# A tradable permit scheme for cost-effective reduction of nitrogen runoff in the sugarcane catchments of the Great Barrier Reef

## Project team

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## Timeframe

Project start date: 1 October 2015
Project end date: 29 February 2016
This project models the feasibility of a nitrogen-trading market in a Wet Tropics catchment in Queensland. Results can potentially be used to inform statewide regulatory planning for water quality improvements.

## Project description

The Great Barrier Reef is Australia's most iconic natural asset. Reef-related tourism supports 64,000 jobs and contributes $6.4 billion to Australia's GDP in 2015-16 (Deloitte Access Economics 2017). Survival of the Reef is threatened by rising water temperatures, ocean acidification and plagues of coral-eating Crown of Thorns starfish (Great Barrier Reef Water Science Taskforce 2016). The Reef's ability to fight back against these threats is being reduced by damaging quantities of sediment, nutrients and pesticides carried into the Reef Lagoon from river catchments along the coast. Amongst the biggest of these water-quality concerns is nitrogen runoff from fertiliser use in sugarcane production. The government's Reef 2050 Long Term Sustainability Plan calls for an 80% reduction in dissolved inorganic nitrogen flowing out onto the Reef by 2025. Our research suggests that nitrogen trading could offer a flexible and cost-effective mechanism to help farmers deliver much-needed improvements in fertiliser use efficiency to reduce these nitrogen losses.

Voluntary schemes like the industry-led Smart Cane Best Management Practice program are making headway towards reducing nitrogen runoff – but there is still quite some way to go. This is where 'nitrogen trading' in a nitrogen 'smart market' might be useful as a flexible way of encouraging farmers to use fertiliser more efficiently, and also providing financial rewards for innovations in farming practice.

A nitrogen market would operate in a possible future where an annual nitrogen load limit is set for each river catchment. Cane farmers would be allowed a fixed level of fertiliser applications per hectare, and would be given an initial allocation of fertiliser permits to match this initial allocation. Farmers would then be allowed to buy or sell permits if they wanted to, through a centralised online 'smart market' platform. An overall cap on the total number of permits issued ensures that the nitrogen load limit for the catchment is never exceeded.

How would a nitrogen market work ?

Putting extra fertiliser on good soil can increase cane profits considerably. Farmers on good soil would therefore be willing to pay more for extra fertiliser permits, on top of their initial allocation. Putting extra fertiliser on poor soil does not

increase cane profits nearly as much – partly because a lot of the nitrogen is lost as runoff. Farmers on poor soil would be willing to sell some permits from their initial allocation if the price that farmers on good soil were willing to pay was higher than the extra profit that could be made from applying the fertiliser on poor soil. It is this difference in the profitability of fertiliser applications between good, low nitrogen loss soil and poorer 'nitrogen leaky' soil that makes the 'smart' nitrogen market work.

Our research simulations suggest that overall cane profits and cane production would be higher with a nitrogen trading market than they would under a fixed per-hectare nitrogen limit – while still operating under the same total cap on nitrogen hitting the Reef. A 'smart' nitrogen market offers the potential to reward improvement and innovation in farming practice, within nitrogen loss limits, thus increasing the Reef's chances of survival.

## Outcomes

A spatially-specific model of a nitrogen-trading market was constructed for the Tully catchment in the Wet Tropics by collating data on sugarcane area, soil class and the Tully drainage network. Using GIS (geographic information system), cane land in the Tully catchment was represented as 4020 'paddock-scale' 250m x 250m grid cells. Each grid cell was modelled as a separate trading entity in nitrogen-trading simulations.

Nitrogen-trading requires an overall cap on the nitrogen load at Tully Heads. To reflect targeted reductions in dissolved inorganic nitrogen (DIN) load from the 2009 baseline, nitrogen caps were tightened in each round of market simulation. Market simulation results suggested that reducing nitrogen fertiliser applications to around 120 kgN/ha may be sufficient to achieve a 50% reduction in total DIN load from the 2009 level. Achieving the Long Term Sustainability Plan's ecologically-relevant 80% DIN load reduction target is more challenging. Our results suggest that a DIN load cap corresponding to uniform nitrogen-applications of 60 kgN/ha would deliver close to a 77% reduction. Simulations suggest that a nitrogen-trading market with initial allocations of 60 kgN/ha would be a more cost-efficient way of achieving this outcome than a fixed (non-tradable) nitrogen application limit of 60 kgN/ha.

The overall effect of trading is to distribute the available nitrogen fertiliser more efficiently across the landscape. Nitrogen fertiliser is traded away from less profitable, leaky soils onto more profitable, less leaky land. Our research suggests that there is sufficient variability in soil types and profitability per hectare across the Tully catchment to drive an active nitrogen trading market. Simulations suggest that more than half of the paddock-sized grid cells would buy or selling nitrogen-permits and this trading would result in increased profits.

Market simulations were extended to include sale of nitrogen-credits from constructed wetlands alongside sales and purchases of nitrogen-permits from changes in fertiliser applications. As the DIN load cap at Tully Heads is tightened, the market-clearing price for nitrogen-permits and nitrogen-credits increases. Simulations suggest that higher nitrogen-prices under tight DIN load caps would be sufficient to persuade some landowners to convert their less-productive cane paddocks to constructed wetlands. These landowners – on the less productive land – find that they can make more money by selling nitrogen-credits from their constructed wetlands than they could from growing sugarcane.

Including constructed wetlands as a source of nitrogen-credits has the potential to increase the gains from market trading considerably, particularly as the DIN load cap is tightened towards the 80% load reduction target. Selling nitrogen-credits from wetlands provides landowners with an alternative source of income, easing their transition out of cane. The nitrogen-credits from wetland also benefit the landowners who remain in cane. With constructed wetlands sucking DIN out of the catchment, more fertiliser can be applied in the catchment without exceeding the total DIN load limit at Tully Heads.

Results suggest that differences in spatial setting and farm management will likely influence market operation and efficiency. Market implementation and governance would have to be tailored to suit the on-ground setting to help market-based nitrogen-management achieve its full potential for improving water quality in the Reef Lagoon.

## Funding

This project is supported through funding from the Australian Government's National Environmental Science Programme.

## For more information, contact

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# Research outputs

**NESP publication**

Smart, JCR, Hasan S, Volders A, Curwen G, Fleming C and Burford M (2016) A tradable permit scheme for cost-effective reduction of nitrogen runoff in the sugarcane catchments of the Great Barrier Reef. Report to the National Environmental Science Programme. Reef and Rainforest Research Centre Limited, Cairns (85pp.).

**Conference paper**

Smart, J.C.R., Hasan, S., Fleming, C.M., Volder, A., Curwen, G. and Burford, M. (2017) A tradable permit scheme for cost-effective reduction in nitrogen runoff in the sugarcane catchments of the Great Barrier Reef, paper presented at 23rd Annual Conference of the European Association of Environmental and Resource Economists, Athens, Greece (28th June – 1 July 2017).