An integrated and interoperable platform enabling 3D stochastic geological modelling

Stochastic modelling of the Lower Burdekin Delta aquifer

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1 Introduction and context

Insights about the sediment distribution of the LBD are crucial for simulating flow dynamics, contaminant transport, seawater intrusion, and surface water-groundwater interactions—all of which are vital for effective resource management and environmental protection in the region (Werner, 2010).

However, despite the conceptual model developed by Mc Mahon (2004) and the existence of tens of thousands of borehole lithological descriptions, the current numerical model used to manage the resource is not adequate for groundwater flow and transport characterisation.

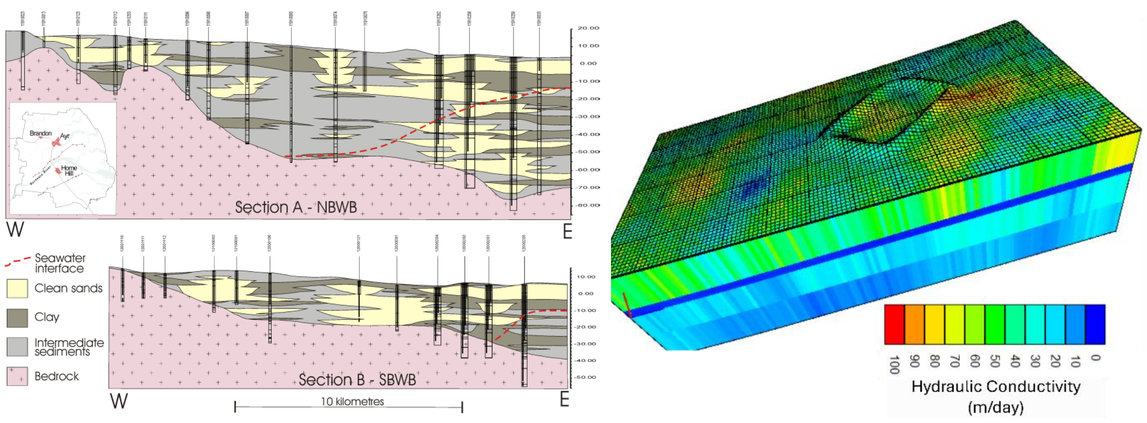


Figure 1: left panel - conceptual model developed by Mc Mahon (2004) ; right panel – analogue to current numerical model (from Zadeh's MSc thesis)

2 Method

a) Develop a stochastic modelling engine compliant with the conceptual model of Mc Mahon (2004)

b) Extract information from legacy boreholes

c) Classify main properties and descriptors into main facies

d) Compute summary statistics for model calibration
   - Facies proportions
   - Thickness distribution per facies
   - Calibration via global optimization (Mockus, 2002)

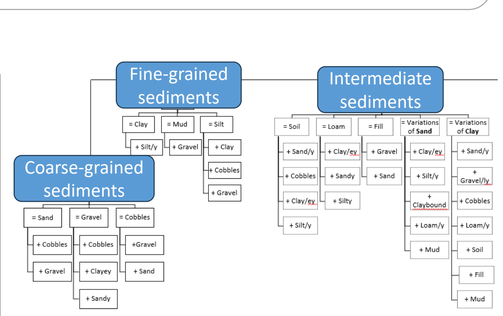
References

- Mariethoz, G., Renard, P., & Straubhaar, J. (2010). The direct sampling method to perform multiple-point geostatistical simulations. Water Resources Research, 46(11).
- McMahon, G. A. (2004). An integrated hydrogeological/hydrogeochemical approach to characterising groundwater zonations within a quaternary coastal deltaic aquifer: The Burdekin River delta, North Queensland (Doctoral dissertation, Queensland University of Technology).
- Mockus, J. (2002). Bayesian heuristic approach to global optimization and examples. Journal of Global Optimization, 22(1), 191-203.
- Werner, A. D. (2010). A review of seawater intrusion and its management in Australia. Hydrogeology Journal, 18(1), 281–285.

3 Results

RN	DESCR	TOP	BOTTOM
20921	TOP SOIL	0.00	3.96
20921	CLAY	3.96	17.07
20921	CLAY SILTY	17.07	17.37
20921	CLAY	17.37	19.81
20921	SAND COARSE AND STONES	19.81	22.86
...	...	...	...
12100520	CLAY GREY HARD	21.20	22.00
12100521	CLAY DARK BROWN FIRM	0.00	1.70
12100521	SAND LIGHT ORANGE BROWN FINETOMEDIUM COARSENS ...	1.70	3.00
12100521	SAND LIGHT GREY FINETOMEDIUM GRAIN TO ABOUT 4 ...	3.00	6.80
12100521	ROCK COMPLETELY WEATHERED TO A OLIVE GREEN CLA...	6.80	7.40

P1	P2	Material_Descriptor
SOIL	NONE	NONE
CLAY	NONE	NONE
CLAY	NONE	SILTY
CLAY	NONE	NONE
SAND	COBBLES	NONE
...	...	...
CLAY	NONE	NONE
CLAY	NONE	FIRM
SAND	NONE	NONE
SAND	NONE	NONE
BASEMENT	CLAY	WEATHERED, GRITTY



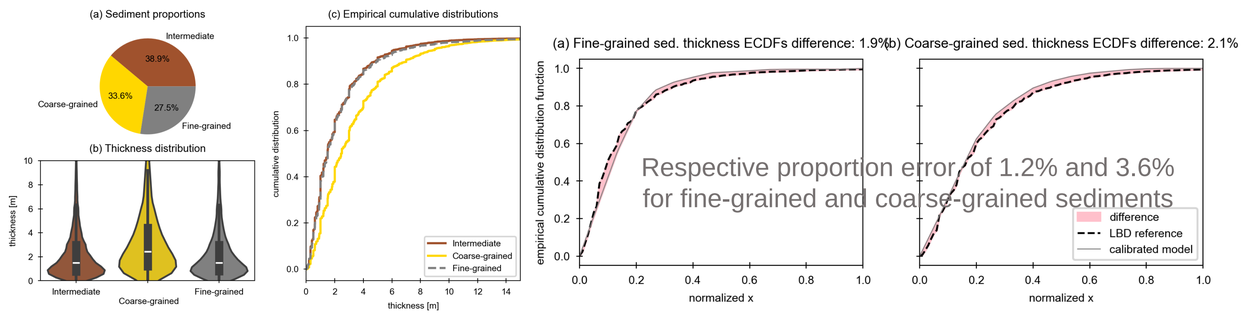


Figure 2: information extraction and consolidation (top row), summary statistics and calibration error (bottom row)

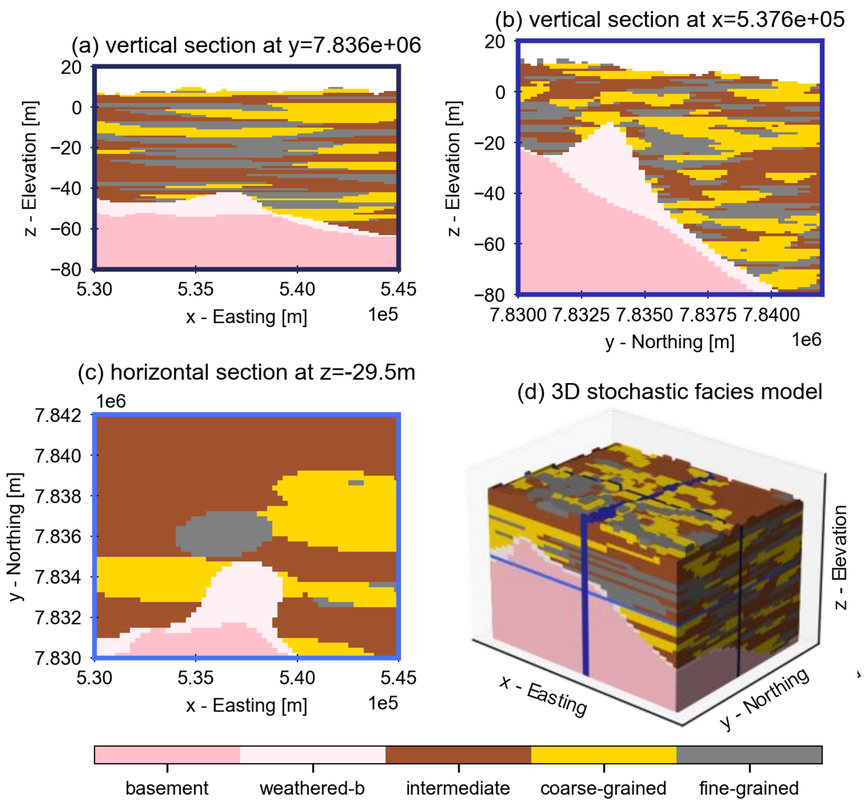


Figure 3: realisation from the calibrated stochastic algorithm

Conclusions

The proposed stochastic modelling engines satisfies:
- Mc Mahon's conceptual model
- Global summary statistics

The code is available on GitHub at https://github.com/gpirot/LBD-facies-modeling

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Next steps

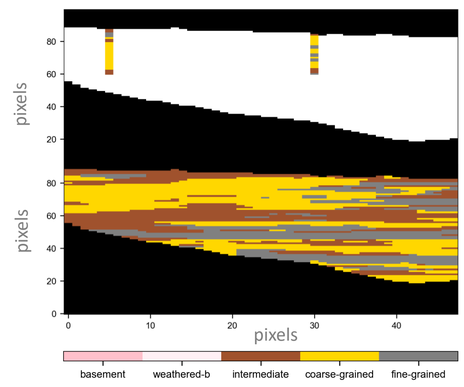

Figure 4: local conditional simulation using the Direct Sampling algorithm (Mariethoz et al., 2010)

Acknowledgments

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