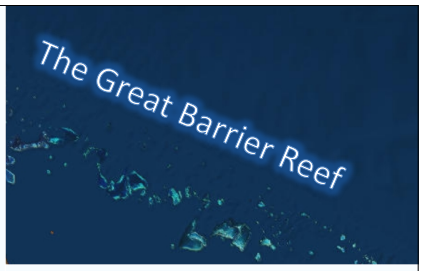
Groundwater pathways for nutrient transport from agricultural land to the Great Barrier Reef

Lucy Reading
Queensland University of Technology, Australia

The World Heritage listed Great Barrier Reef (GBR) off the northeast coast of Australia is the largest reef in the world.

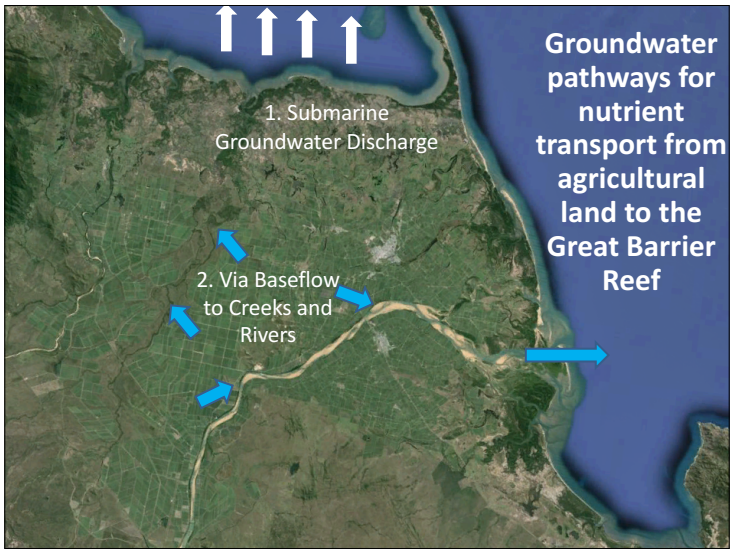
Agricultural production in GBR catchments over the past 150 years has contributed to a decline in water quality entering the GBR lagoon[1].

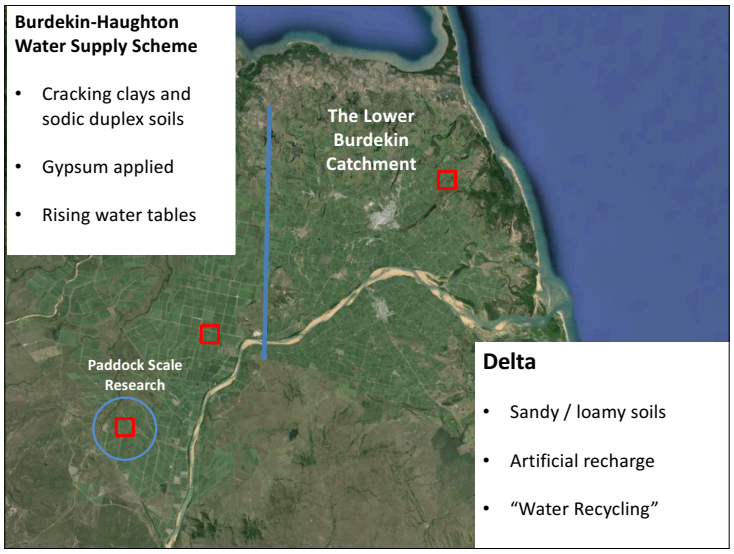
Riverine discharge has been identified as the single largest source of nutrients to inshore areas of the GBR lagoon[2].



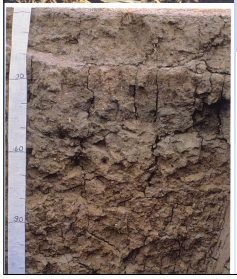
The contribution of groundwater discharge to nutrient concentrations in rivers and streams in GBR catchments is currently uncertain[3].

One of the GBR catchments of particular interest is the Lower Burdekin catchment.

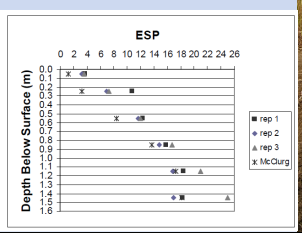




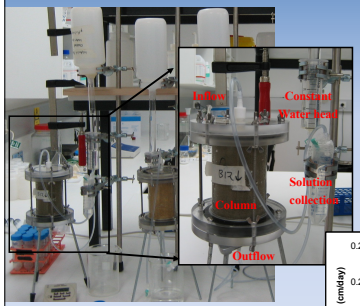
Paddock Scale Research – Field Measurements



- soil characterisation
- soil sampling
- soil analyses
- infiltration measurements

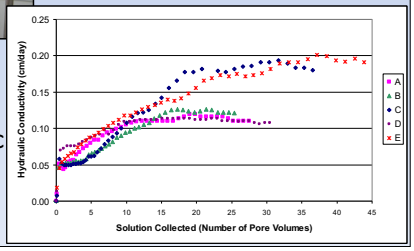


Laboratory Experiments

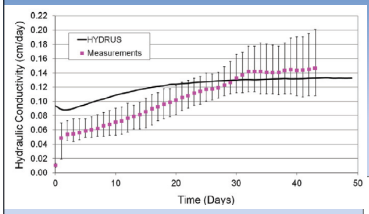


Leaching experiments: applying gypsum solutions and mixed cation salt solutions

Results: impacts of soil chemistry on the hydraulic conductivity of sodic clay soils[4,5]

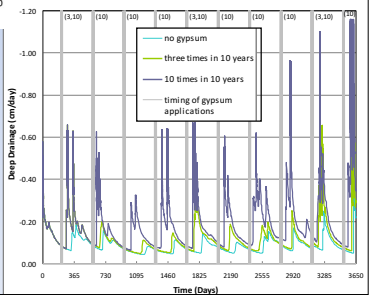


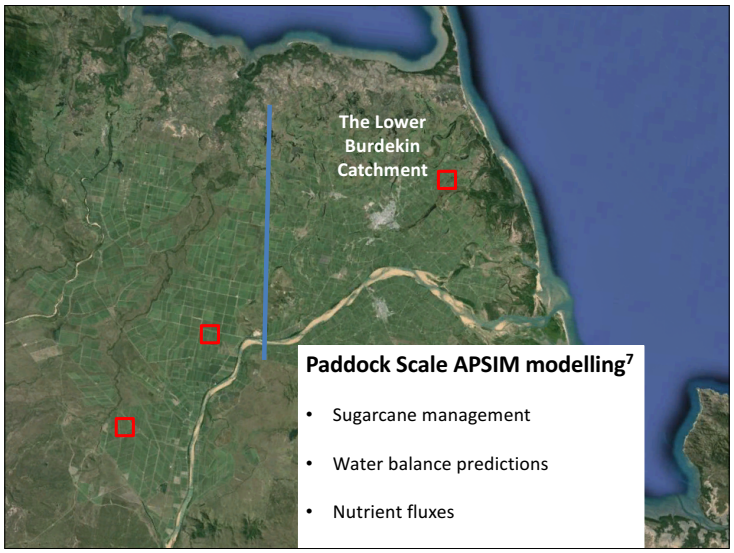
HYDRUS Modelling



The general trends observed in the laboratory were able to be simulated using HYDRUS[6]

HYDRUS was then used to simulate the potential impacts of gypsum applications on deep drainage

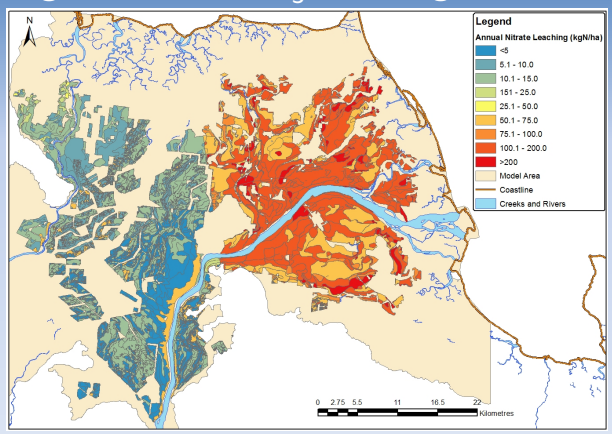




Paddock Scale APSIM modelling[7]

- Sugarcane management
- Water balance predictions
- Nutrient fluxes

Regional scale NO_3 leaching estimates



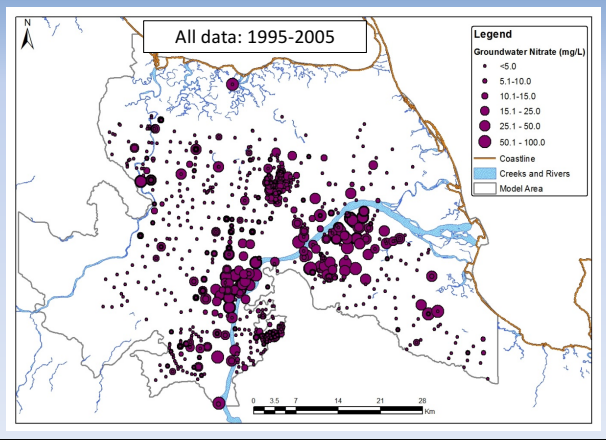
But how much of the NO_3 that leaches below the root zone reaches the GBR?

But how much of the NO3 that leaches below the root zone reaches the GBR?

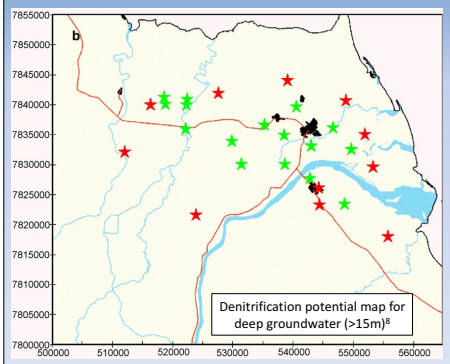
NEED TO KNOW:

- Concentrations of N species in GW
- Attenuation reactions within groundwater
- Transport of N within groundwater
- How much groundwater discharges to …
- Discharge of N species from GW to…

Limited monitoring of N species in GW



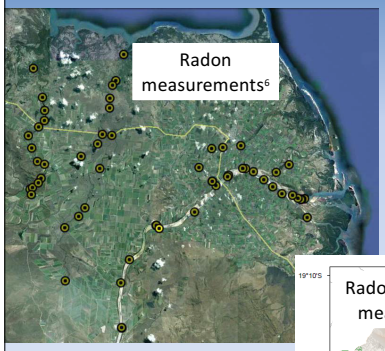
Some evidence of denitrification potential[8]



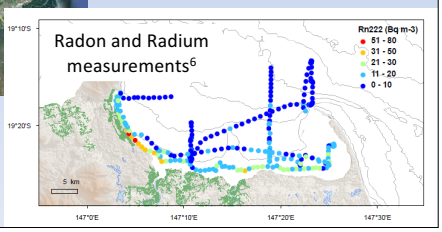
The widespread availability of DOC in high amounts leads to reducing conditions

Green and red symbols refer to areas with high and low potential for denitrification (based on DO, ferrous iron and Eh levels)

Measurements of GW discharge



Estimates of groundwater discharge rates to surface water and the marine environment at the end of the 2004 and 2011 wet seasons[6]



Knowledge Gaps

- Groundwater discharge studies were conducted independently of geochemical studies so it is difficult to estimate nutrient discharge loads with confidence
- Extent of reactions occurring in the riparian zone? e.g. nitrification of ammonium, denitrification of nitrate?
- The influence of preferential flow pathways?

Proposed Methods

- Combining groundwater geochemistry with isotopic tracers (in parallel with updated discharge estimates)
- Experiments using sediments from the hyporheic zone
- Water flow and reactive transport modelling

References

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