AGRICULTURE VICTORIA

Assessing the feasibility and net costs of achieving water quality targets: A case study in the Burnett-Mary region, Queensland, Australia

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Economic Development, Jobs, Transport and Resources

Background

Length: 2,300 km

Area: 344,400 km^2

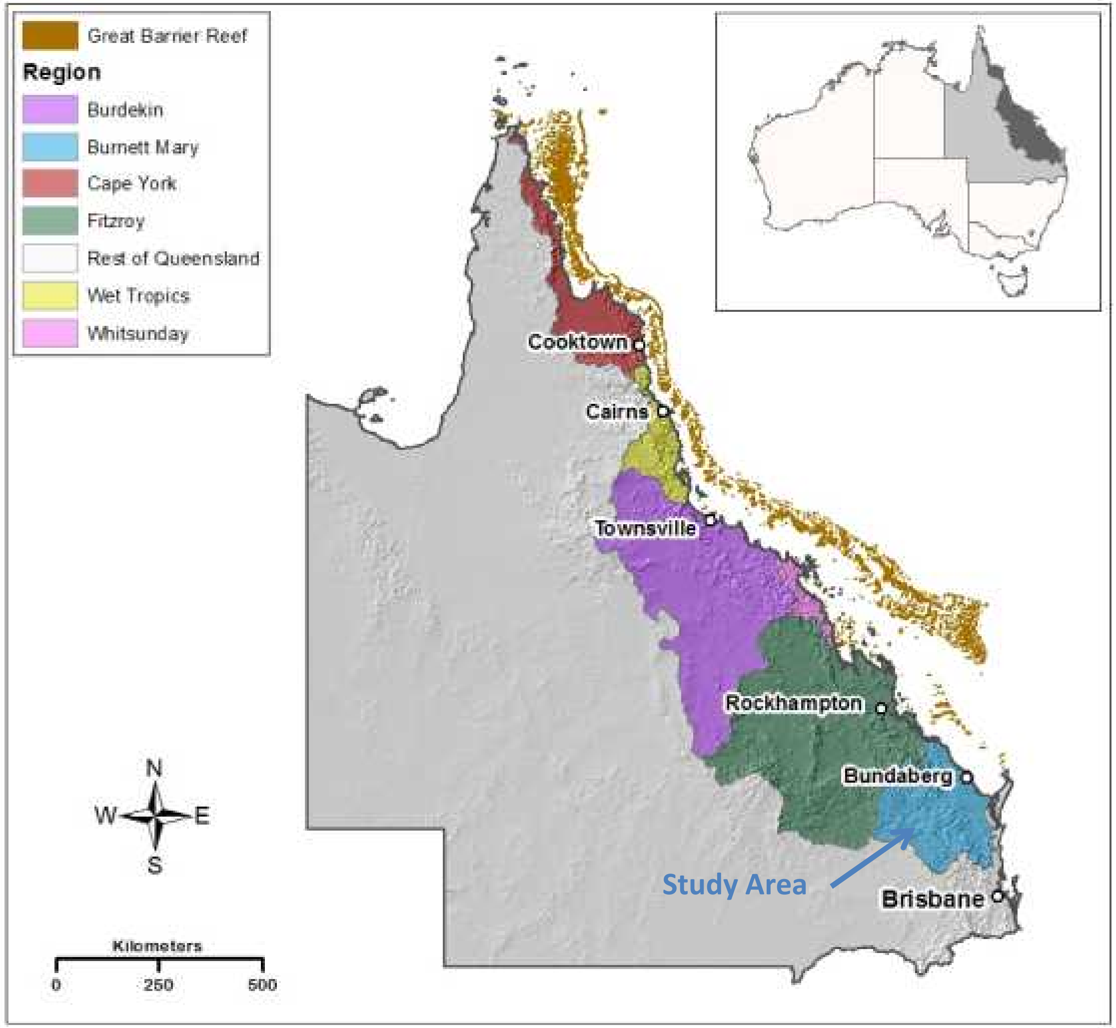
Worlds largest coral reef ecosystem

Includes:

3,000 coral reefs
600 continental islands
300 coral cays (sandy island)
150 inshore mangrove islands

World Heritage Site in 1981

Ramsar listed Great Sandy Strait



Commonwealth initiatives and baseline loads

- The long-term goal is to ensure that by 2020 the quality of water entering the GBR from adjacent catchments has no detrimental impact on the health and resilience of the GBR. (Reef Water Quality Protection Plan 2003).

- A clear set of water quality and management practice targets to reduce sediment, nutrient (nitrogen and phosphorus) and pesticide loads to the GBR lagoon (Reef Plan 2009) .

- The GBR catchments drain an area of 423,134 km^2 of coastal Queensland, consisting of 35 major basins.

- The predominant land uses are grazing (75%), nature conservation (13%), sugar cane (1%) and rain-fed summer and winter cropping (<3%).

- Baseline loads were: TSS 6.95 Mt;
  TN 30 kt; PN 11.7 kt; DIN 5.52 kt; DON 13.14 kt;
  TP 9.33 kt; PP 7.08 kt; DIP 1.65 kt; DOP 0.76 kt

- $200M reef rescue package over 5 years to improve water quality (> 3200 individual land managers to receive water quality grants for on-farm projects).

Land management practice framework

Land management practices (LMP) were defined under an ABCD practice framework for each major industry

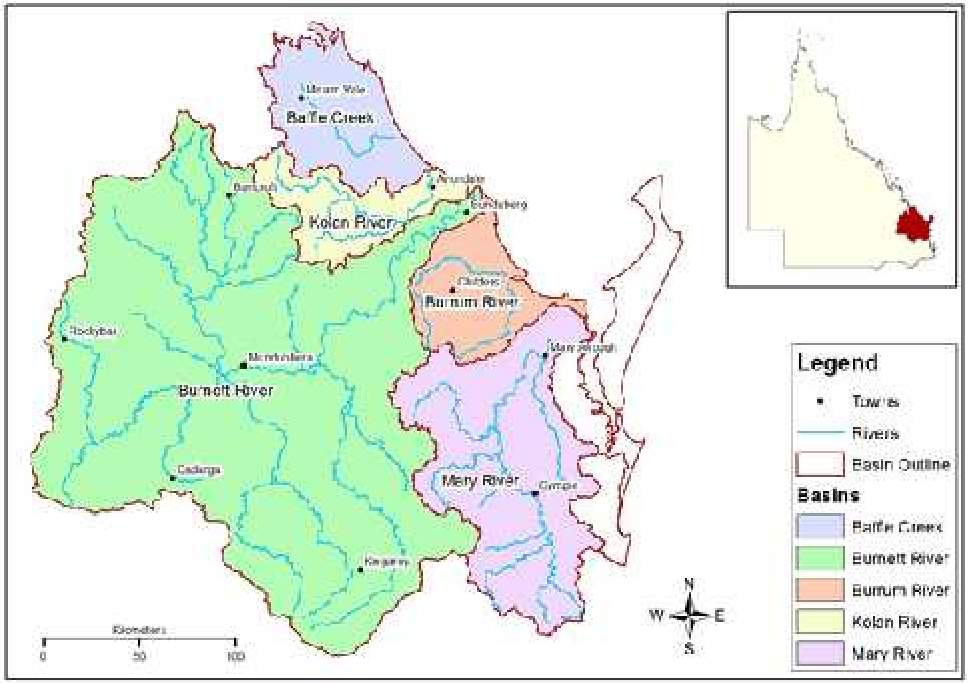
LMP	Sugarcane	Grazing
A	cutting edge	highly likely to maintain land in good condition
B	best practice	likely to maintain land in good/fair condition
C	common practice	likely to degrade some land
D	unacceptable	highly likely to degrade land to poor condition

The proportion of each industry in A,B,C or D class of management was firstly established for the baseline year (2008–2009) and for each subsequent year following implementation of improved management practices.

Water Quality Improvement Plan

Tasks:

- Identification and characterisation of representative farming systems;
- Disaggregation of the calibrated watershed simulation model predictions of end-of-catchment loads to within-catchment soil and productivity levels;
- Estimation of the effectiveness and costs of alternative land management practices;
- Construction of the bio-economic optimisation model.



Effectiveness of management practices

Sugarcane – APSIM / Howleaky

Soil type	Constituent	A	B	C	D
Well drained soil (Red Dermosol)	TSS	0.01	0.01	1	1
	TP	0.17	0.33	1	1
	DIP	0.01	0.01	1	1
	PP	0.20	0.40	1	1
	PN	0.13	0.30	1	1
	DIN	0.01	0.06	1	1
	PSII	0.14	0.48	1	1
Poorly drained soil (Redoxic hydrosol)	TSS	0.01	0.01	1	1
	TP	0.28	0.38	1	1
	DIP	0.54	0.55	1	1
	PP	0.12	0.28	1	1
	PN	0.12	0.28	1	1
	DIN	0.01	0.10	1	1
	PSII	0.15	0.53	1	1

Grazing – GRASP (TSS, PN and PP)

Practice	A	B	C	D
P1	0.16	0.43	0.88	1
P2	0.14	0.40	0.83	1
P3	0.16	0.43	0.88	1
P4	0.17	0.47	0.93	1
P1+P2	0.10	0.32	0.71	1
P1+P2+P3	0.06	0.24	0.59	1
P1+P2+P3+P4	0.04	0.20	0.51	1
P2+P3	0.10	0.32	0.71	1
P2+P3+P4	0.08	0.27	0.64	1
P3+P4	0.13	0.39	0.81	1

Practice 1 = Stocking rate
Practice 2 = Groundcover retention management
Practice 3 = Recovery of poor condition land
Practice 4 = Selective grazing of land

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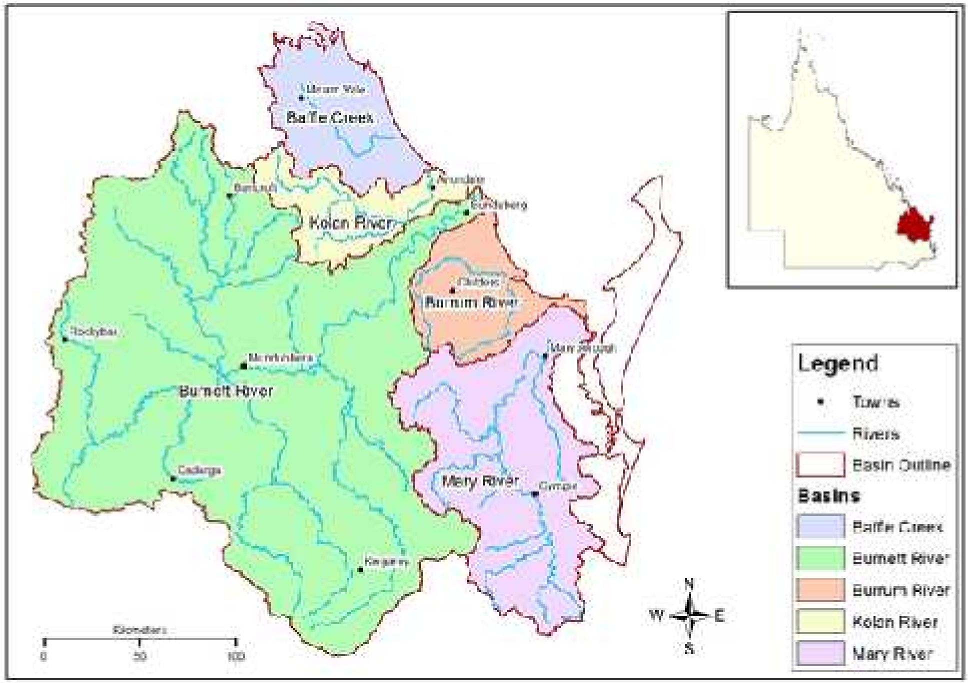

Results – load reductions

Reef Plan Targets (RPTs): based on 2009 and 2013 target settings

Ecologically Relevant Targets (ERTs): acknowledges the lag time between reducing pollutant loads and a subsequent ecological response of significant assets affected by water quality

Scenario	Constituent	Target (% load reduction)	Anthropogenic load reduction (% achieved)					
			Whole Region	Baffle	Kolan	Burnett	Burrum	Mary
Meet RPTs in each basin	TSS	20		22	20	36	40	20
	DIN	50		53	73	91	85	75
	PN	20		135*	48	45	48	30
	PP	20		107*	34	35	40	29
	DIP	20		20	20	20	20	20
	NetProfit**		-$6.5M	-$1.4M	+$0.8M	-$4.5M	+$1.0M	-$2.4M
Whole region RPTs	TSS	20	20	15	24	20	37	19
	DIN	50	80	47	85	89	85	76
	PN	20	39	130*	53	41	48	30
	PP	20	36	99	39	31	40	31
	DIP	20	20	13	25	4	17	24
	TN		82					
	TP		35					
	NetProfit**		-$1.8M	-$0.8M	+$0.7M	+$1.0M	+$1.3M	-$4.0M
Meet ERTs in each basin	TSS	20		51	32	51	40	Not feasible
	DIN	80		80	86	97	87	
	PN	50		158*	60	57	54	
	PP	50		141*	50	50	50	
	DIP	20		48	26	20	20	
	NetProfit**		(-$11.4M in only 4 basins)	-$4.3M	+$0.2M	-$7.6M	+$0.3M	
Whole region ERTS	TSS	20	32	61	37	35	42	27
	DIN	80	87	78	93	97	90	81
	PN	50	50	167*	72	54	66	38
	PP	50	50	150*	64	43	62	40
	DIP	20	21	45	27	5	14	20
	TN		92					
	TP		47					
	NetProfit**		-$16.4M	-$4.9M	-$1.2M	-$2.1M	-$1.3M	-$6.9M

*Values in excess of 100% reflect a total reduction in anthropogenic loads and reduced pre-development exports.
**Negative values indicate a net cost and positive values indicate a net profit.

Results – Area change

Reef Plan Targets (RPTs): based on 2009 and 2013 target settings

Ecologically Relevant Targets (ERTs): acknowledges the lag time between reducing pollutant loads and a subsequent ecological response of significant assets affected by water quality

Cane	A (ha)	B (ha)	C (ha)	D (ha)	Total (ha)
Original area	1,614	5,988	34,083	15,403	57,088
New area - RPTs whole region	1,614	55,474	0	0	57,088
New area - ERTs whole region	46,020	11,068	0	0	57,088
Area change - RPTs whole region	0	49,486	-34,083	-15,403	
Area change - ERTs whole region	44,406	5,080	-34,083	-15,403	
% Area change - RPTs whole region	**0**	**826**	**-100**	**-100**	
% Area change - ERTs whole region	**2,751**	**85**	**-100**	**-100**	

Grazing	A (ha)	B (ha)	C (ha)	D (ha)	Total (ha)
Original area	568,252	1,870,731	900,267	287,279	3,626,529
New area - RPTs whole region	699,601	1,857,923	794,812	274,193	3,626,529
New area - ERTs whole region	812,066	1,785,691	766,248	262,524	3,626,529
Area change - RPTs whole region	131,349	-12,808	-105,455	-13,086	
Area change - ERTs whole region	243,814	-85,040	-134,019	-24,755	
% Area change - RPTs whole region	**23**	**-1**	**-12**	**-5**	
% Area change - ERTs whole region	**43**	**-5**	**-15**	**-9**	

Conclusions

Large and ongoing support will be needed for the grazing industry to achieve Reef Plan Targets (RPTs) .

Achieving pollutant targets on an individual basin scale is much more expensive than if targets can be met on a whole of region scale.

Ecologically Relevant Targets (ERTs) cannot be met without substantial costs and are not feasible if individual basins must meet the targets.

Bio-economic modelling is a powerful tool to assess the benefits and costs of meeting water quality targets.

Bio-Economic model components

Maximise net benefits:

$$\text{®}^{n}=\sum_{s^n=1}^{S^n}\sum_{l^n=1}^{L^n{}_s}\sum_{m^n=1}^{M^n{}_{s,l}}\sum_{p^n=1}^{P^n{}_{s,l,m}} NB^n{}_{s,l,m,p}\,A^n{}_{s,l,m,p}-\sum_{s^n=1}^{S^n}\sum_{g^n=1}^{G^n{}_s} cg^n{}_{s,g}\,GW^n GL^n{}_{s,g}-\sum_{s^n=1}^{S^n}\sum_{r^n=1}^{R^n{}_s} cs^n{}_{s,r}\,SW^n SL^n{}_{s,r}$$

Constituent load constraint:

$$C^n=\sum_{s^n=1}^{S^n}\sum_{l^n=1}^{L^n{}_s}\sum_{m^n=1}^{M^n{}_{s,l}}\sum_{p^n=1}^{P^n{}_{s,l,m}} X^n{}_{s,l,m,p}\,A^n{}_{s,l,m,p}\,DR^n{}_{s,l,m,p}+\sum_{s^n=1}^{S^n}\sum_{g^n=1}^{G^n{}_s} Xg^n{}_{s,g}\,GW^n GL^n{}_{s,g}\,DRg^n{}_{s,g}+\sum_{s^n=1}^{S^n}\sum_{r^n=1}^{R^n{}_s} Xs^n{}_{s,r}\,SW^n SL^n{}_{s,r}\,DRs^n{}_{s,r}$$

Constraints

- the distribution of small, medium and large farms maintained at current levels;
- grazing practices 1, 2, 3 and 4 equally occupy grazing area;
- the area of good and poor soil in sugarcane is maintained at current levels;
- the areas of different productivity classes (high, medium and low) in grazing are maintained at current levels;
- the land use areas currently in A and B class practices are not permitted to be reduced.