# LEAKAGE DUE TO GROUNDWATER PUMPING AT PULLAMING, UPPER NAMOI

**W.A Timms, R.I. Acworth**

*Water Research Laboratory*
*UNSW School of Civil & Environmental Engineering*

## INTRODUCTION

The degree of connection between poor quality water in shallow clayey silts, and underlying productive aquifers is of critical importance to land management. However, past groundwater investigations have only focused on the productive aquifers.

Research aimed to address the following questions:

- How deep does irrigation water drain ?
- Does groundwater quality vary seasonally ?
- Are clayey silts a source of salt ?
- Does groundwater pumping increase vertical recharge ?

An intensive groundwater investigation was undertaken at the Pullaming site during the 1999-2000 irrigation season. The physical and chemical properties of the subsurface clayey silts were thoroughly characterized. Groundwater samples were taken from specially designed piezometers before, during and after groundwater pumped from the deep aquifer was applied to crops by flood irrigation. Samples were also obtained from nearby irrigation bores and piezometers and the Mooki River.

## INVESTIGATION TECHNIQUES

- geophysics – EM31 & electrical imaging & EM39 downhole
- drilling, core recovery and piezometer installation
- automated monitoring of groundwater level, EC, barometric pressure and rainfall
- core analysis – EC1:5, porewater chemistry, moisture, hydraulic conductivity, bulk & clay mineralogy
- hydrochemical & isotopic analysis ($C^{14}$, $H^3$, $\delta^{18}O$, $\delta^2H$)
- PHREEQC geochemical modelling of mixing

## RESULTS

Key geophysical, stratigraphic, groundwater level and groundwater chemistry data are presented in Figures 1-3.

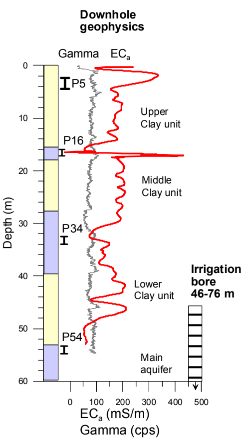


Figure 1 Site stratigraphy, piezometers and downhole. EM39 logs

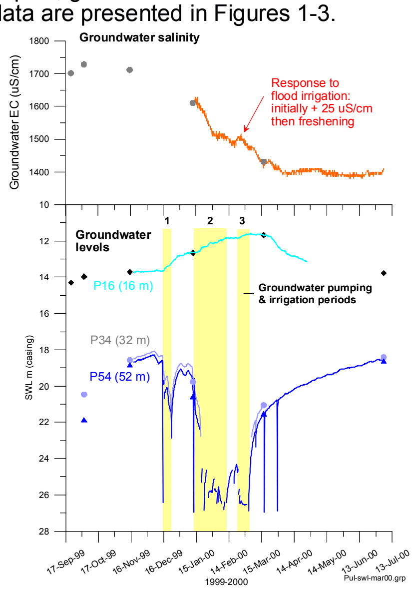


Figure 2 Groundwater levels and shallow groundwater salinity during 1999-2000 season.

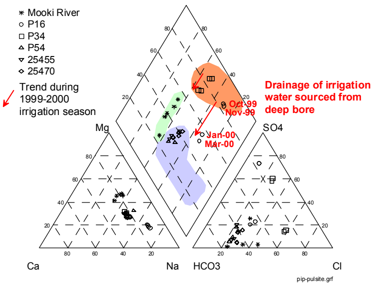


Figure 3 Hydrochemical indicators of downwards leakage of irrigation water sourced from deep bore, 1999-2000 irrigation season.

## IMPROVED CONCEPTUAL MODEL

A significant proportion of groundwater pumped from the deep aquifer and applied by flood irrigation, leaked rapidly through the clayey silt unsaturated zone to the shallow aquifer (Figure 4). Based on various hydrochemical & isotopic techniques, about 30% of the shallow aquifer was replaced by fresh irrigation water.

Hydrochemical changes were also observed in the middle aquifer (35 m depth) due to leakage. Limited leakage occurred through saturated clayey silt to the deep aquifer, confirming that productive aquifers contain mostly palaeowater.

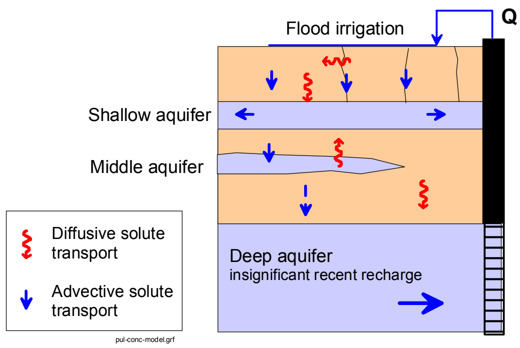


Figure 4. Improved conceptual model for groundwater flux at Pullaming.

## CONCLUSIONS

There was a clear relationship between pumping and increased downwards leakage. Salt stored within the clayey silts was partially mobilised during leakage, but was mostly bypassed by preferential flow. Long term trends in groundwater quality and shallow groundwater level remain unknown. Further work to quantify leakage and groundwater quality impacts due to pumping is important for achieving sustainable groundwater management.

## REFERENCES

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**CONTACT: Ph. 02 9949 4488, Fx. 02 9949 4188, Email: w.timms@wrl.unsw.edu.au**