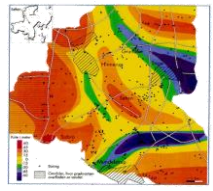
APPLIED GEOPHYSICS TO CREATE INSIGHT AND REDUCE UNCERTAINTIES

TIME DOMAIN ELECTROMAGNETICS (TDEM)

MAX HALKJÆR
HYDRO-GEOPHYSICIST
RAMBØLL

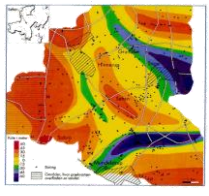
WE NEEDED MORE DATA TO REDUCE UNCERTAINTIES AND TO REPLENISH AND SUSTAINABLY MANAGE AQUIFERS

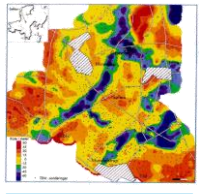


Thomsen et al. 2004

Data
• Information from 518 wells

WE NEEDED MORE DATA TO REDUCE UNCERTAINTIES AND TO REPLENISH AND SUSTAINABLY MANAGE AQUIFERS





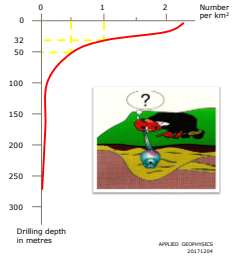
Thomsen et al. 2004

Data
• Information from 518 wells

Data
• Information from 518 wells
• And 1400 TDEM soundings

SHALLOW AND TOO FEW WELLS

- Drill depth versus frequency in Aarhus County
- Results:
  Total of 2.5 drillings per km^2
  < 32 m: 1 drilling per 1 km^2
  < 50 m: 1 drilling per 2 km^2
  < 100m: 1 drilling per 15 km^2
- Conclusion: we don't know enough



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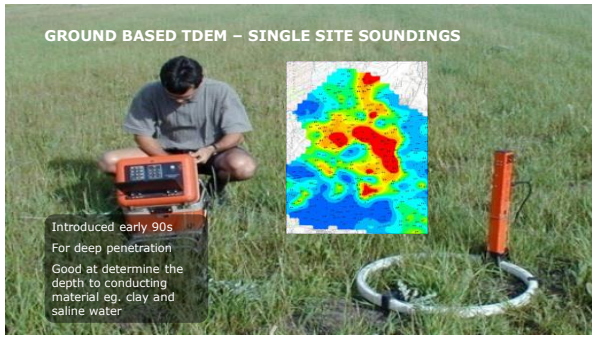
GROUND BASED TDEM – SINGLE SITE SOUNDINGS

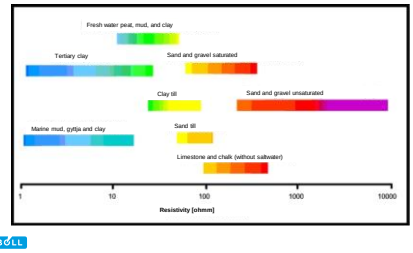


Introduced early 90s

For deep penetration

Good at determine the depth to conducting material eg. clay and saline water

CORRELATION - RESISTIVITY – HYDROGEOLOGY



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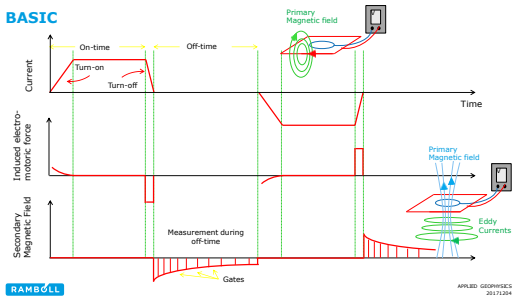
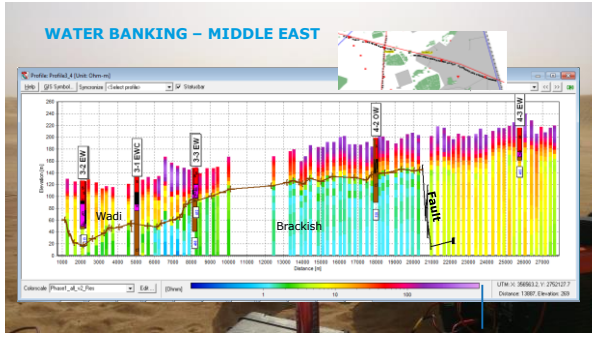
BASIC

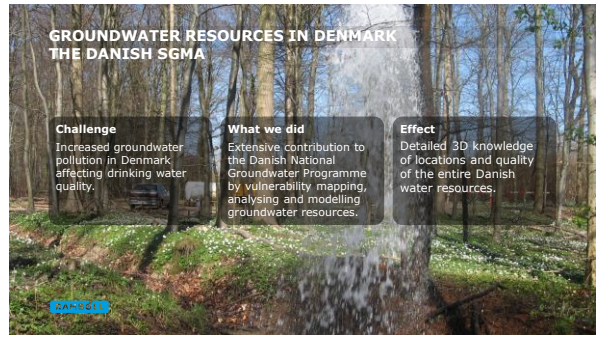


AQUIFER STORAGE AND RECOVERY MIDDLE EAST

WATER BANKING – MIDDLE EAST



GROUNDWATER RESOURCES IN DENMARK THE DANISH SGMA



AIRBORNE GEOPHYSICS SKYTEM

- Developed specifically for groundwater
- High production rate
- Cost efficient
- High vertical and lateral resolution
- No need to access the ground

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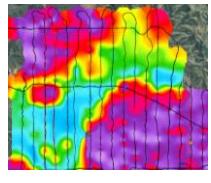
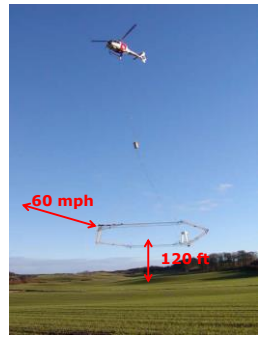
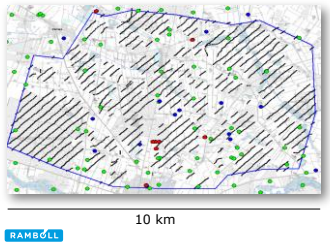
SURVEY SPECIFICATIONS

- Speed
- Height
- Line spacing
- Only possible in rural areas





Western Denmark – SkyTEM



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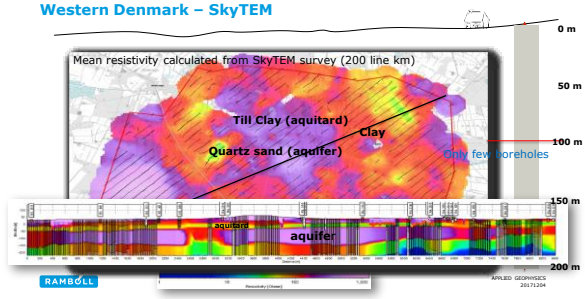
Western Denmark – SkyTEM



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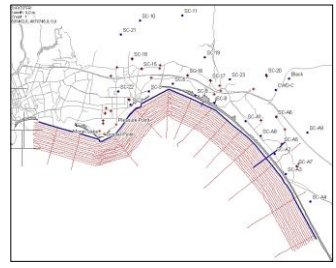
MONTEREY BAY, CALIFORINIA

Challenge
Increased the knowledge of the salt – fresh water interaction in a coastal environment

Effect
An understanding of the fresh-saltwater inter action

What we did
320 line km of near shore skytem survey with a 100m line spacing

Hydrogeological interpretation



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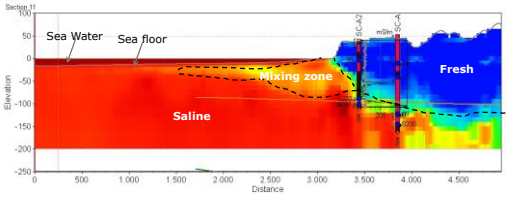
MONTEREY BAY, CALIFORINIA



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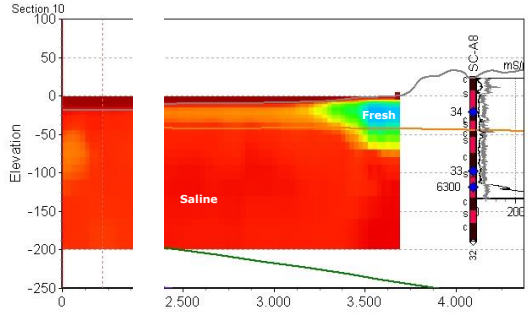
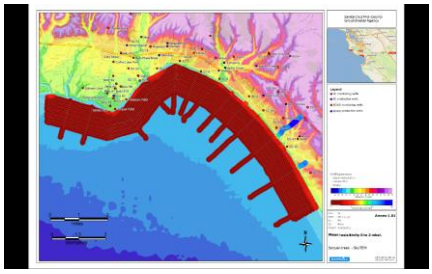


0 TO 2 METER BELOW SEA LEVEL



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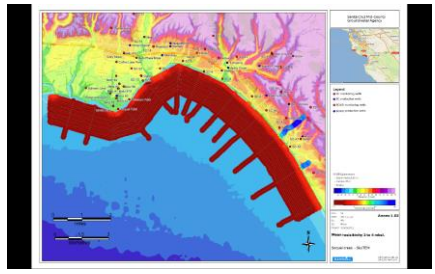
2 TO 4 METER BELOW SEA LEVEL



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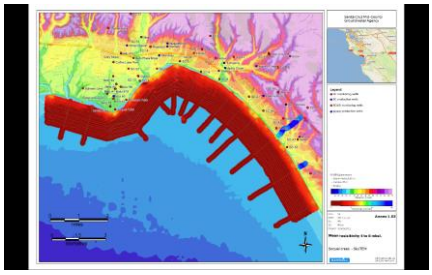
4 TO 6 METER BELOW SEA LEVEL



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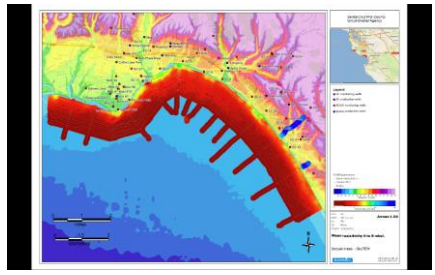
6 TO 8 METER BELOW SEA LEVEL



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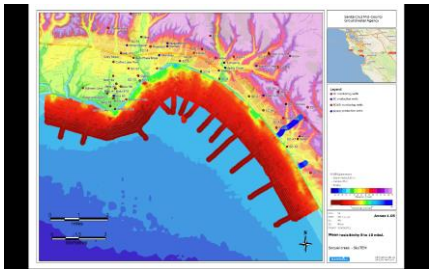
8 TO 10 METER BELOW SEA LEVEL



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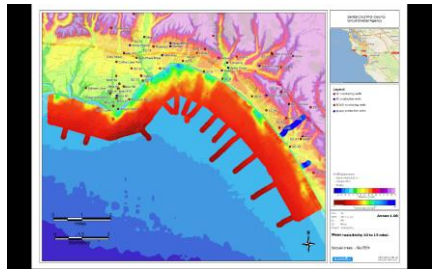
10 TO 15 METER BELOW SEA LEVEL



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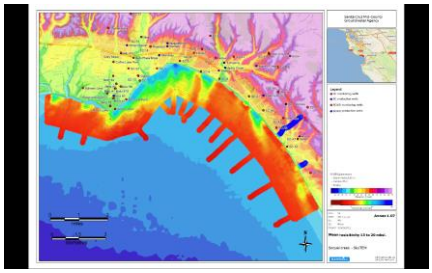
15 TO 20 METER BELOW SEA LEVEL



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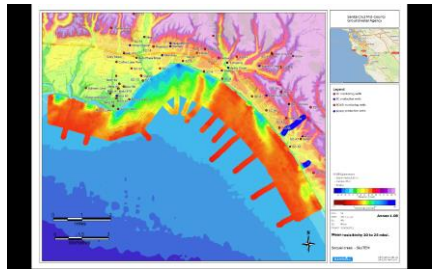
20 TO 25 METER BELOW SEA LEVEL



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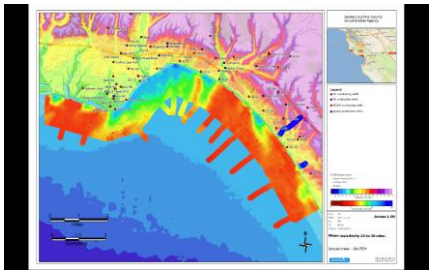
25 TO 30 METER BELOW SEA LEVEL



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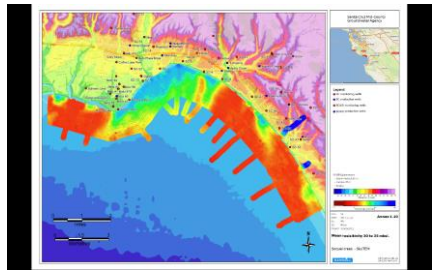
30 TO 35 METER BELOW SEA LEVEL



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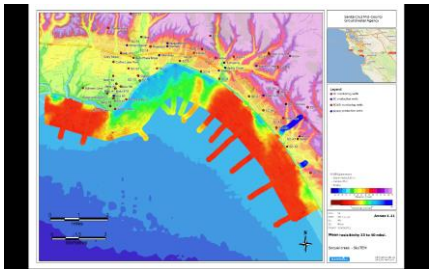
35 TO 40 METER BELOW SEA LEVEL



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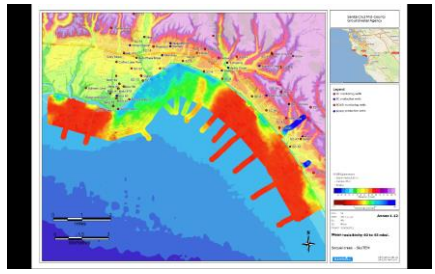
40 TO 45 METER BELOW SEA LEVEL



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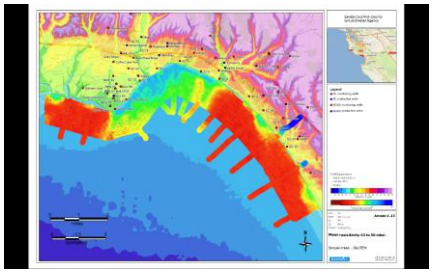
45 TO 50 METER BELOW SEA LEVEL



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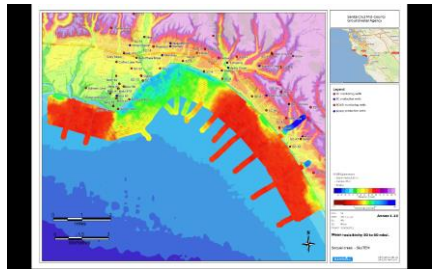
50 TO 60 METER BELOW SEA LEVEL



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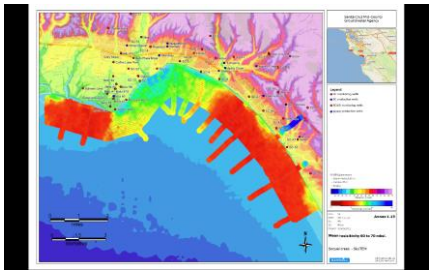
60 TO 70 METER BELOW SEA LEVEL



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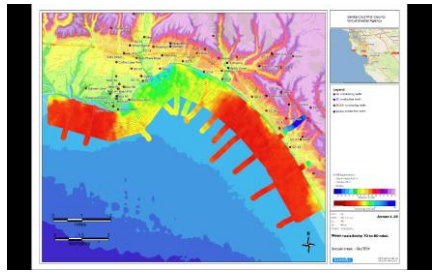
70 TO 80 METER BELOW SEA LEVEL



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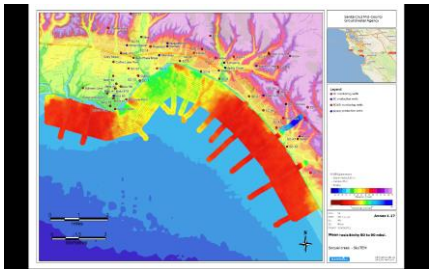
80 TO 90 METER BELOW SEA LEVEL



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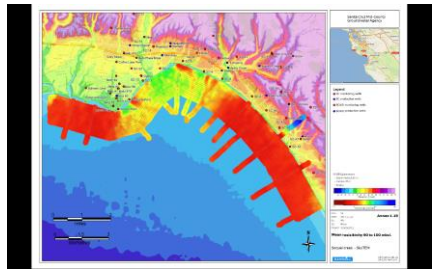
90 TO 100 METER BELOW SEA LEVEL



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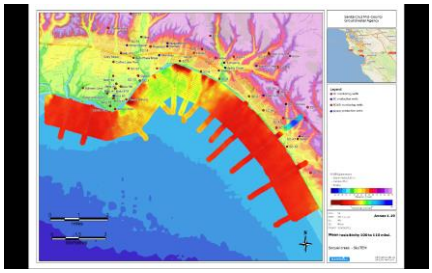
100 TO 110 METER BELOW SEA LEVEL



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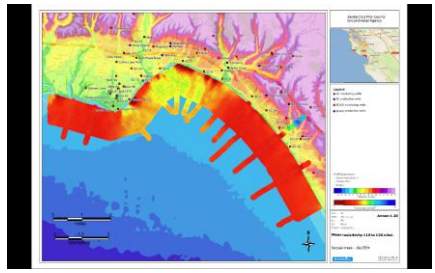
110 TO 120 METER BELOW SEA LEVEL



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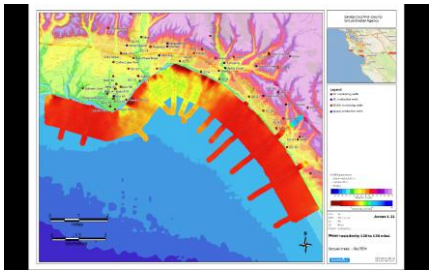
120 TO 130 METER BELOW SEA LEVEL



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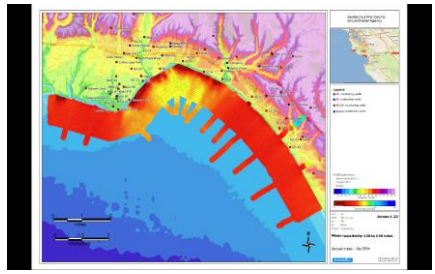
130 TO 140 METER BELOW SEA LEVEL



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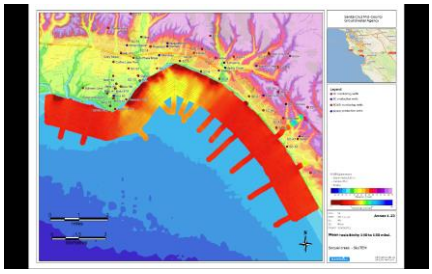
140 TO 150 METER BELOW SEA LEVEL



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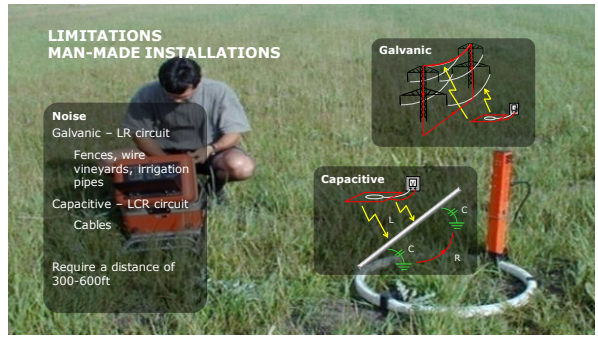
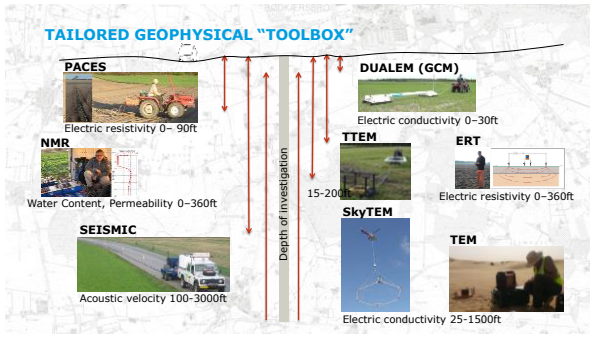
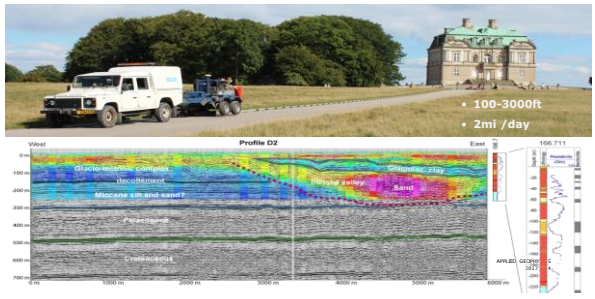


TAILORED GEOPHYSICAL "TOOLBOX"



GROUND BASED TDEM – TTEM

Reflection Seismic – Land streamer vibrosis



KEY TAKE AWAYS

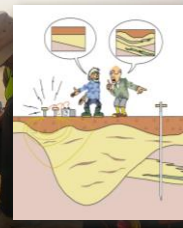
Select the right geophysical tool and understand the benefits and the limitation

Dense measurements

Use information from boreholes to validate and to constrain the geophysical inversion

Aim for high quality systems – resistivity contrasts less than a factor of 2 can be essential

Geophysics is inexpensive !



THANKS

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