Quantifying the impact of leaky wells using AEM in the Condamine Catchment

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The Condamine Catchment is within the Surat Basin, and has seen much exploration for gas resources, particularly since 2000. Abandoned exploration wells leak gas and may discharge poor quality water from the Walloon Coal Measures (WCM) into the overlying fresh groundwater within the Condamine River Alluvial (CRA). Thus there are concerns about the impact of improperly decommissioned exploration wells. To quantify the potential impact of a leaky abandoned well on groundwater resources, consideration of both point and broad scale processes is required. Traditional attempts to simulate groundwater processes generally utilise Finite Difference (FD) or Finite Element (FE) modelling. The development of the Analytical Element Method (AEM) provides an alternative modelling paradigm. The general difference between FD/FE and AEM models, are:

1. FD/FE models require explicit discretisation of the domain, whereas AEM models do not;
2. In AEM models an aquifer has infinite extent, while FD/FE models require defined boundaries;
3. In FD/FE models a point (well) or line (stream) feature influence is averaged over the node/cell, whereas in AEM models they are not averaged;
4. FD/FE models are more suitable for modelling heterogeneous settings than AEM models;
5. AEM models are more suitable for modelling the near well zone than FE/FD models.

A steady state AEM model was calibrated against known groundwater level and river-based flow using PEST. A hypothetical leaky well was incorporated into the model to provide a direct link between the WCM and CRA. Calibration constrained Latin Hyper-cube sampling was undertaken to assess predictive uncertainty. Results found a fully open 96 millimetre diameter hole (HQ core) allowed on average 120 m3/day of flux to the CRA from the WCM. A log relationship between hole diameter and transfer flux is apparent, where a 50 and 250 millimetre diameter hole equates to 112 and 131 m3/day of flux, respectively.