Investigation of $\delta^{18}O$ and $\delta^{2}H$ in the Namoi River catchment - surface water/groundwater interactions

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OBJECTIVE

To use naturally occurring stable water isotopes ($\delta^{18}O$ and $\delta^{2}H$) to understand river aquifer exchange.

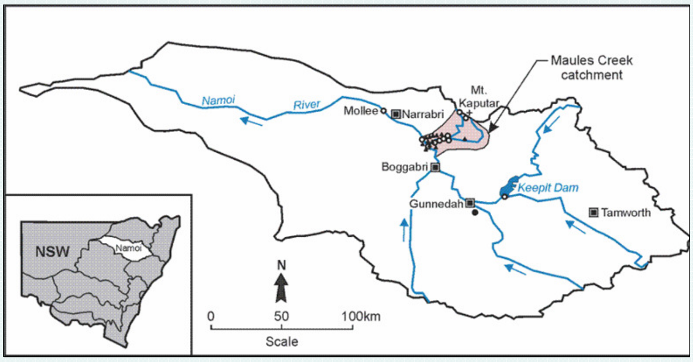

Fig. 1: The location of Maules Creek Catchment and sampling sites for rainfall (●), surface water (○) and groundwater (▲) in the Namoi catchment, NSW. Arrows show surface water flow directions.

METHOD

Rainfall, surface water and groundwater samples were collected in the Namoi Valley (Fig. **1**) for $\delta^{18}O$ and $\delta^{2}H$ analysis at various times between 1998 and 2007. At one site along the Namoi River two multilevel observation wells were installed near a groundwater abstraction bore to study the effects of abstraction near the river. All water samples were sent to CSIRO Land and Water in Adelaide, SA for analysis by Isotope Ratio Mass Spectrometry (IRMS). Reported precision of the isotope ratios was 0.15‰ VSMOW for $\delta^{18}O$ and 1.0‰ VSMOW for $\delta^{2}H$.

RESULTS

The rainfall samples defines the Local Meteoric Water Line (LMWL - Fig. **2**) which is only marginally above the World Meteoric Water Line (WMWL). Most of the groundwater samples are grouped in a dense cluster along this line indicating a rainwater source. The relative depleted nature of the groundwater samples indicate the regional recharge is mainly from heavy depleted rainfall events. In contrast, surface waters, particularly from the Namoi River, plot along the Local Evaporation Line (LEL - Fig. **2**) due to substantial evaporative fractionation.

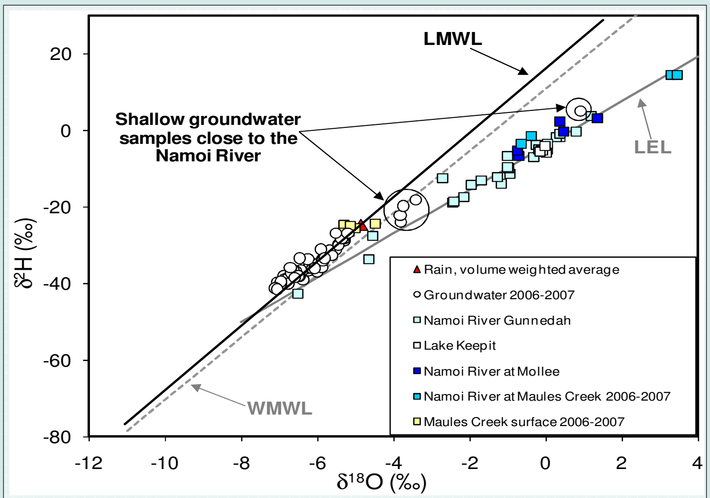

Fig. 2: $\delta^{2}H$ and $\delta^{18}O$ (‰ VSMOW) in surface water and groundwater. WMWL (World Meteoric Water Line): $\delta^{2}H = 8.13 \cdot \delta^{18}O + 10.8$; LMWL (Local Meteoric Water Line): $\delta^{2}H = 8.17 \cdot \delta^{18}O - 11.3$; and LEL (Local Evaporation Line): $\delta^{2}H = 5.7 \cdot \delta^{18}O - 3.91$.

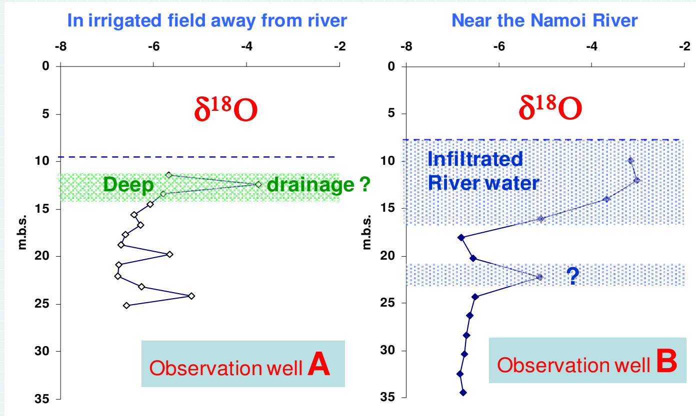

Fig. 3: Depth profiles of $\delta^{18}O$ in multi-level wells in an irrigated field (left) and between the field and the Namoi River (right). Enriched $\delta^{18}O$ values in the right-hand side well indicate infiltrated river water.

The difference in stable isotope composition between the regional groundwater and the river water, can be used for tracing the exchange of water between river and aquifer. This is hinted in Fig. **2** where shallow groundwater samples from near the river plot in between the regional groundwater cluster and the LEL. This river recharge was investigated in detail at the site along the Namoi (Fig. **3**). Enriched river water is visible in the upper 6-7 m of the multilevel well close to the river. A different pattern is seen at the multilevel well further from the river. Fig. **4** shows the conceptual hydrological model as gained from the stable isotope investigation.

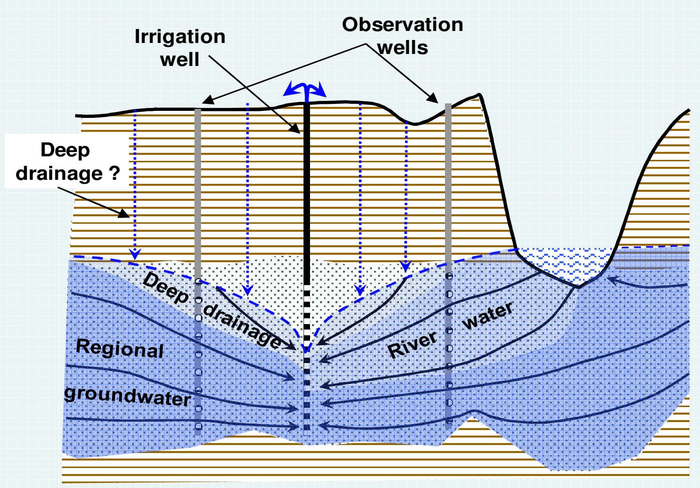

Fig. 2: Conceptual model of sources of water and groundwater flow induced by pumping near a river.

CONCLUSION

This field study demonstrates that $\delta^{18}O$ and $\delta^{2}H$ measurements of surface water and groundwater samples are valuable for understanding hydrological processes such as recharge and river aquifer interactions within semi-arid catchments.

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MORE INFORMATION

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