The Pareto principle – Something for hydrogeophysical practitioners to remember when employing geophysical data in groundwater resource assessment?

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SUMMARY

The Pareto principle, named after the Italian engineer, economist, and sociologist Vilfredo Pareto, (also known as the 80:20 rule) states that, for many events, roughly 80% of the effects come from 20% of the causes. A variation of that principle might be to suggest that to achieve 80% of what is needed, only 20% of effort is required, whereas to deliver the final 20% requires 80% of the effort. I'd like to argue that in the application of geophysical methods to hydrogeology, particularly where airborne electromagnetic techniques are employed, it is perhaps worth remembering that principle when considering their application for groundwater resource assessments in data poor areas. Practitioners of hydrogeophysical investigations, myself included, are sometimes guilty of making the case for analysing and interpreting geophysical data without being necessarily cognisant as to how, at what cost, and to what extent groundwater resource assessments can be improved through their incorporation.

Most applications of AEM for groundwater resource assessment in remote parts of Australia only require limited effort on the processing and analysis of the data once acquired. Examples abound on the use of AEM in defining palaeovalleys across the Australian outback to aid the location of groundwater resources for mining purposes. More often than not, their relatively simple transformation using CDI's, rather than their full inversion, is adequate for determining where to drill, and to then progress conventional hydrogeological investigations that might result in a bore field. Often the products supplied by the contractors are adequate for such needs. Our collective challenge is to understand at what point there is value in going beyond this step.

Of course there are also examples which demonstrate the relevance of a more considered approach to geophysical data analysis and interpretation, including studies linked to managed aquifer recharge, to drill targeting which requires water of a certain quality in a particular aquifer, or where the accurate definition of an aquifer bound or salt water interface may be required in the absence of drill hole data. We are well placed to deliver into these areas benefiting from the emergence of practical and robust data inversion techniques. However in many of these studies even the extra effort employed is sometimes not without fault. For example, while the geophysics community regularly deal with measurement and model uncertainty, arising from issues such as equivalence, we seem to gloss over these matters and rarely transfer of them into hydrogeological domain. Similarly, we sometimes appear to ignore the limits of groundwater models. We may expend considerable effort in using geophysical data to help conceptualise an aquifer and its variability, and then argue till we are blue in the face that the detail in the geophysics needs to be incorporated into a "groundwater model", conveniently forgetting that most models have low absolute accuracy, but good resolution and some predictive capability with the latter being determined by (limited) data other than that from geophysics. The limited data tends to lead to a generalized representation of the aquifer system which is then calibrated to measured data, usually water levels, to enhance model utility.

In summary, while acknowledging that geophysics can offer much to improve groundwater resource assessment, it's appropriate to question the worth of data during the survey design stage, and to consider whether, if and when, the Pareto principle might be enacted.

Key words: Pareto principle, aquifers, airborne EM, AEM systems, inversion, transformation