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Enabling Delta Life

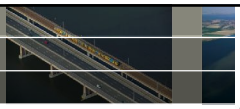
AEM in the Coastal Zone

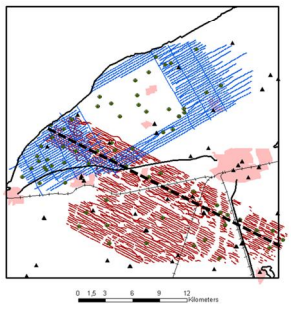
freshsalt.deltares.nl
zoetzout.deltares.nl

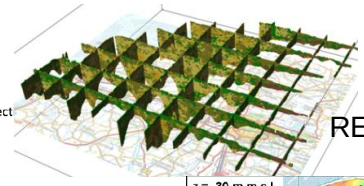
Gualbert Oude Essink

5/8/2013

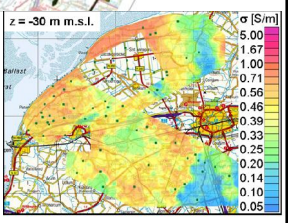
Case Wetterskip Fryslân



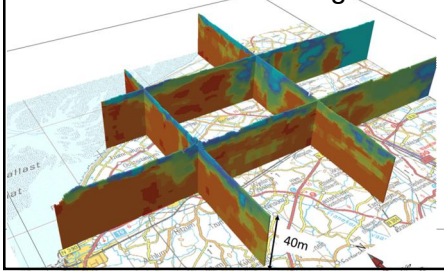


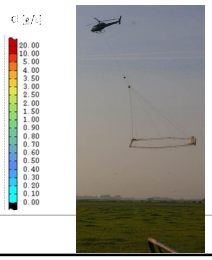


REGIS

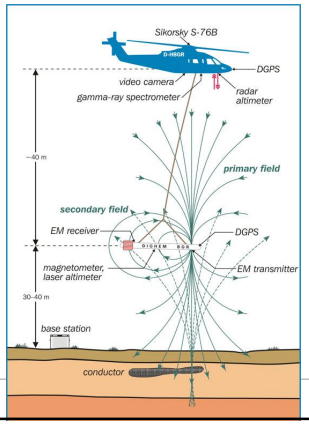


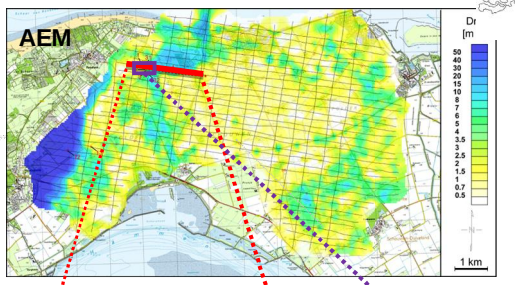
3D zoet-zout verdeling

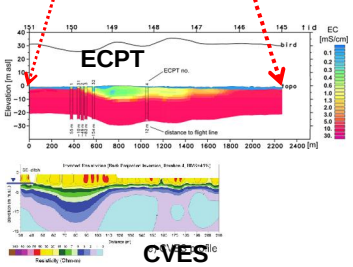


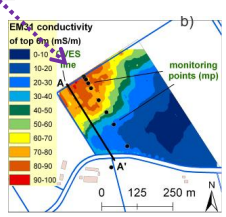


Case Schouwen-Duiveland









EM31

conventional monitoring techniques

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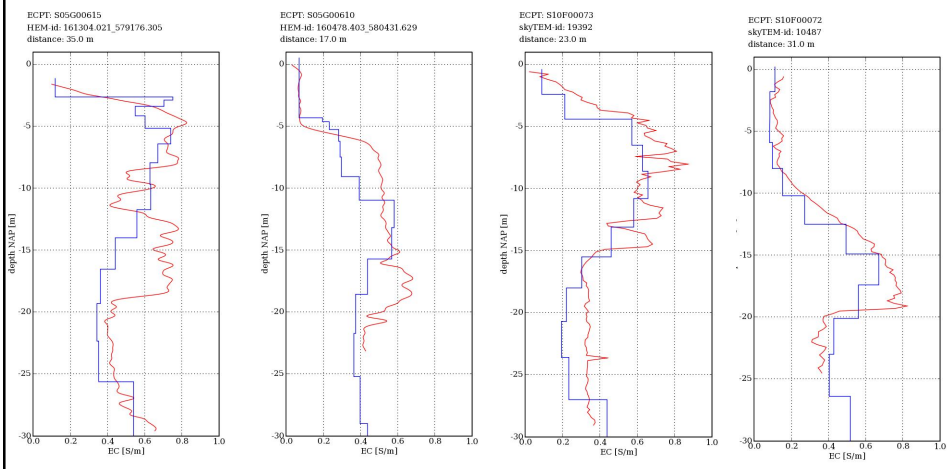
Compare Airborne EM with ECPT, Case Wetterskip Fryslân



EC from ECPT

EC from inversion

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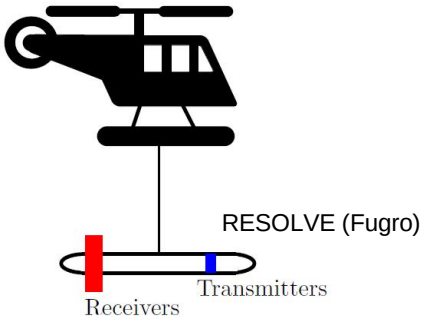
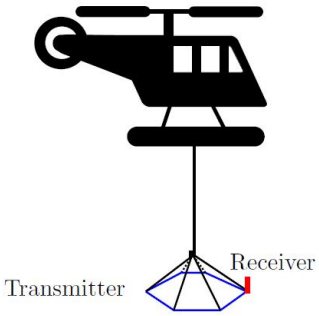
HEM and SKY-TEM





HEM is helicopter-borne
frequency-domain

how much of the signal lies within each given frequency band

SkyTEM is helicopter-borne
time domain
a signal changes over time

Larger penetration, but slower

Tools and AEM advantages

Key issues to achieve fresh water management:

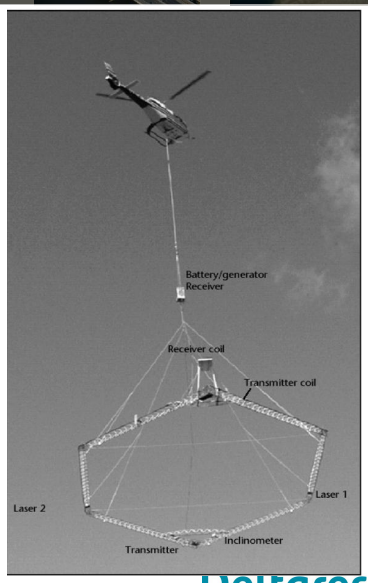
- **Characterize** groundwater systems, **identify** fresh water resources (quantity and quality) and make **predictions** of changes in these resources
- Have cost-efficient tools such as geophysical methods and numerical models

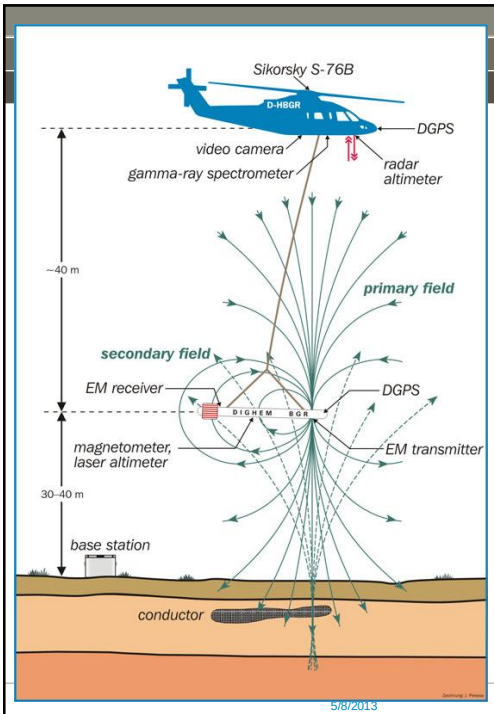
Advantages AEM:

- Collection data very fast (within 1 yr a distribution, not just after 10's of yrs)-> interesting for data-poor countries
- 3D result (standard methods are 0D, 1D or 2D)
- Change in fresh-saline distribution can be detected by repetition measurement

AEM to detect fresh and saline groundwater

Electrical conductance measurements





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Monitoring salt in groundwater

Electrical conductance measurements

$\rho_s = F^* \rho_w$

ρ_s = resistance subsoil & groundwater
ρ_w = resistance groundwater
F = formation factor

Lithology	**F**
Gravel with sand	7
Coarse sand	5
Sand with silt	2 - 3
Clay	*1-3**
peat	*1**

→ *F varies with the resistance of the groundwater*

If the lithology is known AND the measurement is in an aquifer
→ ρ_w can be calculated

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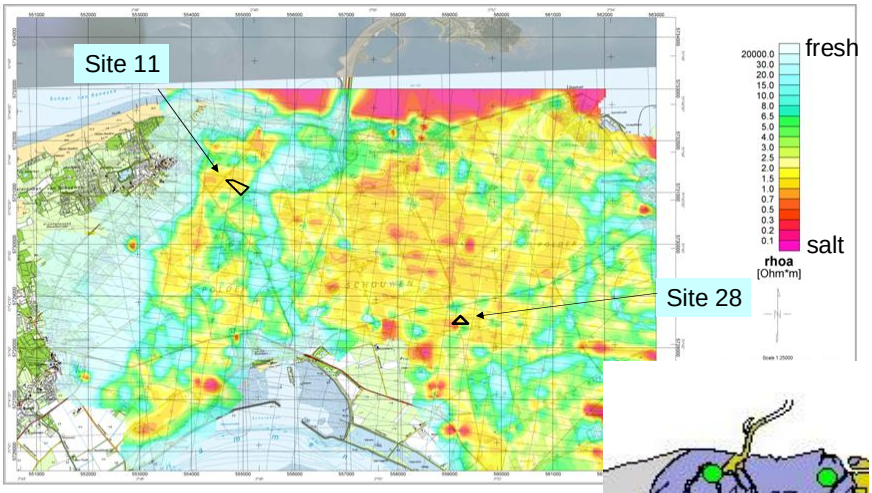
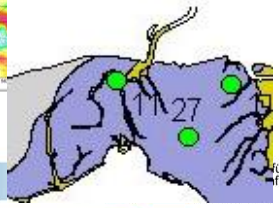
HEM results

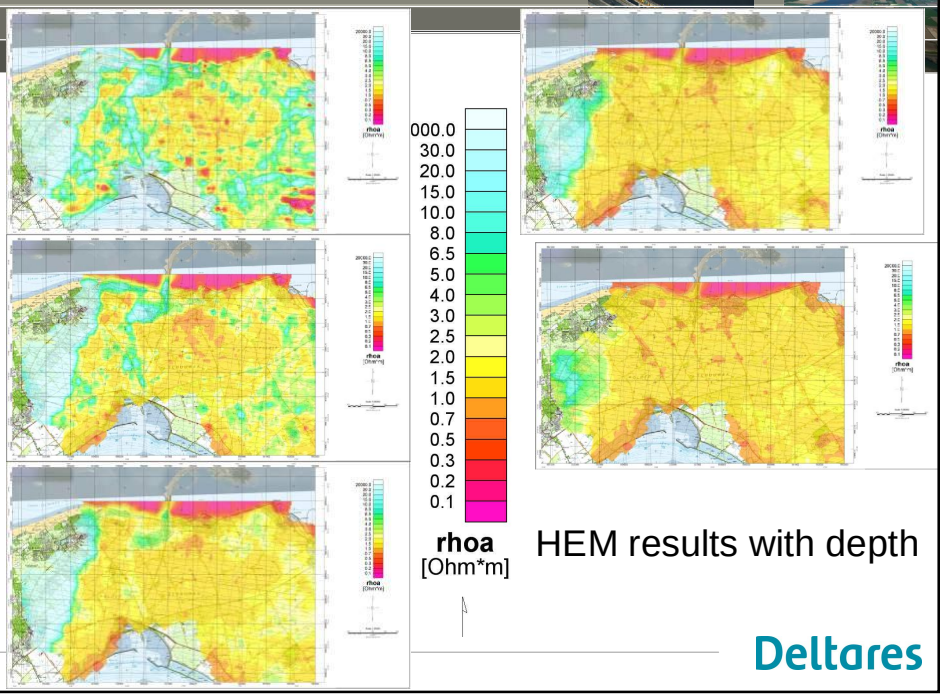


apparant resistivity for f_6 = 133 kHz



The Interreg IVB North Sea Region Programme

GEOZENTRUM HANNOVER



HEM results with depth

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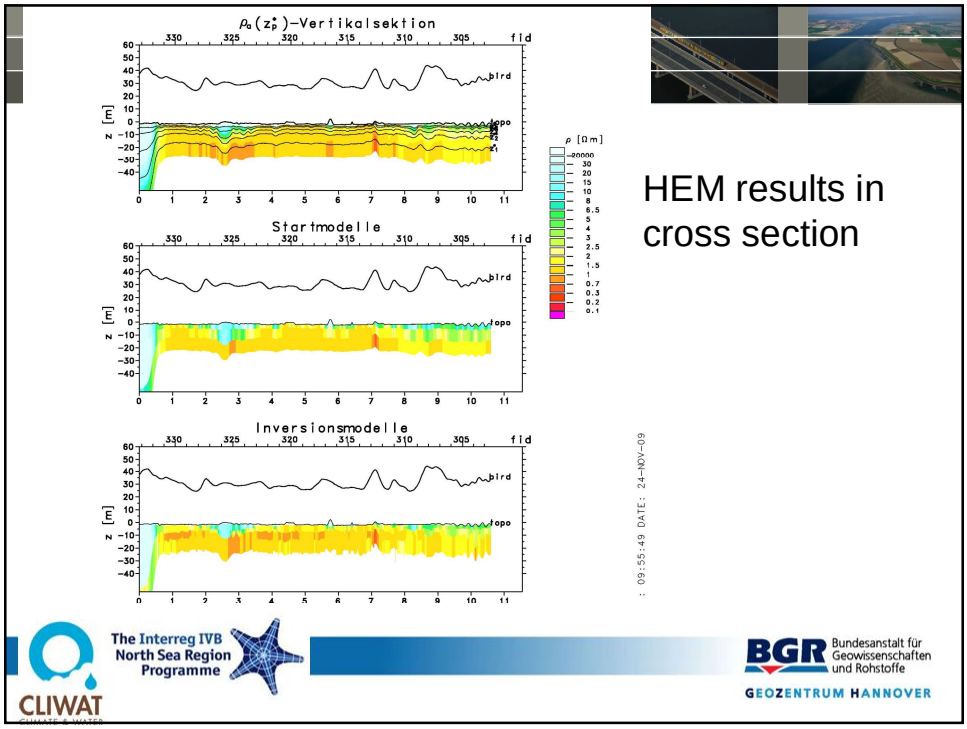


HEM results in cross section

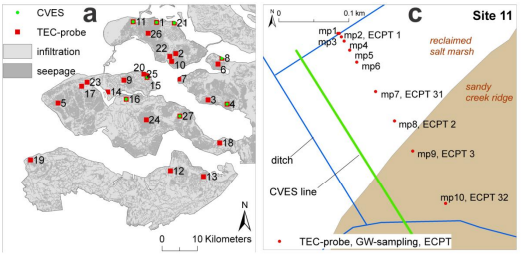
The Interreg IVB North Sea Region Programme

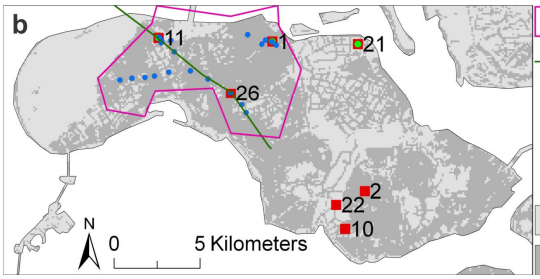
CLIWAT

BGR Bundesanstalt für Geowissenschaften und Rohstoffe

GEOZENTRUM HANNOVER

Monitoring and data assimilation





HEM area
cross section
ECPT
CVES
TEC-probe
infiltration
seepage

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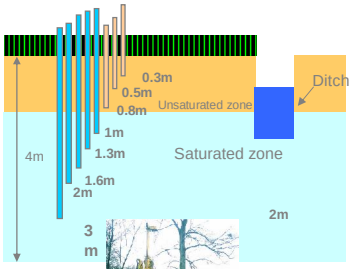
Monitoring and data assimilation
complex (fresh-brackish-saline) water systems



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