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A Groundwater Flow Model of the Maules Creek Catchment

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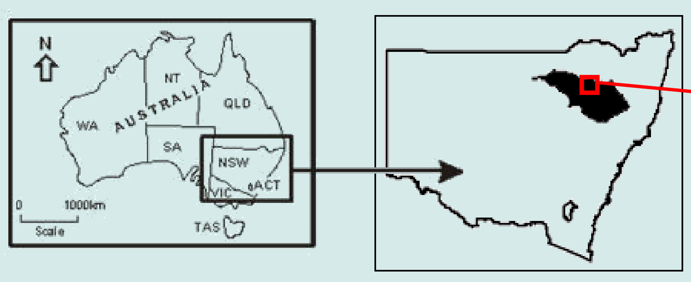
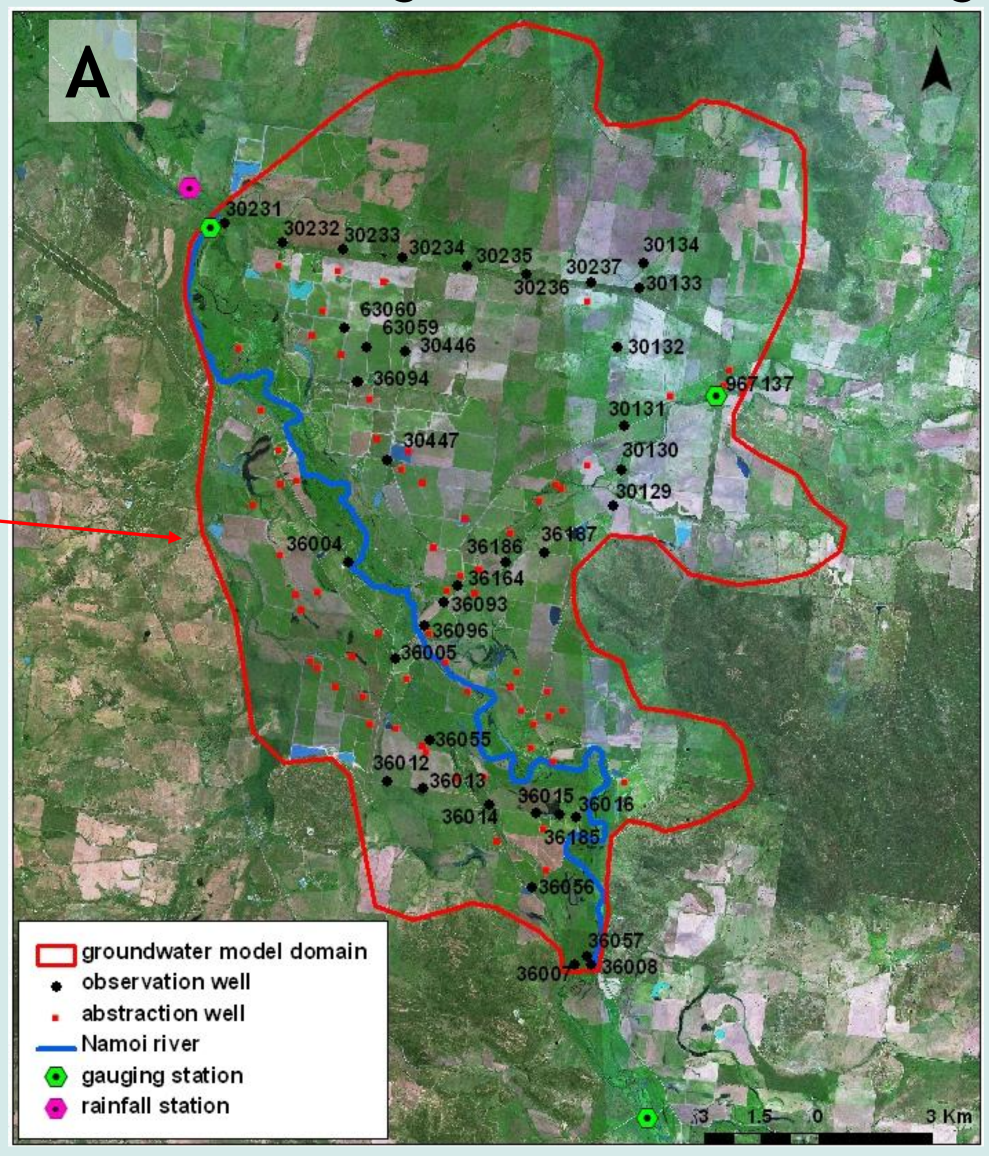
OBJECTIVE

To provide a better understanding of the dynamics of the alluvial aquifer in the Maules Creek Catchment by an integrated modelling of the catchment water resources.

INTRODUCTION

A conceptual model was developed for the Maules Creek alluvial aquifer situated in the Namoi Valley (NSW, Australia). The Namoi River flows through the catchment and is gauged at two locations: Boggabri (in the South) and Turrawan (in the North). Since the mid 1980s, flood irrigation farming along the Namoi River has relied on groundwater abstraction (68 irrigation wells) to grow cotton, sorghum and wheat. Throughout the catchment there are 37 groundwater monitoring boreholes (64 observation points) installed by the NSW state government with the standing water level being recorded 3 to 4 times each year (Fig. A).

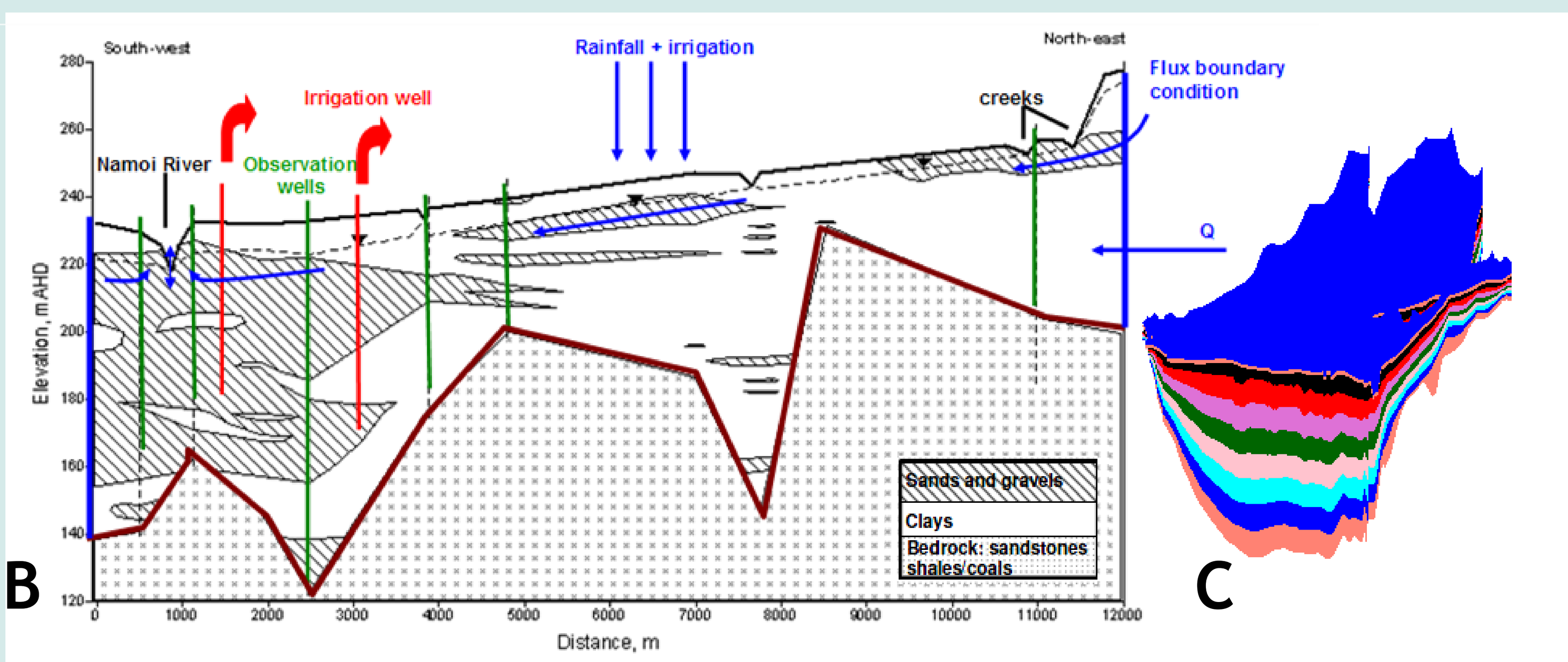




A: Study area with the location of observation wells, abstraction wells, gauging and rainfall stations in the groundwater model domain.

MODEL DEVELOPMENT

The model was developed using the FEFLOW 5.4 finite element flow and transport code. The hydrogeology is represented by 9 layers bounded by impermeable bedrock (Figs. B and C). Hydrologic stresses include diffuse recharge (computed using daily soil moisture balances based on rainfall and evapotranspiration records, soil type and land use), irrigation return (deep drainage), stream-aquifer interaction, lateral groundwater inflow/outflow and groundwater pumping. The hydraulic head distribution for 1978, obtained from a steady state model, was used as the initial condition for the transient model which was run from January 1978 to April 2007. The hydraulic conductivity distribution in the model was assigned on the basis of a 3D geologic model built in EarthVision and Mathematica using bore logs from the DWE database. Parameter values used for the model are listed in Table 1.

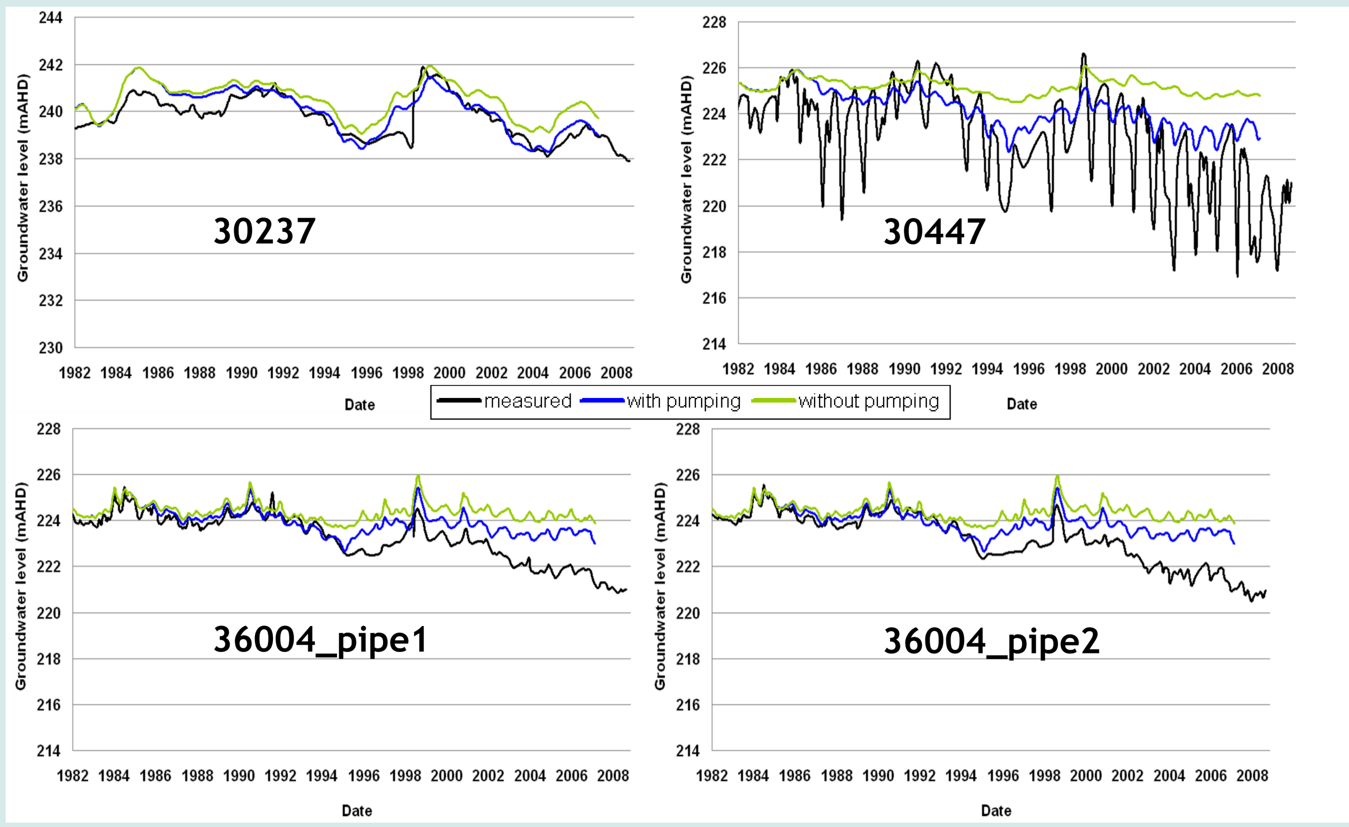


B: conceptual model. C: 3D-layer configuration of the groundwater model.

	Value	Application
Kxx = Kyy	Sand = 10^{-3} m/s, Clay = 8* 10^{-5} m/s; Sand = 10^{-3} m/s, Clay = 10^{-6} m/s;	Layer 1 Layer 2-9
Anisotropy	0.1	Layer 1-9
Transfer rate	In = 0.5 d^{-1} Out = 1 d^{-1}	First 2 layers (related to Cauchy boundary conditions)
Specific yield	Sand = 0.1 Clay = 0.01	Layer 1-9
Specific storage	10^{-5} 1/m	Layer 1-9

Table 1: Parameter values used for the groundwater model.

MODEL CALIBRATION

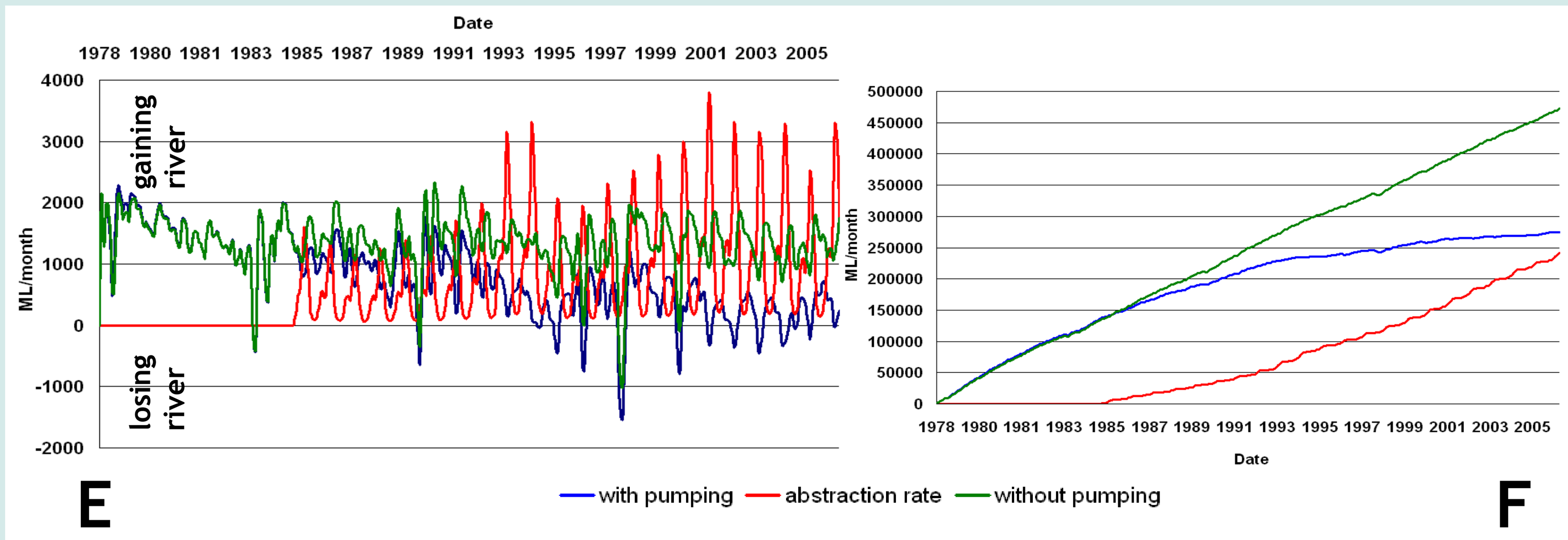


Model calibration was based on matching simulated bore hydrographs with observed hydrographs. The calibration period is from 1982 to 2007 (Fig. D).

D: Examples simulated and observed hydrographs used for calibration.

SCENARIOS

For assessing the effect of groundwater abstraction on the stream-aquifer interaction, two scenarios were compared: with and without groundwater abstraction. The total river flux versus time was computed for each scenario (Figs. E and F).



E: Groundwater flux to the river vs time. F: Cumulative abstraction rate and groundwater flux to the river vs time for the two scenarios modelled.

DISCUSSION AND CONCLUSION

The procedure in this study aims at describing the physical processes of this complex aquifer system using:

- a daily soil moisture water balance calculation based on FAO version of the Penman-Monteith equation;
- spatially variable hydraulic conductivity distribution based on bore-log data as a result of three-dimensional geological modelling, giving a better representation of the aquifer geology than previous simple layered models;
- transient coupling of the aquifer to water levels in the Namoi River.

The groundwater model has provided a better understanding of the alluvial aquifer system and its dynamics. In the no groundwater abstraction scenario, the river is gaining water from the aquifer overall with variations through time due to climatic effects. In the groundwater pumping scenario, the river changes from being gaining to losing during the irrigation season (Fig. E). Less groundwater is discharging into the Namoi River during the pumping scenario overall (the cumulative flux from the aquifer to the river is diminished by 20% over the whole period post 1985) as seen in the cumulative flow curves (Fig. F). Generally, the model performance is good with the model correctly capturing the recovered water levels after the irrigation season, as well as the long-term trends shown in the measured hydrographs. However, in areas where the groundwater abstraction-induced drawdown is large (up to 8-10 m) the seasonal dynamic is not captured well by the model.

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MORE INFORMATION

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