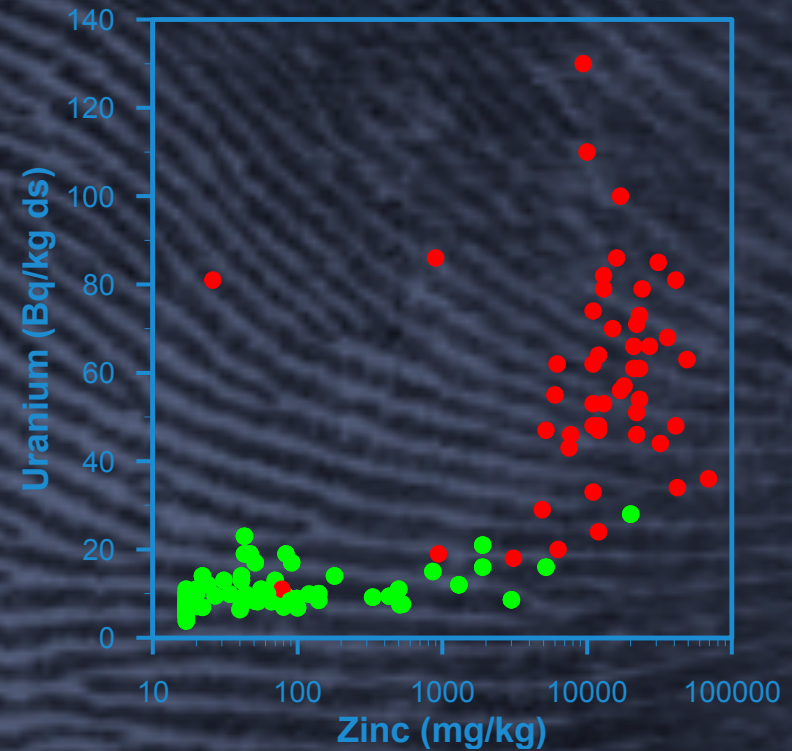
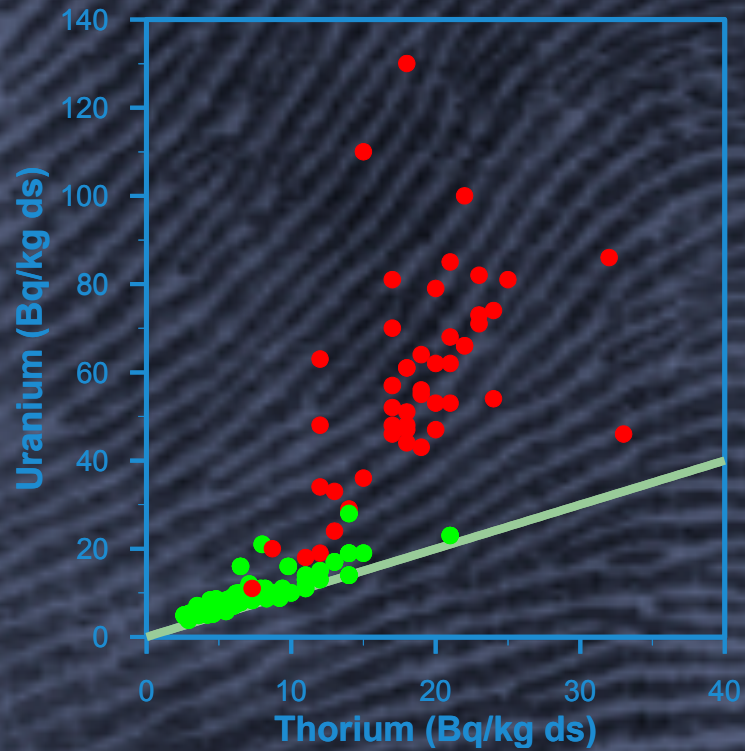
## Lab-analyses

- 1100 corings used for modelling

## Ground truthing

- 2180 corings used for validation

# Pathfinder element: uranium





# Carborne assessment





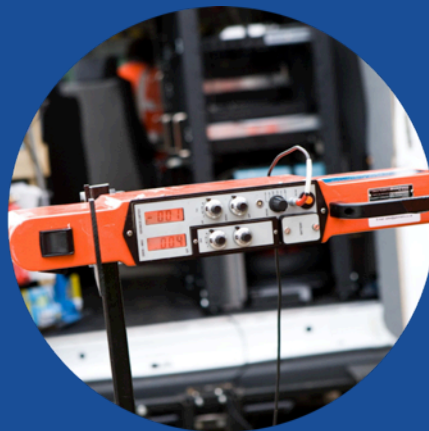
# Seaborne assessment



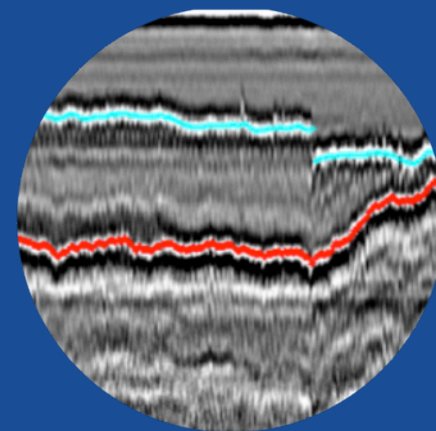




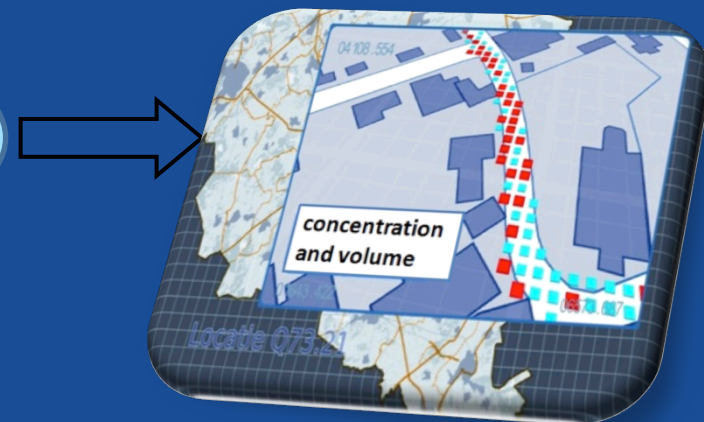
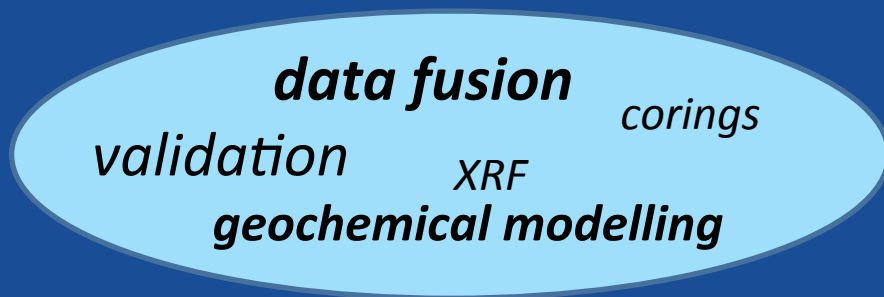
**Radiometrics**  
*quantification*



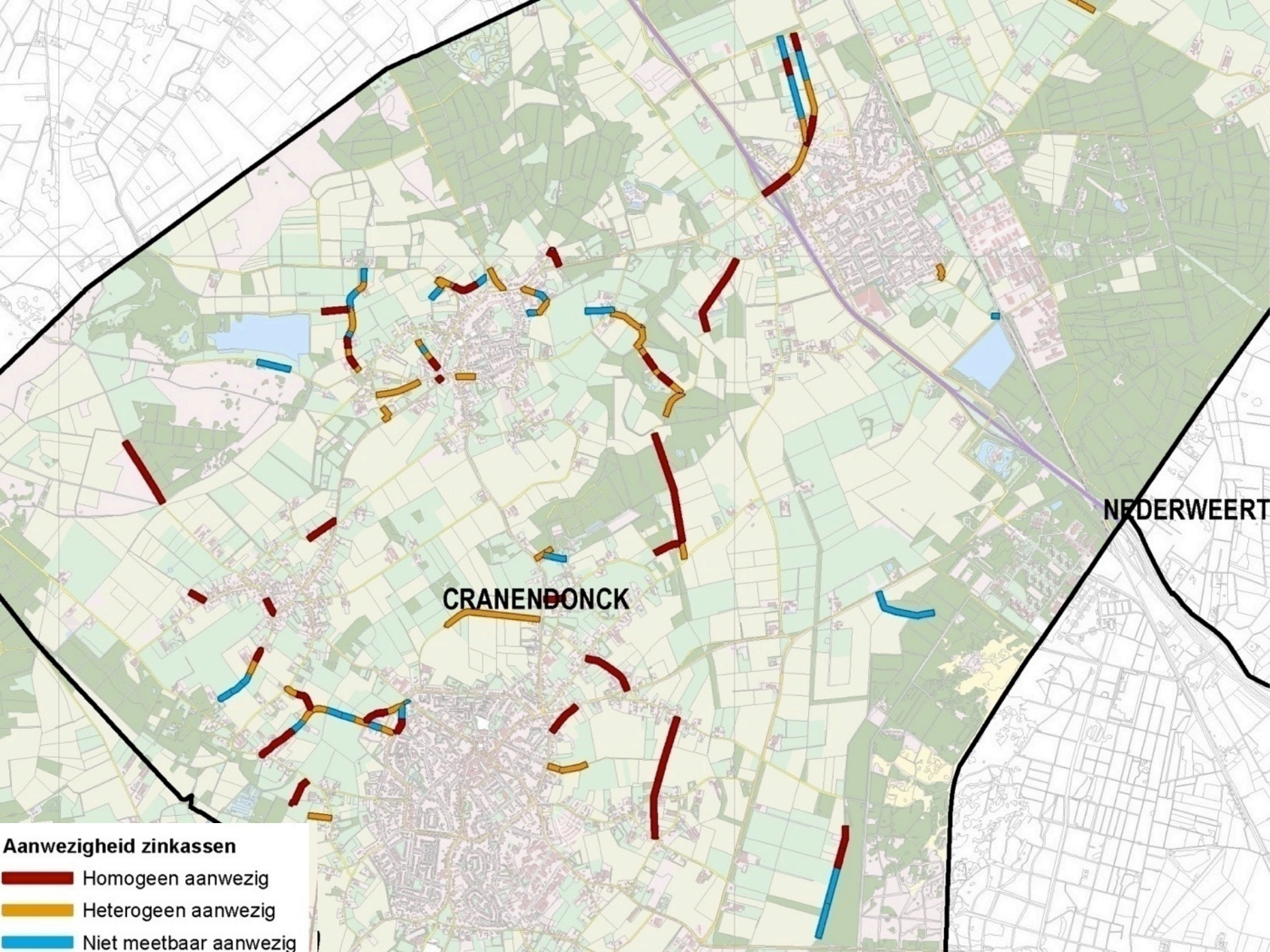
**EM**  
*presence*



**GPR**  
*volume*







CRANENDONCK

NEDERWEERT

**Aanwezigheid zinkassen**

- Homogeen aanwezig
- Heterogeen aanwezig
- Niet meetbaar aanwezig



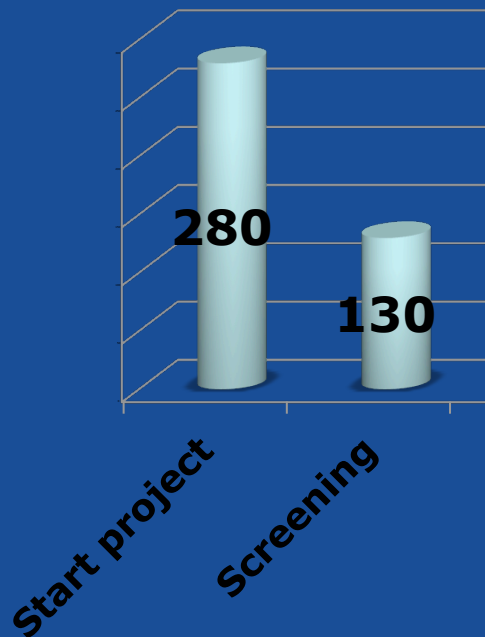
# Validation

		Corings	
		No	Yes
Geophysics	No	True negative	<b>False negative</b>
	Yes	<b>False positive</b>	True positive

		Corings	
		No	Yes
Geophysics	No		<b>9%</b>
	Yes	<b>8%</b>	

- Results of geophysics are compared to corings
- For validation purpose: corings represent the 'truth'
- Validation based on 1750 corings
- Uncertainty in method < 10%!

**Estimated costs  
m€**



**With zinc slag mapping,  
size of problem reduced**

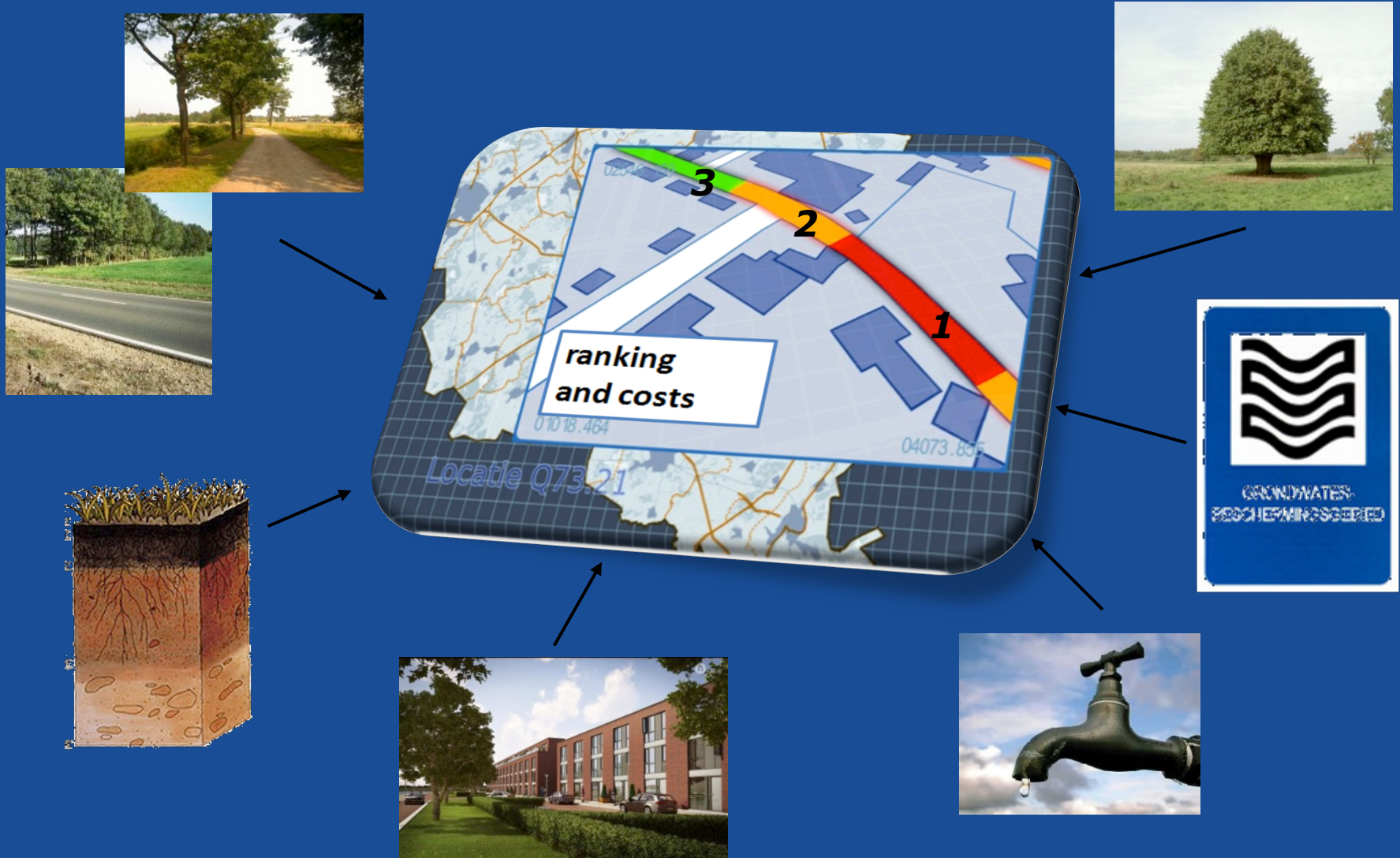
*but*

**funding for remediation not  
enough**

*therefore*

**Risk based assessment**

# Risk based assessment





# Remediation of mine tailings?

## Estimated costs m€



Start of project, costs estimated: 280 m€

Use of geophysics for screening

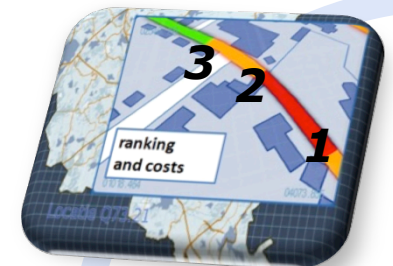
- Reduction of zinc slag problem

Risk based assessment

- Zoning on potential risk for leaching

Remediation

- Remediation program based on risks and costs





**Remediation is feasible!**