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COMMENT ON "MODELLING THE CHRISTCHURCH AQUIFERS" BY L.K. BOON AND B. HUNT

R. J. Burden

P.O. Box 12, Greenhithe, Auckland

My pleasure at seeing the title of another paper by Dr Hunt on modelling the Canterbury Plains groundwater system (Boon and Hunt, 1985) was rather diminished after I read the paper. My concern focuses on some technical details presented by Boon and Hunt and more generally on the application of mathematical models when field data is very limited.

Boon and Hunt state in their introduction that ". . . . the amount and quality of data needed for a major modelling effort is far from complete". This statement would appear to be a large understatement when the data referred to consist of one pump test and some tentative estimates of aquifer and aquitard thicknesses. And yet the authors have applied this limited data to an extremely complex 5-layer aquifer system and constructed a finite difference model with 325 independent nodes. The philosophy adopted by Boon and Hunt seems to be that any mathematical model is better than no mathematical model. I believe that output from a model that may have uncertainties of $\pm$ 10%, $\pm$ 100% or even $\pm$ 1000% (no uncertainty estimates are given in the paper) could be very misleading if applied as a management tool. The Boon and Hunt models require sensititivy analyses, calibration and some form of verification before any confidence can be placed in their predictions.

My second concern focuses on some of the technical details of the study. I am not aware of any evidence that would support the authors' claim that "The top boundary of the upper confined aquifer is believed to be relatively impermeable and modelled herein as an aquiclude". My first reaction on reading this was that the authors wished to exclude from their model the added complexity of the water table aquifer.

Boon and Hunt have chosen boundary conditions for the eastern boundary that approximate a salt water interface. Furthermore, they assume that water moves only in a horizontal direction through the aquifers. Presumably they are assuming that water from the aquifers flows into the ocean beyond the coastline although this is not explicitly stated. In a study of the Central Plains groundwater system, I presented hydrological evidence that indicated an inflow/outflow balance for the Central Plains groundwater system as a whole without the need to invoke any losses to the ocean (Burden 1984). The implication from the water balance is that, near the coastline, a major component of the water flow in the aquifers may be vertical and not horizontal as assumed by Boon and Hunt.

My own work in the Christchurch aquifers offers one approach to improving the currently limited data base. From temperature-depth profiles in a 150 m deep well, I calculated hydraulic conductivities of 7×10^{-7} and 1.2×10^{-8} for aquitards at depths of about 70 and 140 m below ground respectively

(Burden 1983). As Boon and Hunt have failed to include information on their estimates of the depth of the aquifers and aquitards it is not possible to make any comparison with their study.

REFERENCES

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REPLY

L. K. Boon and B. Hunt

The writers are pleased that Mr Burden appreciates some of the difficulties involved in constructing a model for an aquifer system that has a scarcity of data. However, if Burden rereads the second paragraph of the introduction, he will find that no claim for completeness has been made. In fact, the writers state therein that "the amount and quality of data needed for a major modelling effort is far from complete" and that one of the two purposes of the exercise was "to learn the amount and type of data that should be gathered in the future to improve the model". The writers would also like to point out that the finite difference model referred to by Burden is only one of two models constructed for the Christchurch aquifer system. In our opinion, the second model, which is referred to as the semi-analytical model, is probably more useful for predicting the effects of water abstraction from individual wells. Both models can be improved or modified in the future as more accurate and complete data becomes available.

The decision to model the top aquifer boundary as impermeable and to ignore the presence of the overlying unconfined aquifer was made on the advice of the Catchment Board geologist, Mr J. H. Weeber. Including the top unconfined aquifer in either model would involve nothing more than putting one more layer in these models and substituting a number or function for Q_i/A on the right side of (1) to account for rainfall recharge. However, the layer of less permeable material between aquifer 1 and the unconfined aquifer was believed to be impermeable enough and thick enough to behave as an aquiclude throughout most of the Christchurch region.

There is no disagreement between the way in which flow was modelled along the coast with the finite-difference model and the suggestion by Burden that seepage is mainly in the vertical direction along the coast. By setting the horizontal velocity equal to zero in aquifers 2-4 along the coast, all water in the model was forced to leak vertically upward through the bottom aquitards and to exit to the sea through the top aquifer. As pointed out in the paper, it would have been difficult to assume any other set of boundary conditions along the coast for this particular problem.

Estimates of aquifer and aquitard elevations and thicknesses were obtained from geologic data furnished by the North Canterbury Catchment Board. Space limitations made it impossible to include these in the paper since this would

have required either a series of contour maps or a collection of vertical elevation views. Thus, a comparison of aquitard permeabilities would require not only elevations but also horizontal locations and units for the permeability values estimated by Burden. The writers are unable to comment further upon this point since they have not seen the paper by Burden (1983).