Groundwater Modelling Matters

Groundwater Series: Skills & Knowledge | Fact Sheet 6 | Produced by Cotton Catchment Communities CRC and UNSW Water Research Laboratory

Why a model?

Models are generally used to answer a range of questions. The questions can range from being as simple as "what is the volume of groundwater flow, and what direction is it moving?" to "will the level of water in the river decrease significantly if we increase the yield from our groundwater bores, and will this affect the amount of salt in our soil?" It would seem that groundwater modelling is the answer to all our questions, but is it?

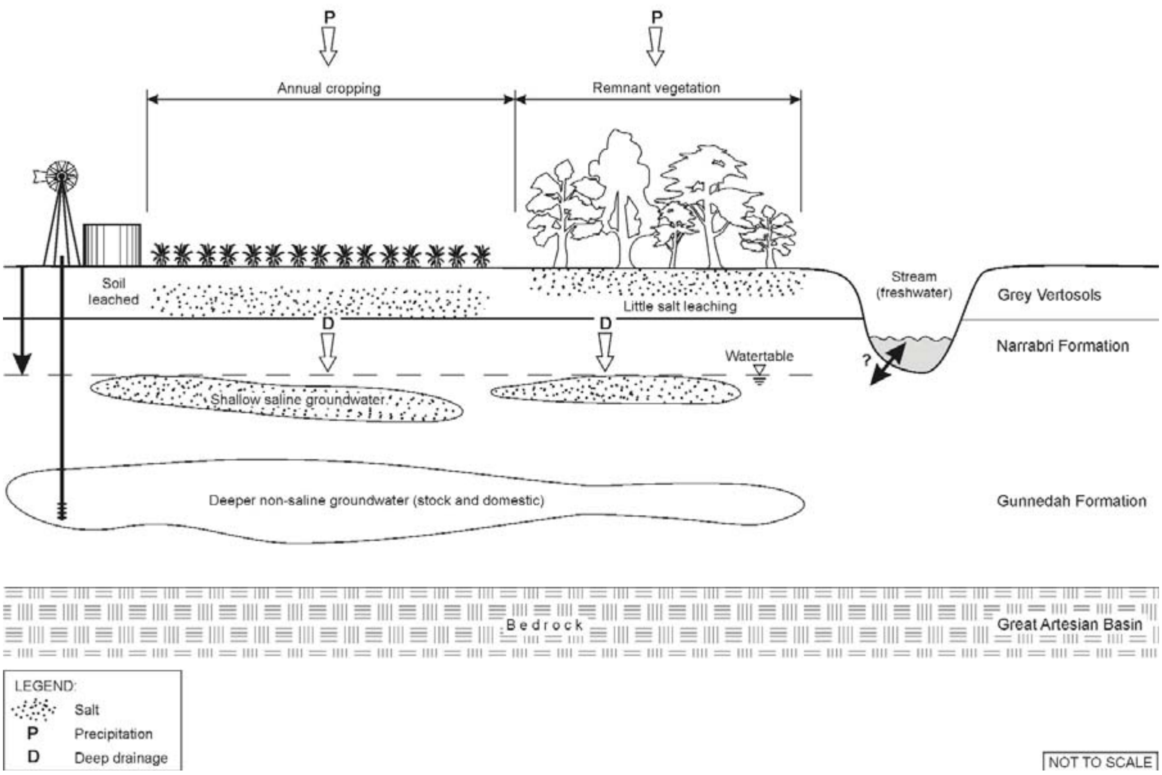
So what is a model?

Models range in size, cost and complexity. The simplest of models is a conceptual model. A conceptual model gives a broad view of the underlying groundwater system without giving any quantitative results. It is in most basic terms a map of the groundwater system.

The next level of model is a basic model. A basic model involves some calculations, so the answers are quantitative, but there is still no necessity for large computational resources, it can be thought of as equivalent to calculations in an Excel Spreadsheet. Models of this complexity typically cost in the order of $20,000.

The third level of model is an impact assessment model. There is a moderate level of complexity for this model with a substantial amount of data required, and model taking months to fully develop. An impact assessment model is capable of predicting the impacts on the groundwater system of certain management policies. With the increase in data and time required to make this model, the cost increases to the range of $100,000.

The final and highest complexity model is an aquifer simulator. For such a model large computing resources are required, with a three-dimensional grid being designed in an attempt to represent current groundwater conditions and make specific calculations and prediction



A conceptual model of the Cryon Plain, North East NSW. (Courtesy Rick Young, Timms et al. 2007

about groundwater movement due to changed weather conditions or farming practices. Aquifer simulators start at $100,000, with the price increasing depending on the complexity of the question being answered.

It is important to realise that there is no clear distinction between the models, with even the most complex model needing the correct conceptual model in order to succeed in being a useful predictive tool.

How is a model made?

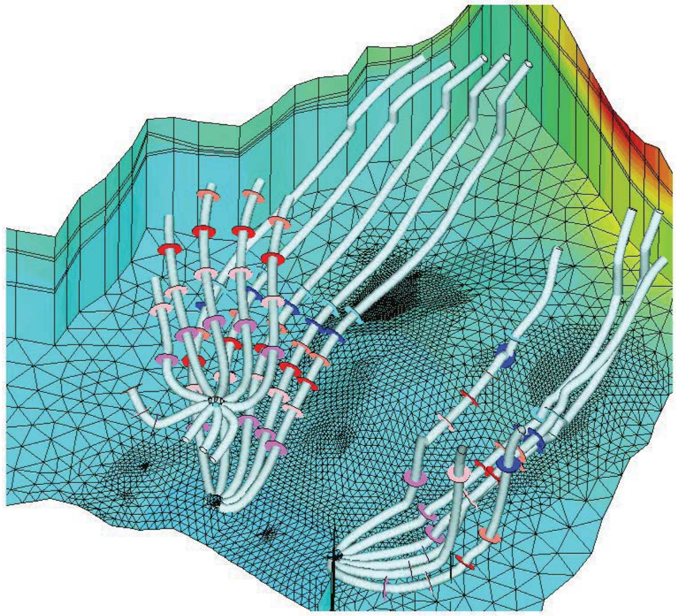
The first step is to try to conceptualise the model. That is, try to get an overall idea of how the groundwater system works and what questions are trying to be answered.

That being achieved, the second step is to collect the data which will form the basis of the model. Data is single biggest constraint on what model can be chosen, with the more complex the model, the more data being required. The Earth's geology is very variable and when modelling groundwater areas spanning hundreds and even thousands of kilometres in length tend to be modelled. With groundwater model data being sourced from boreholes, it is easy to see that when making a model it's like trying to build a haystack from a few pieces of straw. Commonly up to 50% of time spent is spent gathering data for the model.

The third step in building a model is to convert the data and conceptual model into one which the computer can simulate. The majority of the time henceforth is spent adjusting the parameters in the model so that when the model does simulate real life conditions (like pumping from a borehole or a flood), the groundwater behaviour is accurately predicted.

With all this done, and sometimes 80% of the budget spent, the fourth step is to actually answer the questions that were asked in the first place.

There is however one final fifth step, that is often forgotten after those questions have been answered. That step is to validate the model. All models, regardless of their complexity should be checked to see if the results they predicted were valid. This step is often performed several years after the model was initially created.



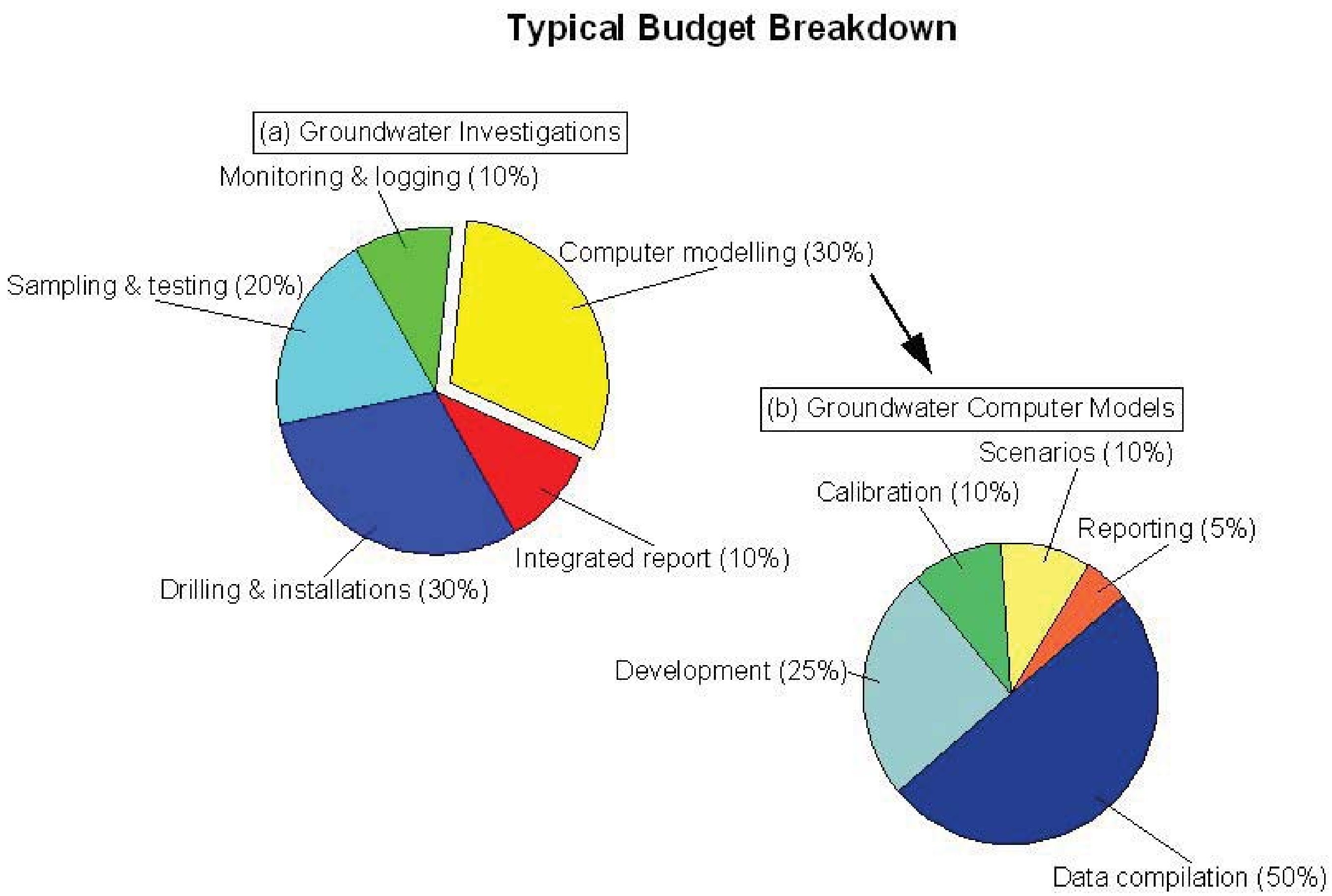
Pathlines showing particle movement from an aquifer simulator (after FEFLOW v5.2, 2006)

How to pick the right model

When buying a new car you need to decide what fits. You probably wouldn't buy a large four wheel drive if all you needed was a small car to go work and back everyday. Likewise when buying a car you might also consider the inputs and outputs, the fact being that although a four wheel drive might give you more power, it also needs more fuel to run. This is exactly what choosing a groundwater model is like. It needs to be considered what exactly are the questions that need answering? If it's a simple question, is a conceptual model enough? Because, the more complex the model becomes the more data that is needed to be gathered, and the more expertise that is required from the modelling team. Both these facts mean that the cost of the model can increase substantially with increased complexity. There is often a trade-off between the resources available and the objectives that can be met by using a groundwater model.

Summary

Groundwater models are a very important and useful tool for the correct management of one of our most precious resources, and when applied appropriately serve to enhance our sustainable management of groundwater. The reality is however is that all models have assumptions built in and although useful are incorrect. The



key challenge for the person asking the questions is to make sure their model is useful as possible. Some general rules of thumb are:

Set clear objectives for the modelling exercise.

Go with the simplest model that can achieve your objectives.

Go with a model that fits your time, budget and most importantly, available data.

If unsure about what model is suitable talk to a groundwater modeller.

References

Murray-Darling Basin Commission (2003), Groundwater Models – A community guide to better understanding.

Cooperative Research Centre for Catchment Hydrology, General approaches to modelling and practical issues of model choice.

Murray-Darling Basin Commission (2000), Groundwater Flow Modelling Guideline.

WRL Solution Capability – Groundwater flow and reactive transport modelling. Download at www.wrl.unsw.edu.au/consulting/capsheets/groundwater/WRL-Solutions-02500.pdf

Timms W, Cunningham IL and M Schwarz, 2007. Hydrogeological Investigation of the Fate of Salt Mobilised Under Dryland Cropping on the Cryon Plain, North Western NSW. WRL Technical Report 2007/38. On behalf of NSW Department of Primary Industries, NAP Project.

Source and references www.connectedwaters.unsw.edu.au

Cotton Catchment Communities CRC

University of New South Wales
School of Civil & Environmental Engineering
Water Research Laboratory

Australian Government
Department of Agriculture, Fisheries and Forestry
National Landcare Programme