Reconstruction of baseline groundwater levels and mapping of groundwater response patterns using cluster analysis and the Backwards Water Table Fluctuation method - An example from southwestern Australia.

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Quantification of long-term hydrologic change in groundwater often requires the comparison of pre- and post- hydrologic states. The assessment of these changes in ungauged or poorly gauged catchments is particularly difficult, as historical records pre-change are non-existent or obtained through indirect methods such as remote sensing. With the objective of estimating groundwater levels pre- hydrologic change and facilitate the quantification of impacts, a novel methodology based on groundwater level fluctuations has been developed to run backwards in time and provide reverse hindcasts of groundwater levels, within bounds of parameter uncertainty and model defects. The method is applicable on a monitoring borehole basis, but the use of multiple models from different boreholes and simultaneous calibration using highly-parameterised inversion methods provide not only more robust estimates, but also a framework for sensitivity and uncertainty analysis. The method was applied in a terminal catchment in southwestern Australia where groundwater levels are being impacted from a consistent decline in rainfall rates in the last 50 years. The reconstructed water level time-series obtained allowed for i) Estimation of groundwater levels prior to rainfall decline and initial conditions for forward focussed groundwater models, ii) Estimation of net recharge rates prior and during the rainfall decline and iii) mapping of similar groundwater level behaviour in boreholes based on correlation and cluster analysis of simulated hydrographs. The method has been demonstrated to be suitable for areas with shallow groundwater levels and fast response to rainfall events and can assist in understanding trajectories of hydrologic change in areas with limited monitoring.