Geophysics in hydrogeological inverse problem: Hero or Villain?

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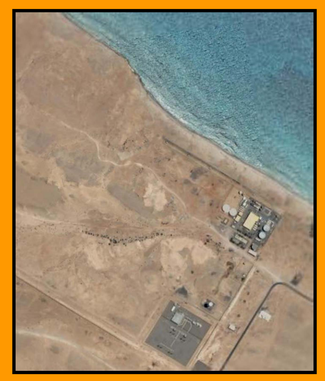
I) Motivation: Large efforts devoted to conditioning to dependent variables (e.g. heads). Intensive use of geophysics for delineation of hydrogeological bodies. It has been shown that it is a powerful data type for gaining information on aquifer properties. Most of the applications use toy examples. Small number of real-field applications.

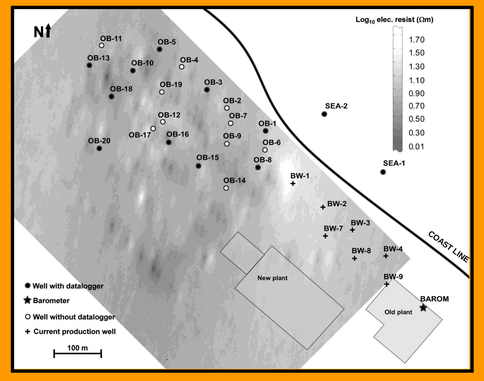
II) Application: Conditional estimation of T and S fields using four sets of conditioning data. Spatial variability of T and S characterized by the regularized pilot points method

- SET 1: Only T and S data arising from prior interpretation of pumping tests. Ordinary kriging. No calibration is performed
- SET 2: Set 1 & head variations in response to tidal fluctuation and to three long term pumping tests.
- SET 3: Set 1 & Electrical resistivity data (included as external drift). No calibration is performed
- SET 4: Set 3 & head variations in response to tidal fluctuation and to three long term pumping tests.

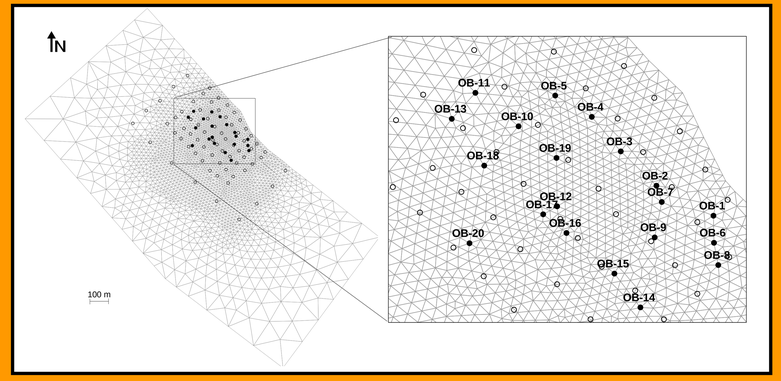
III) The site and the model : Located (somewhere) in Oman. A desalination plant currently pumps 1200 m3/h from beach wells (freshwater production = 504 m3/h). Aim: design an optimum pumping network to increase pumping to 9000 m3/h (freshwater production = 3346 m3/h) minimizing the side effects. Highly karstified area (i.e. large heterogeneities expected).



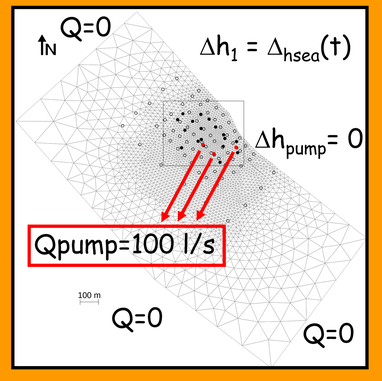
The site



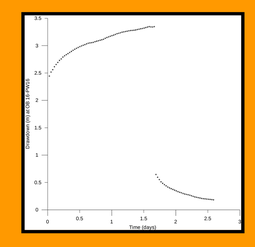
Boreholes and resistivity data

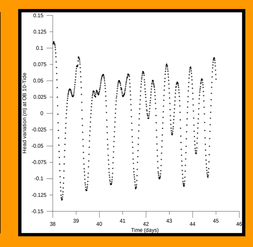


Finite Elem. Discretization (5074 elements / 2585 nodes)



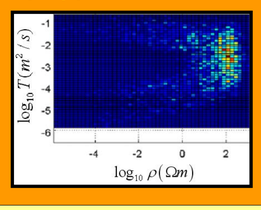
Boundary conditions





Dependent variable data. Hard to filter

Joint pdf (T,ρ). Poster H23A-1018

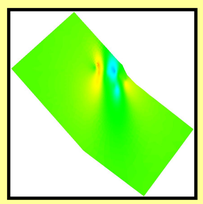


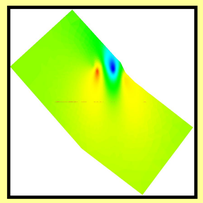
IV) Results:

$\log_{10}$T(m2/s)

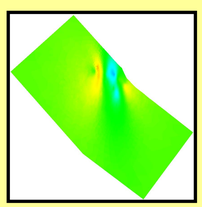
$\log_{10}$S

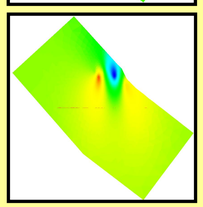
Hard

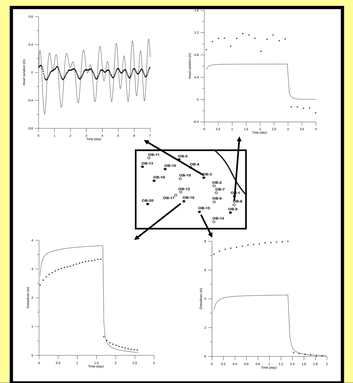


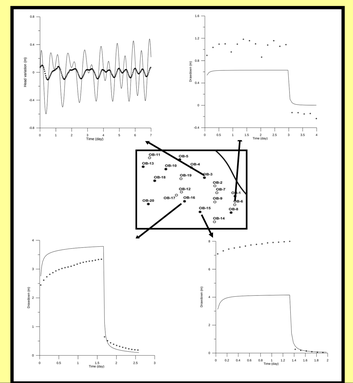


Geoph. & Hard

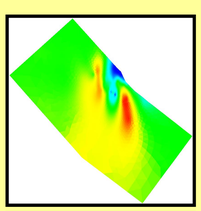


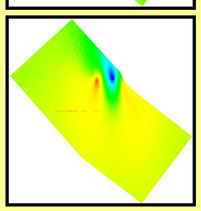


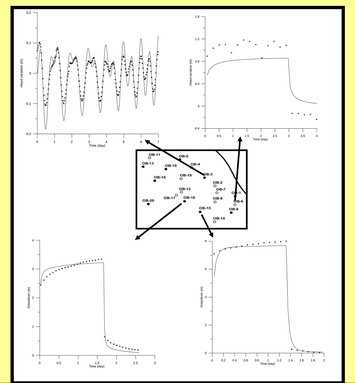




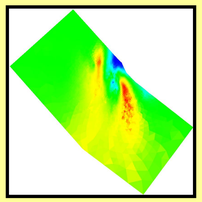
Hard & Heads

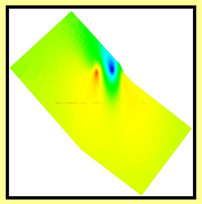


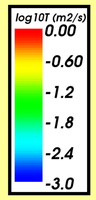


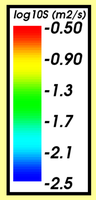


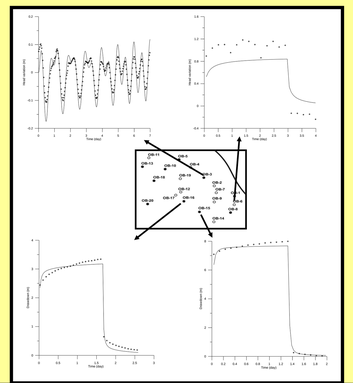
All



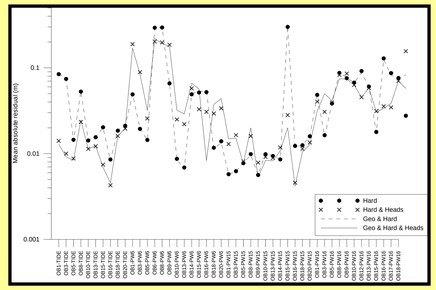




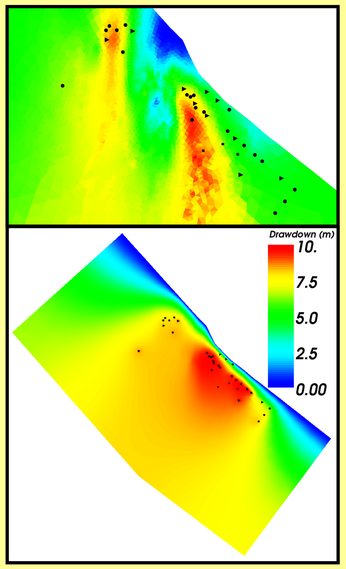




Standardized residuals



Optimum pumping network



CPU time (in seconds)

Hard : 1.20

Geoph. & Hard : 1.22

Hard & Heads : 56548

Geoph. & Hard & Heads : 44797

(21 % less)

V) Conclusions

1. Included geophysics helps : CPU reduced dramatically and (slightly) better fits. **HERO.**
2. Conditioning to geophysical data (i.e. including them in the objective function) would improve much more. Correlation function T-ρ required. ON-GOING WORK. **SUPER-HERO ???**