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Hydrological investigations of surface water groundwater interactions in a sub-catchment in the Namoi Valley, NSW, Australia

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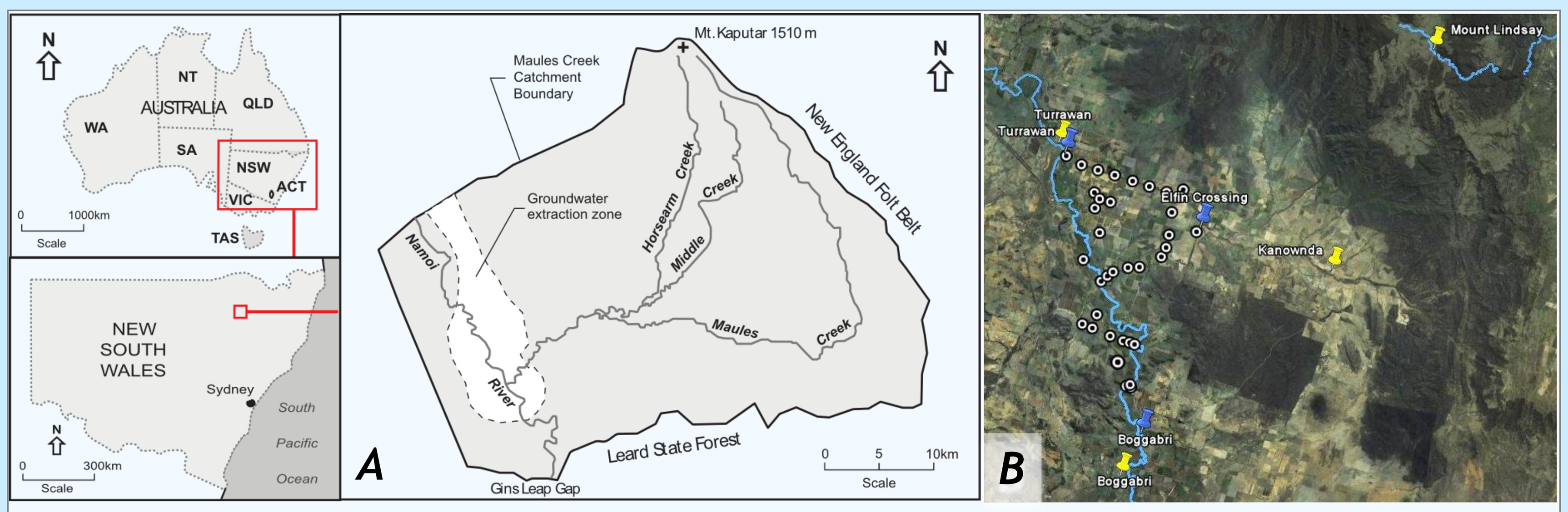
Introduction

This poster demonstrates how the joint analysis of rainfall, borehole hydrographs and stream-flow data can help elucidate the river-aquifer interactions occurring within a catchment.

Background

The Maules Creek Catchment (approx. 1100 km^2) is located in the semi-arid region of North-Western New South Wales, Australia (Fig. **A**). The alluvial plains of the catchment (200-250m AHD) are bounded by the Nandewar Mountain range in the East (1000m AHD).

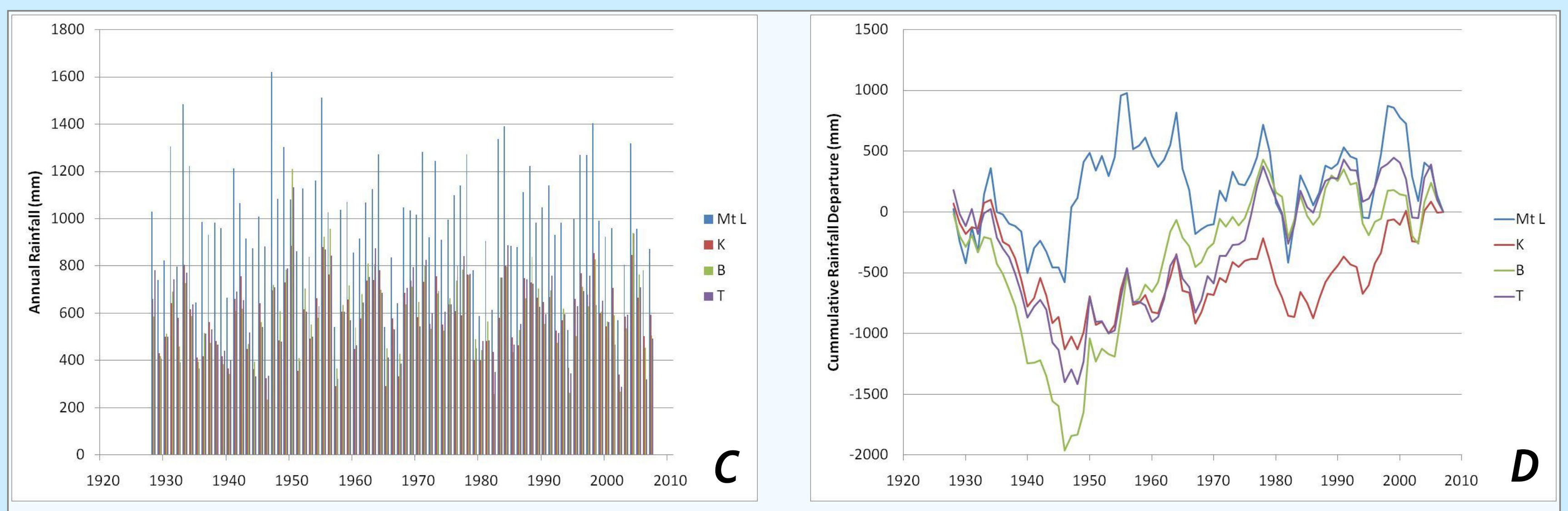


A: Location of catchment. B: Rainfall (yellow pegs), Borehole hydrograph (black/white dots) and Stream flow (blue pegs) data sources.

The Namoi River flows though the catchment and is gauged at either end, at Boggabri in the South and Turrawan in the North. The main tributary is Maules Creek, gauged at Elfin Crossing. Within the catchment, below and to the east of the Namoi River, is a large (up to 4km wide and 100m deep) palaeochannel filled with interbedded clays, sands and gravels. Groundwater from permeable units is abstracted for flood irrigation of cotton, sorghum and wheat.

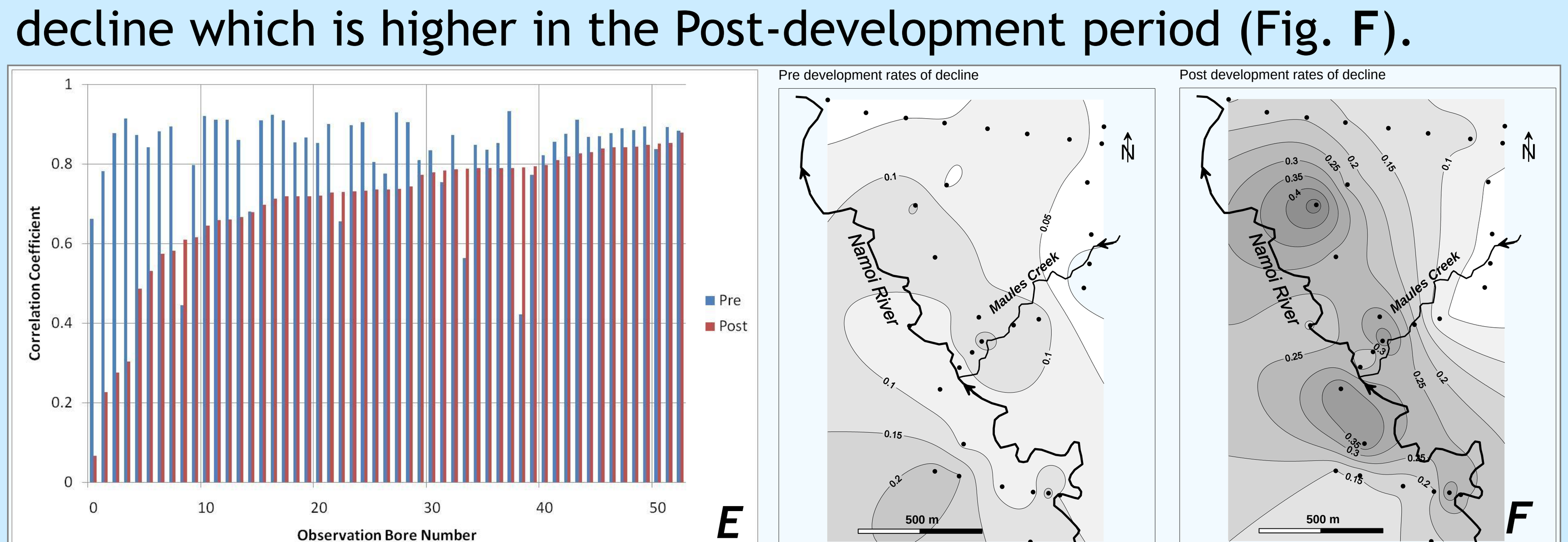
Catchment Data

Three types of data were analysed: rainfall, borehole hydrographs and stream-flow (Fig. **B**). The terms: "Pre-development" and "Post-development" refer to before and after the on-set of major groundwater abstraction which occurred around 1985. The Cumulative Rainfall Departure curves (CRDs) show the rainfall deviations from the long-term average such as the dry period leading up to the 40ties (Figs. **C** and **D**). It can also be seen that rainfall in the mountains (Mt L) is higher than on the plain (K, B and T) with 1000 mm/a versus 600 mm/a.



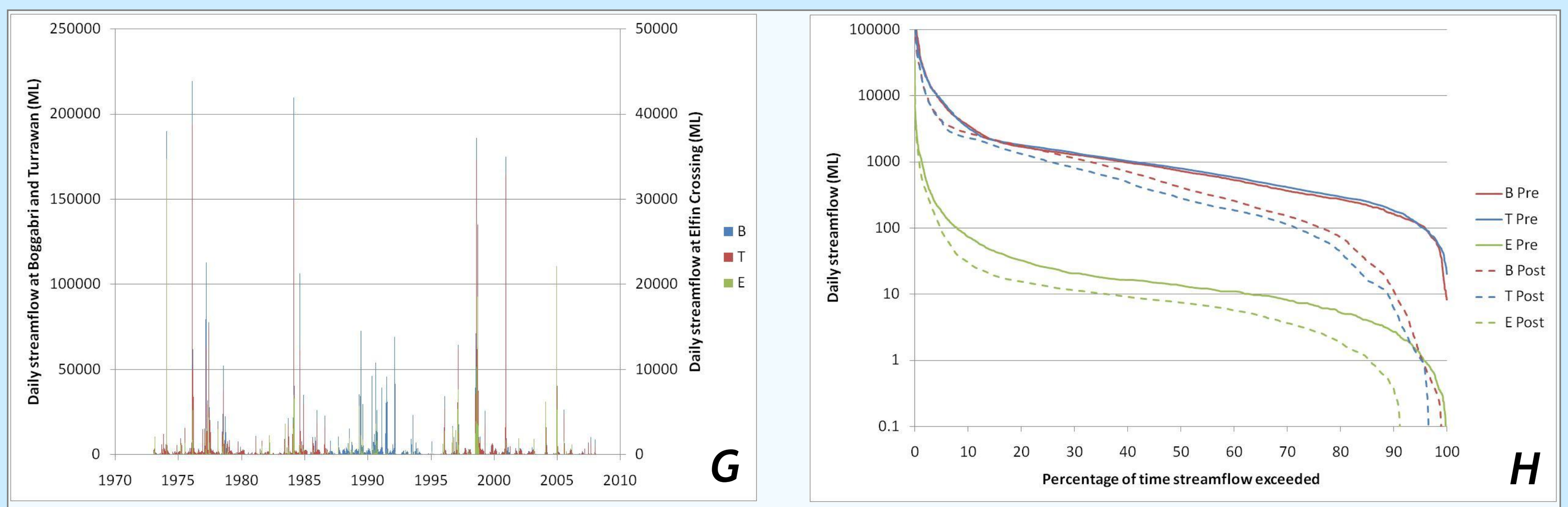
C: Raw rainfall data for four stations. D: Rainfall data presented as Cumulative Rainfall Departure curves.

The shape of the CRDs are similar to the shape of the borehole hydrographs (since they are linked via recharge). Pre-development there was a high degree of correlation (Fig. **E**) but this decreases in the Post-development period, presumably due to groundwater abstraction. This is reflected in the rate of groundwater head decline which is higher in the Post-development period (Fig. **F**).



E: Correlation of CRD versus groundwater heads for Pre- and Post-development. F: Rate of groundwater heads decline in the two periods.

Stream flow records also show a change between the Pre-development and Post-development periods (Figs. **G** and **H**). In the first period there is more water leaving the catchment at Turrawan than entering at Boggabri, indicating a gaining river system. In the second period the river system appears to become losing.



H: Raw Streamflow data for three gauging stations. I: Streamflow data presented as Flow Duration curves.

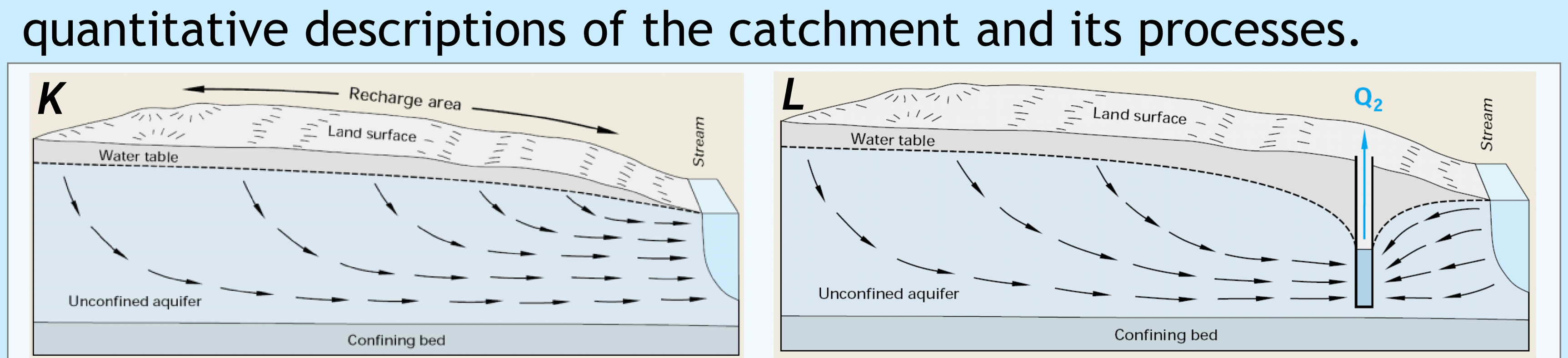
Farm Data

The mechanism driving the change in river-aquifer behaviour was further studied by looking at farm scale data (Figs. **I** and **J**). These hydrographs shows that under non-flooding and non-pumping scenarios the river was gaining water from the aquifer (however, with a very small gradient). During periods of pumping the head gradients reversed causing losing conditions to develop. This was also the case for periods of flooding .

I: Image of field site showing location of river stage monitoring and boreholes. J: Hydrographs covering three periods: (1) non-pumping and non-flooding, (2) pumping, (3) flooding.

Conclusion

From this analysis it can be seen that: (i) groundwater heads are correlated to rainfall, (ii) the degree of correlation has decreased over time, (iii) the rate of groundwater head decline has increased over time, and (iv) the Namoi River has changed from being a gaining river to a losing river over time. A possible mechanism to explain this change in river-aquifer dynamic is illustrated by the site data: during non-pumping/non-flooding periods the Namoi River is gaining, while during pumping or flooding it is losing. These hydrological processes are conceptually illustrated in Figs. **K** and **L** below. There is a need to further this understanding by moving from qualitative to quantitative descriptions of the catchment and its processes.



K: Natural Conditions: flow of water from mountains to river via aquifer. L: Conditions induced by groundwater abstraction: change in hydraulic gradients such that river changes from being gaining to losing.

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More Information

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