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Hydrology and Earth System Sciences Discussions

Interactive comment on "Implications of deep drainage through saline clay for groundwater recharge and sustainable cropping in a semi-arid catchment, Australia" *by* W. A. Timms et al.

R. S. Crosbie (Referee)

russell.crosbie@csiro.au

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This paper describes a case study that investigated deep drainage and recharge in the Lower Namoi area in Australia. Through a field study backed up by numerical modeling, the authors concluded that the increase in deep drainage under continuous cropping is unlikely to cause a salinity problem in the area.

The paper is well written, the experiment is well planned and the analysis of the field data is (mostly) technically correct. I have very few technical comments on the paper but my major concern is the overstating of the importance of the results. The use of

phrases such as "unique study" (P10054, L4) and "for the first time" (P10057, L14) should be applicable at a global scale when published in an international journal rather than just applying to the Lower Namoi. I would suggest that that the authors need to expand their lit review from focusing on the Namoi to the rest of Australia and the world and then put their results into a wider context.

Detailed comments: P10054, L3 - (UNEP 1992) defines semi-arid as having P/PET of between 0.2 and 0.5. Only using rainfall can include some temperate regions (east coast of England?)

P10054, L4 – is this study unique because it is the first in the lower Namoi?

P10054, L14 – was the deeper groundwater from the confined aquifers?

P10054, L21 – add "conditions" after antecedent

P10054, L22 – why were piezometers installed in the unsaturated zone?

P10054, L22 – add "was" after recharge

P10054, L24 – space before "after"

P10054, L27 – the saline groundwater could not discharge in the area but could it discharge further downstream?

P10055, L1-9 – this paragraph needs references

P10056, L17-8 – the models are available (MIKE-SHE, MODHMS, TOPOG and Hydro-GeoSphere are examples) but they are not widely used for groundwater management in Australia. The PRAMS and SWAMS models in WA would be the exception.

P10057, L4 – there are older studies, e.g. (Jolly 1989)

P10057, L5 – a recent review of field studies of recharge/deep drainage in Australia identified 725 estimates of recharge in areas of less than 500 mm rainfall, 205 of these were on Vertosol soils (Crosbie et al. 2010).

P10057, L14 – A proper literature review would have revealed that there are many similar studies that have been carried out, this may be the "first time" such a study has been carried out in the Lower Namoi though. The study that I am most familiar with was carried out in the same department under the same funding source. At Brays Flat the recharge under several land uses was investigated using a water balance and found no recharge during the study period due to the sodic subsoils, numerical modeling estimated the long term recharge rate to be a small fraction of a mm per year (Crosbie et al. 2008). At the same site chloride profiles were taken down to the water table to reveal salt storage equivalent to several hundred thousand years of accumulation for a recharge rate of a small fraction of a mm per year (Crosbie 2006). The recommendations for land management on the site were that farming practices should not sacrifice profit to reduce recharge as the areas under cropping-pasture rotations were not the cause of the saline scald (Mitchell 2007). Other examples are the Brigalow sites in Qld where the increase in deep drainage has not yet hit the water table (Silburn et al. 2009; Silburn et al. 2010 in press; Tolmie et al. 2004) and the Mallee where a lot of the early work on this topic was completed (Cook et al. 2001).

P10058, L9 – space between 'type' and 'and'

P10058, L15 – I am guessing potential evapotranspiration here is pan evaporation, it seems too high for something like Penman-Monteith or Preistley-Taylor. Need to be more specific.

P10058, L17 & 19 – Is the site 20 or 30 km from Walgett?

P10058, L20 – the slope over this distance has little meaning, a local slope from a DEM at the study site would be better (even though it will still say it is flat)

P10062, L24 – It is usually better to cite the original paper rather than a summary in a tech report (Walker et al. 1991)

P10064, L11 – repetition, delete sentence

P10066, L10 – Need consistency in units, earlier in the paper tension was referred to in kPa rather than hPa.

P10066, L28 – delete 'are'

P10067, L9 – was the deeper groundwater from a confined aquifer? If it is then it has little relevance to the salinity of the soil or shallow groundwater.

P10068, L4 – losing streams and disconnected streams are not mutually exclusive (Brunner et al. 2009; Brownbill et al. 2011).

P10068, L6 – The groundwater may not discharge to the surface water in the immediate area, but what about further downstream?

P10068, L10-11 – Having a water level above the screen does not make an aquifer confined.

P10068, L12 – the BE seems low to me for a confined system, considering the ksat I would suggest that even the water table aquifer is semi-confined

P10068, L21 – Is this surface loading or recharge?

P10069, L6 – this sounds like preferential flow down the casing rather than an increase in groundwater level. If the water level in the sump is below the screen then how did it get in there? If the groundwater level had actually risen to above the bottom of the screen then the observation could not be below the bottom of the screen. The 0.1 m of water observed is still 0.9 m below the screen.

P10069, L14-26 – I do not think this is a valid calculation as the water in the sump probably does not represent a rise in the water table (see comment above)

P10069, L25 – there are other methods available such as age based tracers, but I agree, it is very difficult to estimate such low rates of recharge especially when using a water balance approach

P10072, L3-8 – How much does the episodic deep drainage modeled at 5m get attenuated before it reaches the water table at 20m? Considering the ksat values it could take years. A constant rate of recharge will show up in the groundwater hydrograph as a flat line, this is exactly what is shown in figure 8. The assumption of a constant recharge in the groundwater model is appropriate considering the available data (although probably wrong).

P10072, L6 – There is also a history of episodic recharge in the groundwater literature (Crosbie et al.; Lewis and Walker 2002)

P10074, L3-4 – the lag times between deep drainage and recharge has been studied for decades (Cook et al. 2002; Jolly et al. 1989; Leaney et al. 2011)

P10074, L4-5 – this could be modeled quite adequately with a Richard's Equation based numerical model that had the model domain extended below the water table

P10075, L15 – the chloride deposition at Walgett is likely to be substantially less than at Gunnedah, see the groundwater theme at http://www.ga.gov.au/mapconnect/

P10075, L17 – the 20,000 years assumes no leaching to groundwater

P10075, L19 – any salt deposited 13,000 years ago would have been leached from the root zone by now even if the deep drainage rate were 0.1 mm/yr (but not yet hit the water table).

P10075, L26-27 – doubled compared to what? I would have expected at least an order of magnitude increase compared to native veg (although still very small)

P10076, L9-10 – what about downstream?

P10076, L11 – cf native veg?

P10076, L15-16 - losing streams and disconnected streams are not mutually exclusive (Brunner et al. 2009; Brownbill et al. 2011).

P10076, L21-22 – it is already happening, the wetting front is well below the root zone

P10076, L24-26 – the time lag could be calculated using the tools recently developed by CSIRO/GA http://www.csiro.au/products/Recharge-Discharge-Estimation-Suite.html

P10077, L1-2 – there are many examples, some cited earlier in this review

P10077, L29-30 – the Bond reference is repeated

Brownbill RJ, Lamontagne S, Williams RM, Cook PG, Simmons CT, Merrick N (2011) Interconnection of surface and groundwater systems – river losses from losing-disconnected streams. Technical final report. NSW Office of Water, Sydney,

Brunner P, Cook PG, Simmons CT (2009) Hydrogeologic controls on disconnection between surface water and groundwater. Water Resour Res 45 (1):W01422. doi:10.1029/2008wr006953

Cook PG, Jolly ID, Walker GR, Robinson NI From Drainage to Recharge to Discharge: Some Timelags in Subsurface Hydrology. In: Dubai International Conference on Water Resources and Integrated Management in the Third Millenium, Dubai, UAE, Feb, 2002 2002.

Cook PG, Leaney FW, Jolly ID (2001) Groundwater Recharge In The Mallee Region, And Salinity Implications For The Murray River – A Review. CSIRO Land and Water Technical Report 45/01, Adelaide

Crosbie JA (2006) Utilising the Chloride profile method to estimate groundwater recharge in a salinity affected catchment in NSW. Final Year Research Project, University of Melbourne, Melbourne

Crosbie R, McCallum J, Walker G, Chiew F Episodic recharge and climate change in the Murray-Darling Basin, Australia. Hydrogeol J:1-17. doi:10.1007/s10040-011-0804-4

Crosbie RS, Jolly ID, Leaney FW, Petheram C (2010) Can the dataset of field based recharge estimates in Australia be used to predict recharge in data-poor areas? Hydrol Earth Syst Sc 14 (10):2023-2038

Crosbie RS, Wilson B, Hughes JD, McCulloch C, King WM (2008) A comparison of the water use of tree belts and pasture in recharge and discharge zones in a saline catchment in the Central West of NSW, Australia. Agric Water Manage 95 (3):211-223

Jolly ID (1989) Investigation into the potential for increased stream salinisation in the Darling Basin. CSIRO, Adelaide

Jolly ID, Cook PG, Allison GB, Hughes MW (1989) Simultaneous water and solute movement through an unsaturated soil following an increase in recharge. J Hydrol 111 (1-4):391-396

Leaney F, Crosbie R, O'Grady A, Jolly I, Gow L, Davies P, Wilford J, Kilgour P (2011) Recharge and discharge estimation in data poor areas: Scientific reference guide. CSIRO: Water for a Healthy Country National Research Flagship

Lewis FM, Walker GR (2002) Assessing the potential for significant and episodic recharge in southwestern Australia using rainfall data. Hydrogeol J 10 (1):229-237

Mitchell D (2007) Land use recommendations from integrated hydrology research in the Lachlan Catchment - the Brays Flat reseach site. NSW Department of Primary Industries, Orange

Silburn DM, Cowie BA, Thornton CM (2009) The Brigalow Catchment Study revisited: Effects of land development on deep drainage determined from non-steady chloride profiles. J Hydrol 373 (3-4):487-498

Silburn DM, Tolmie PE, Biggs AJW, Whish JPM, French V (2010 in press) Effect of land use on deep drainage in a high salinity hazard area. Aust J Soil Res

Tolmie PE, Silburn DM, Biggs AJW (2004) Estimating deep drainage in the Queensland

Murray-Darling Basin using soil chloride. Department of Natural Resources and Mines, Toowoomba

UNEP (1992) World atlas of desertification. United Nations Environment Program,

Walker GR, Jolly ID, Cook PG (1991) A new chloride leaching approach to the estimation of diffuse recharge following a change in land use. J Hydrol 128 (1-4):49-67

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