CONNECTED WATERS

Australian Government
Geoscience Australia

UNSW
THE UNIVERSITY OF NEW SOUTH WALES

Interpreting hydraulic and hydrochemical data in an Australian alluvial aquifer-aquitard system using multivariate statistics.

Scott B. COOK, Wendy TIMMS, Bryce F.J. KELLY, Ross S. BRODIE, Andy BAKER

Never Stand Still | Engineering | School of Mining Engineering

Authors: Scott B, Ross S. BRODIE[3],

4. *School of Biol ustralia*

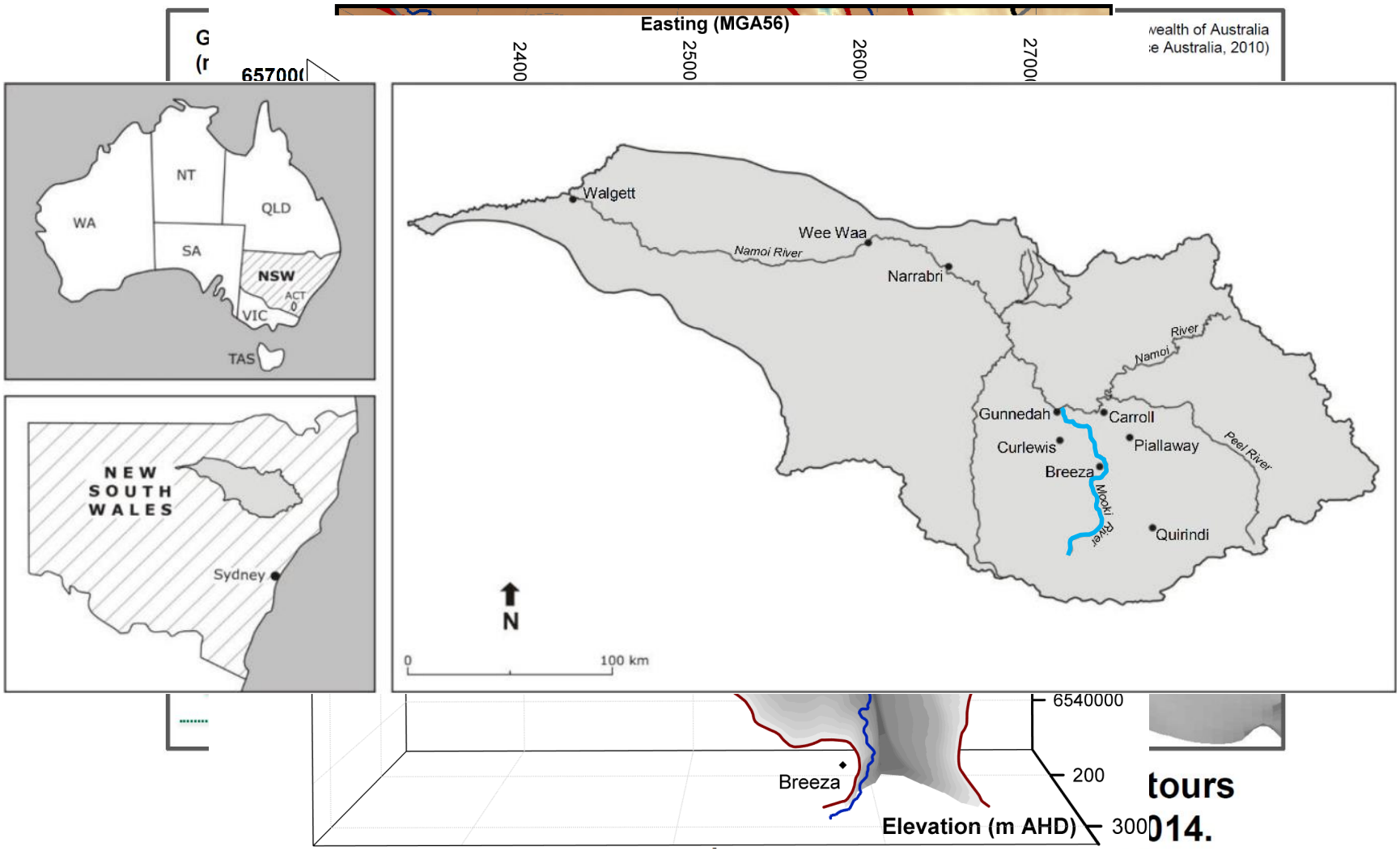
2. *Univ tive*

Main study focus:

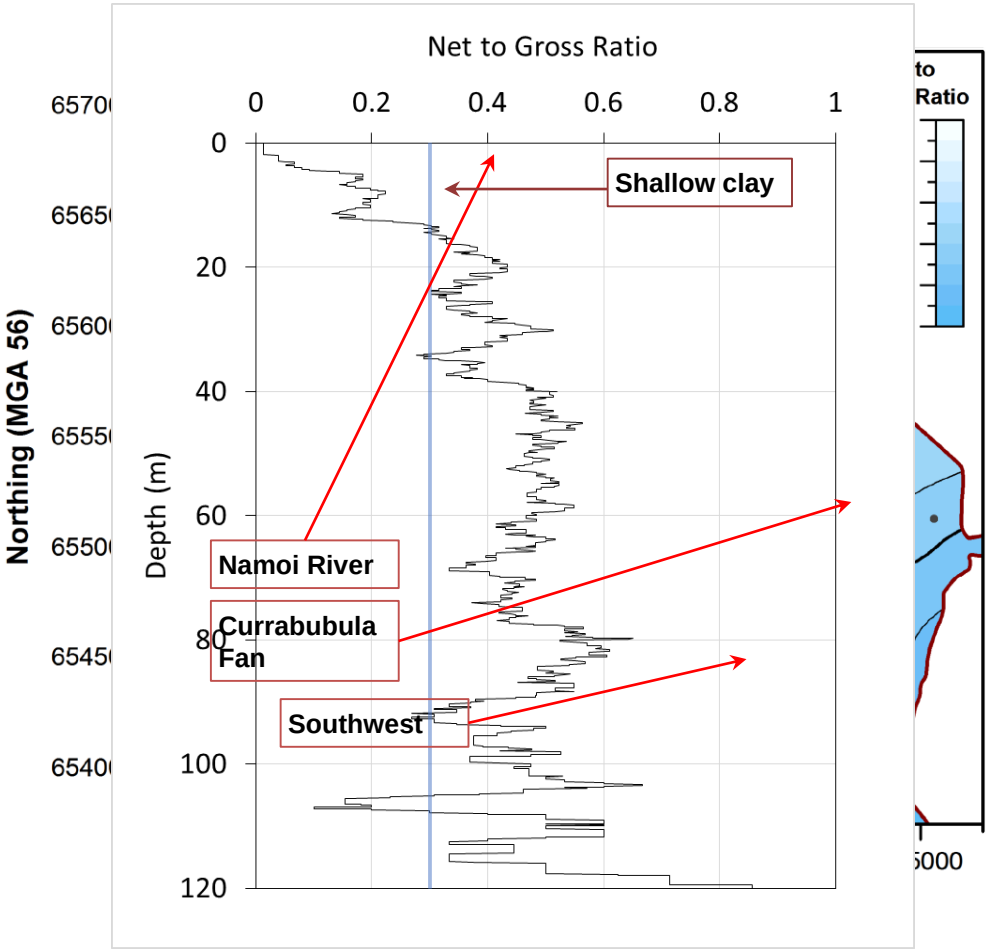
Using multivariate statistics to support hydraulic connectivity assessments

MEA Mining Education Australia

Mooki River, New South Wales, Australia

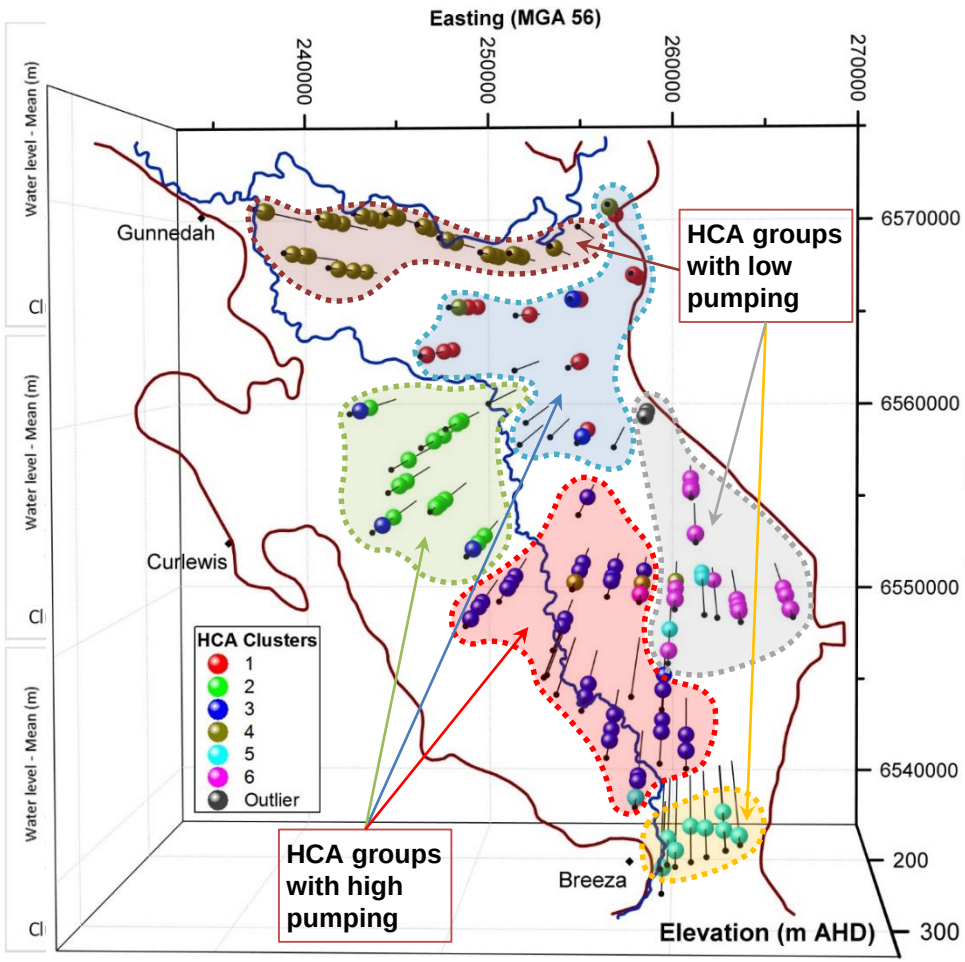


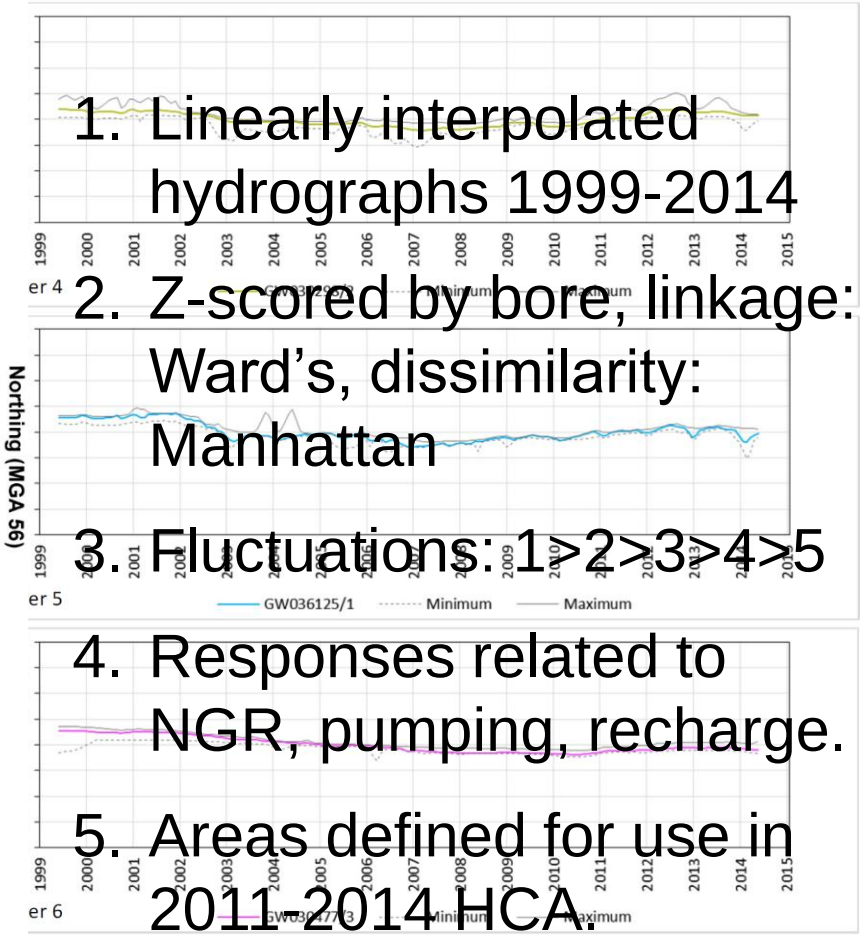
Lithological uncertainty and net to gross ratio



1. Heterogeneous alluvial sequence
2. Net (coarse):Gross (total) (NGR)
3. Connectivity = 0.3
4. Lithological data: drillers' logs, hydrogeologists logs and wireline logs
5. 0.3 uncertain

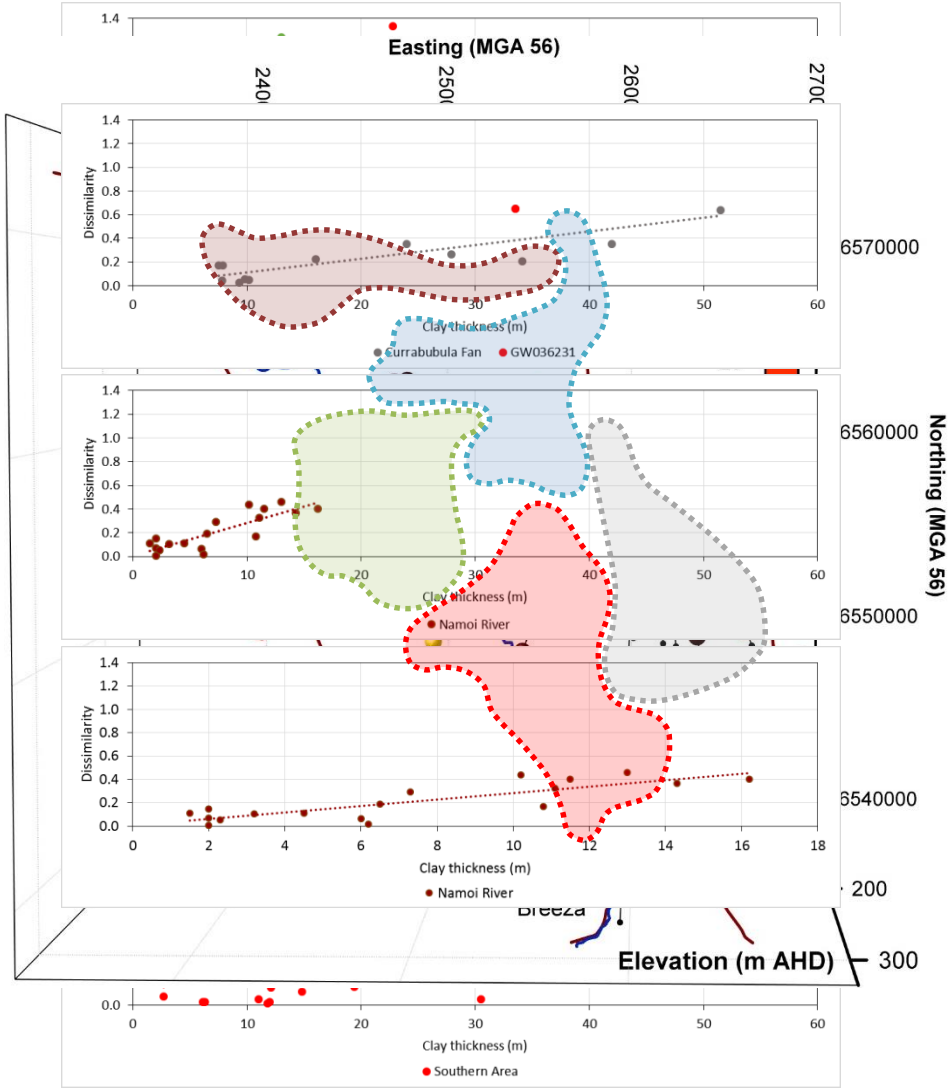
HCA Hydraulics: Analysis of hydrographs





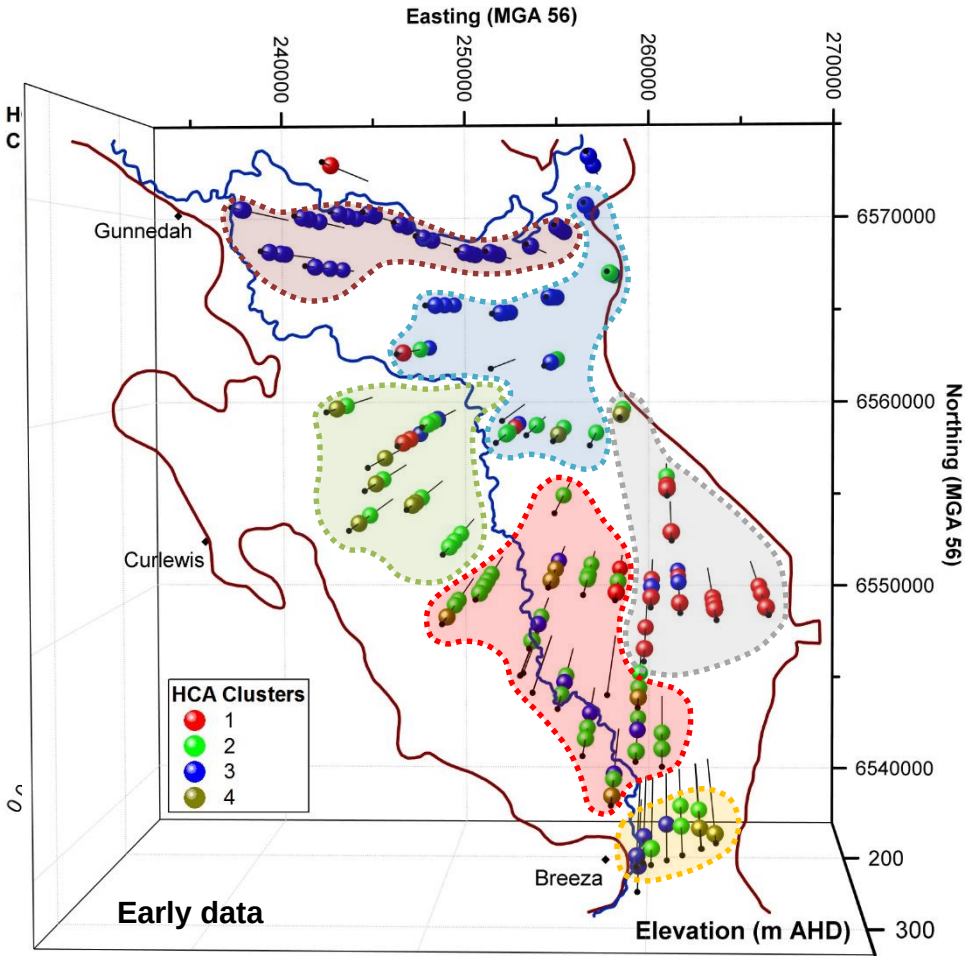
1. Linearly interpolated hydrographs 1999-2014
2. Z-scored by bore, linkage: Ward's, dissimilarity: Manhattan
3. Fluctuations: 1>2>3>4>5
4. Responses related to NGR, pumping, recharge.
5. Areas defined for use in 2011-2014 HCA.

HCA Hydraulics: Analysis of hydrographs



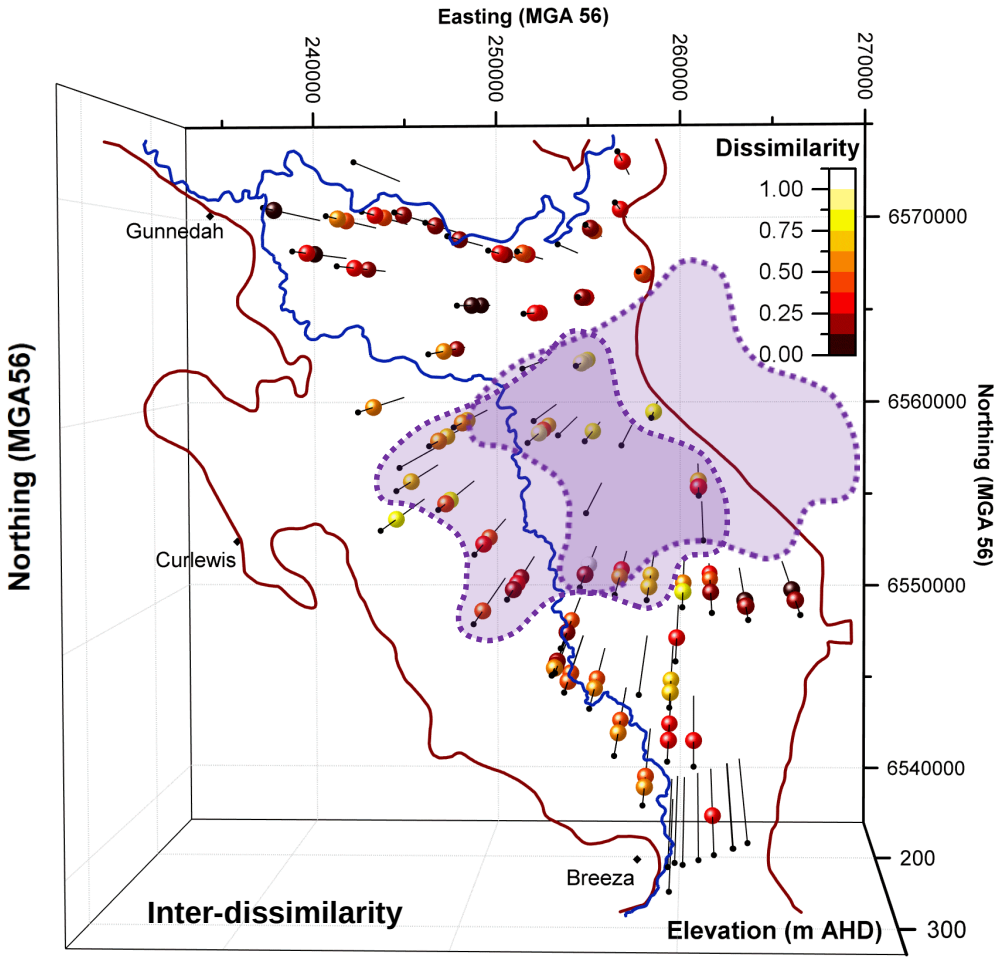
1. Linearly interpolated hydrographs 2011-2014
2. Dissimilarity matrix from HCA for quantification of difference between vertically adjacent wells
3. Dissimilarity = difference in the difference from $\bar{x}$ (standard deviations)
4. Correlations with clay thickness

HCA Chemistry: Analysis of major ions



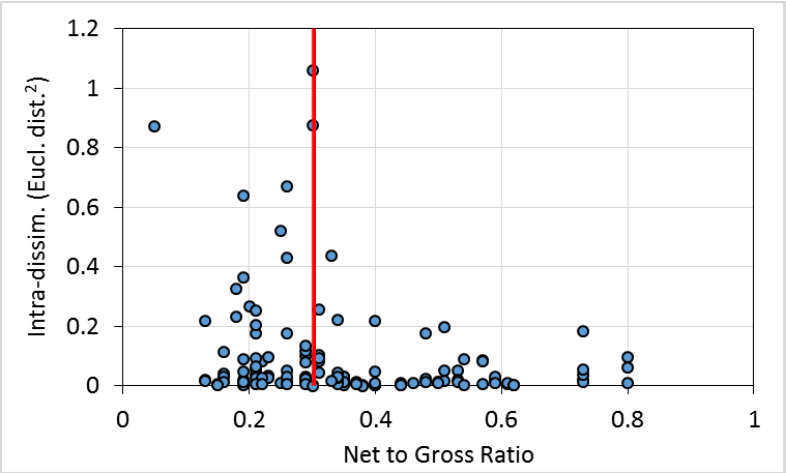
1. HCA of ionic ratios (733 analyses), 1970-2015
2. Dissimilarity: Eucl.dist.^{2}, linkage: Ward's
3. Chemistry and hydraulic group correspondence
4. Chemistry related to recharge and lithology
5. TDS: 2&3<1<4
6. Vertical differences

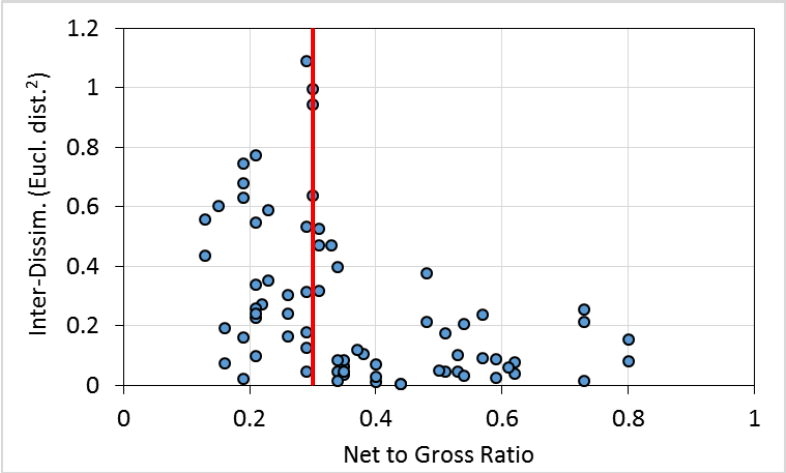
HCA Chemistry: Analysis of major ions



1. Temporal changes evident
2. Quantified using dissimilarity matrix
3. Correlation between max. intra and inter-dissimilarity (Euclidean distance)
4. Areas of maximum change correspond to low NGRs
5. Lower dilution volumes, higher salinity, greater head change

HCA Chemistry: Analysis of major ions





1. 0.3 Net to Gross Ratio connectivity threshold approx. corresponds to:
   - HCA cluster (4a-4c)
   - Elevated TDS >2,000 mg/L
   - Elevated intra-dissimilarity
   - Elevated inter-dissimilarity
2. Substantial salt stores in catchment clays so correlation is anticipated.

Summary and conclusions

1. NGR known to be good predictor of connectivity but uncertainty in lithology makes NGR uncertain.
2. HCA of hydrographs and chemistry support lithological interpretation and NGRs.
3. NGRs can be used to predict connectivity in the Mooki and refine catchment groundwater model.
4. Wider applications:
   - Multiple lines of evidence for connectivity
   - Estimations of connectivity where lithological data lacking
   - Insight into catchment processes and quantification of temporal change using multiple parameters

CONNECTED WATERS

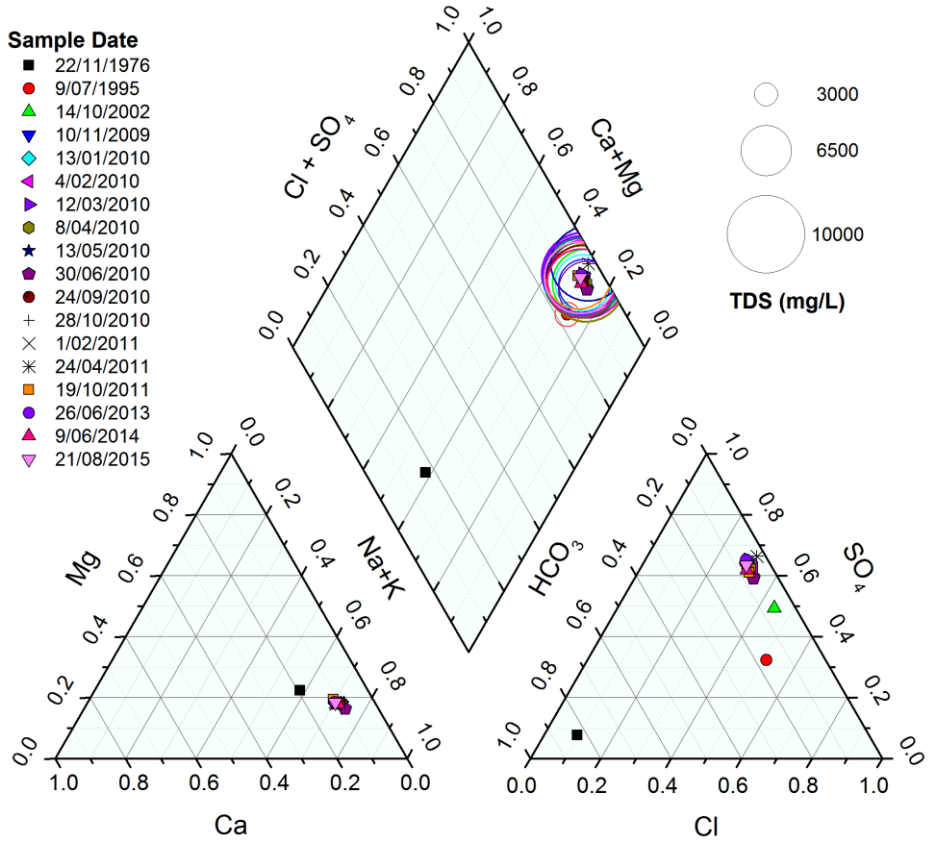
Australian Government

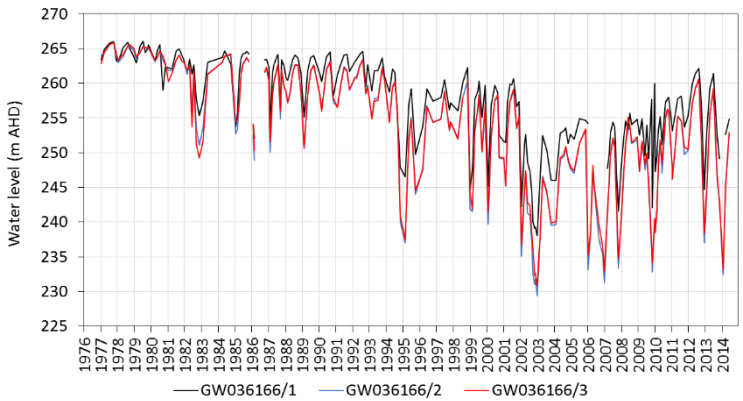
Geoscience Australia

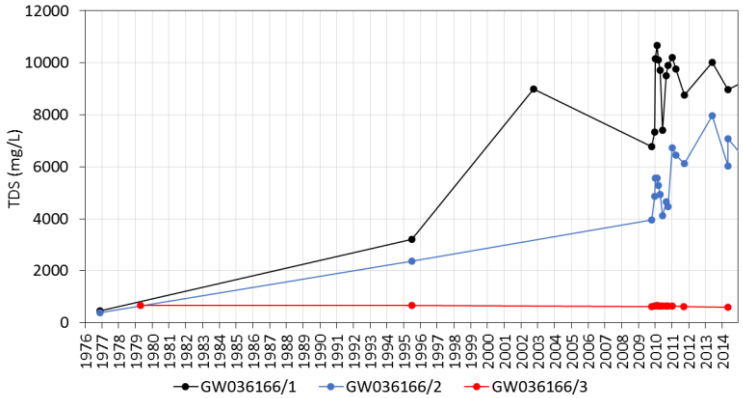
Thank You

UNSW THE UNIVERSITY OF NEW SOUTH WALES

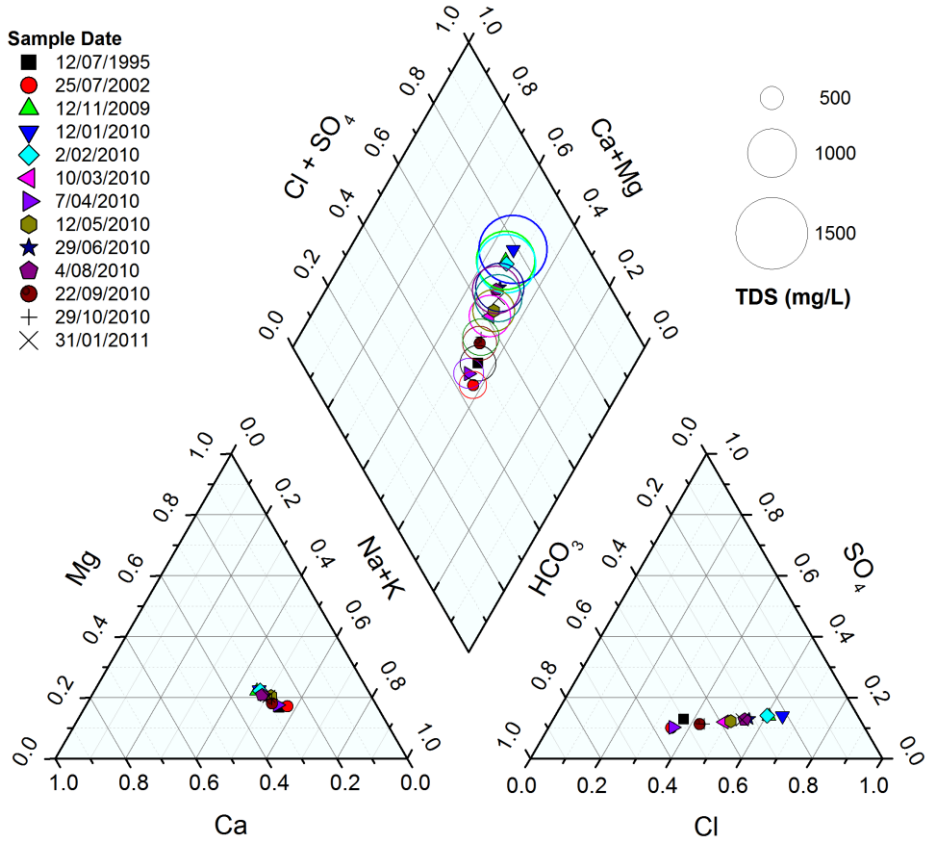
HCA chemistry Examples: GW036166/1; Dissimilarity (Eucl. Dist.) = 1.03

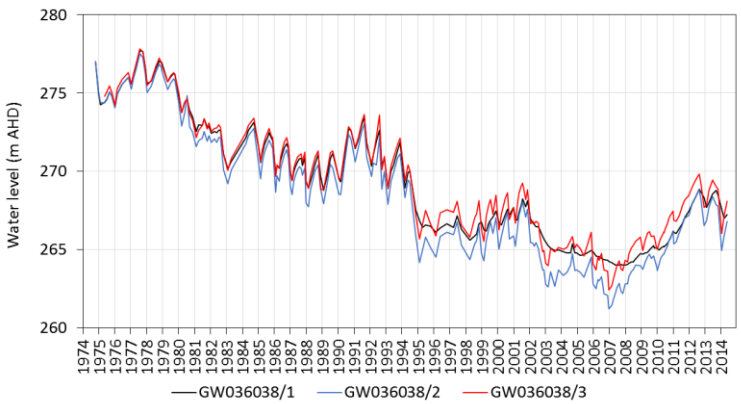


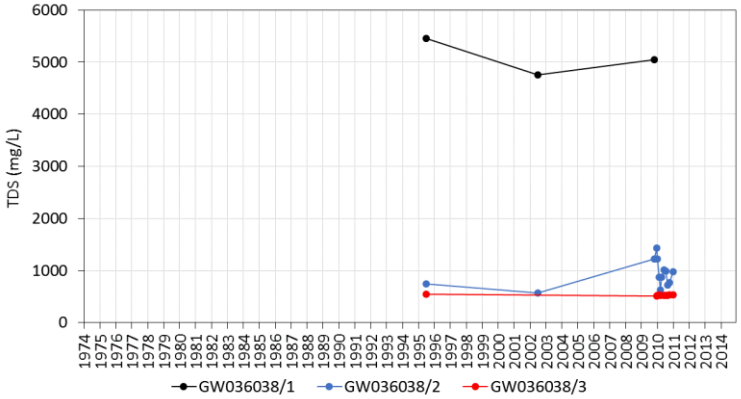




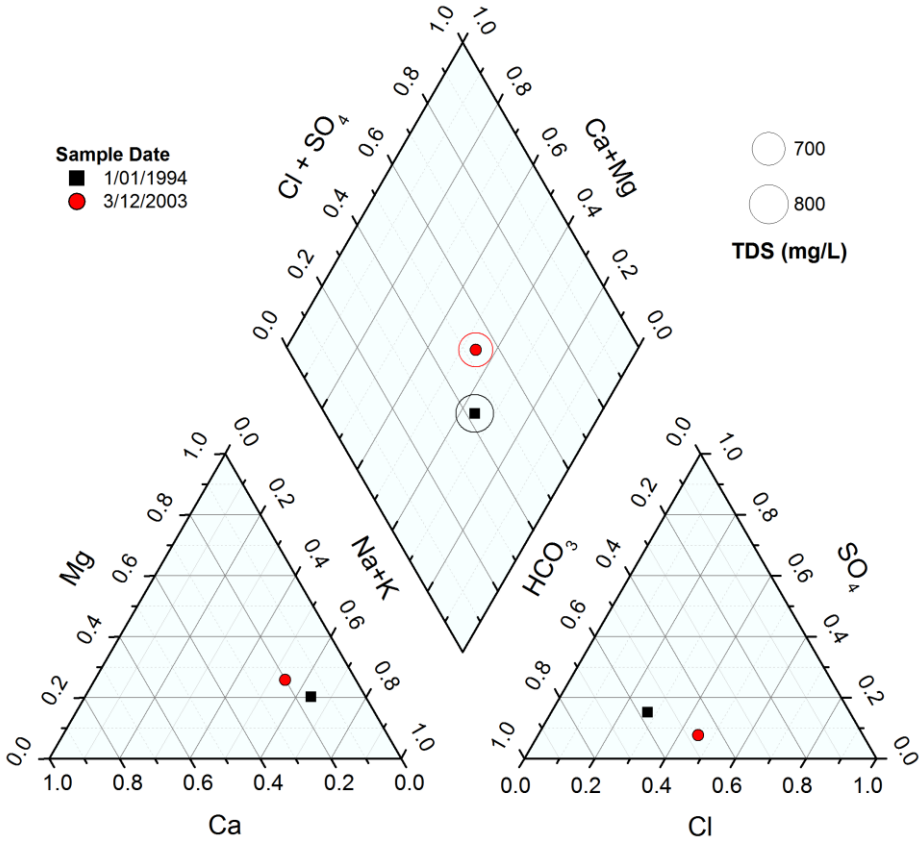
HCA chemistry Examples: GW036038/2 Dissimilarity (Eucl. Dist.) = 0.47

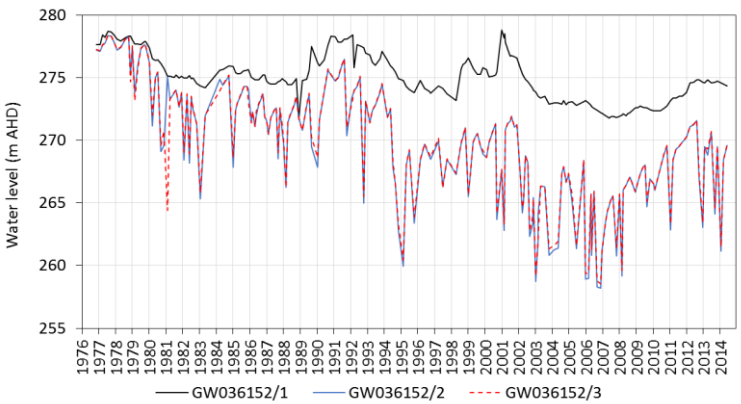


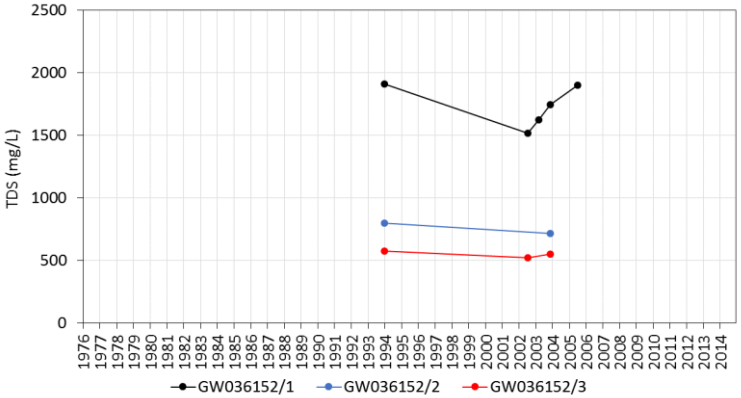




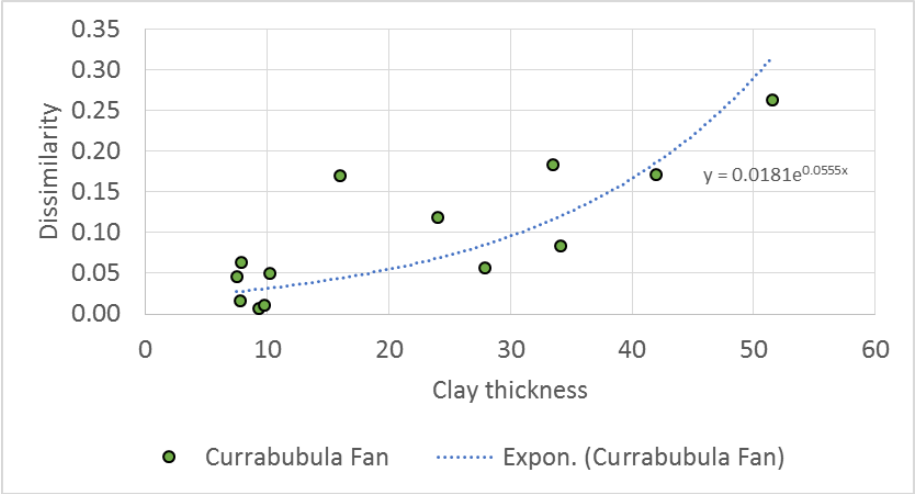
HCA chemistry Examples: GW036152/2; Dissimilarity (Eucl. Dist.) = 0.25

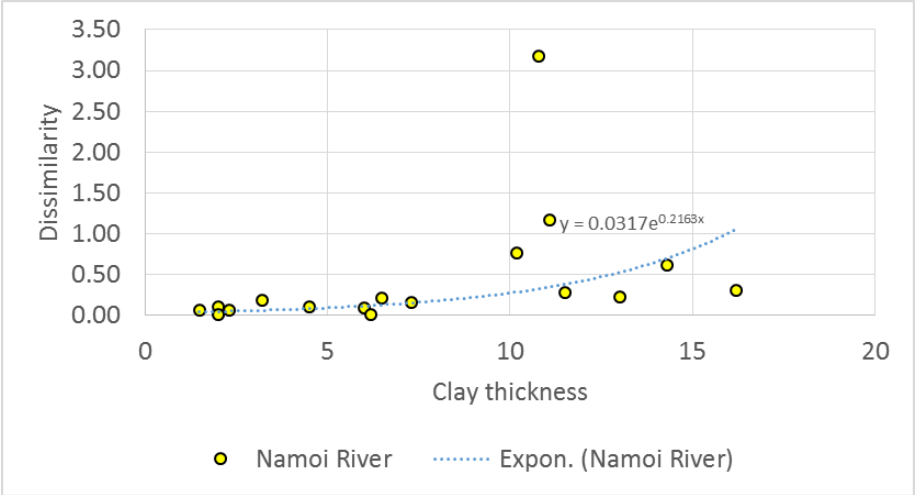






Unadjusted water hydrograph HCA





1. Level (m AHD) – mean
2. Linkage: Ward's
3. Dissimilarity: Manhattan
4. Exponential / linear.