Rainfall drives nitrogen transport and reduced attenuation in a coastal horticultural catchment

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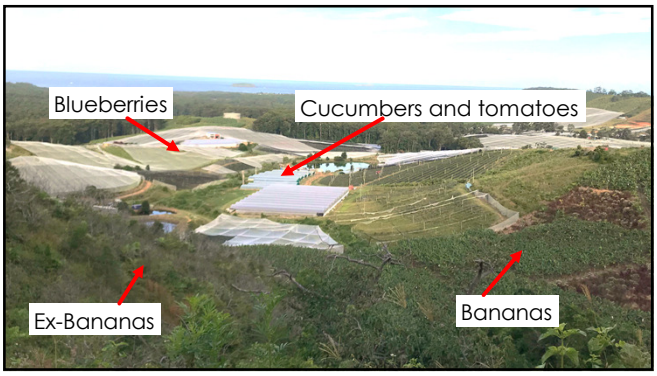
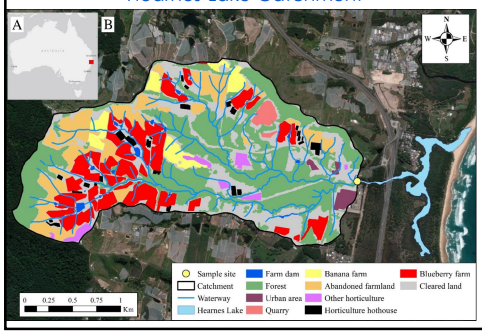
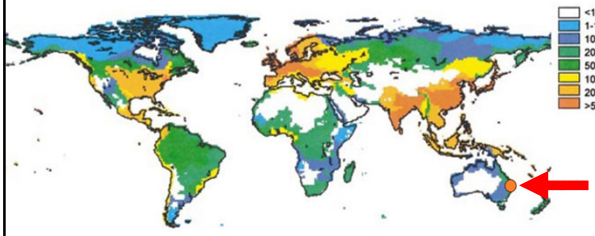


Hearnes Lake Catchment

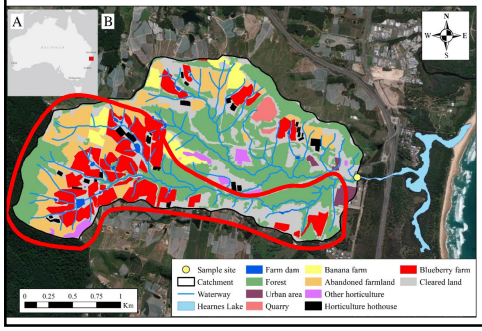


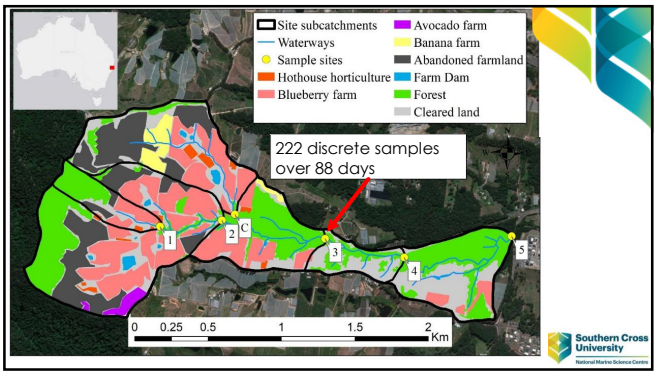
Inorganic N similar to loads expected in China and India

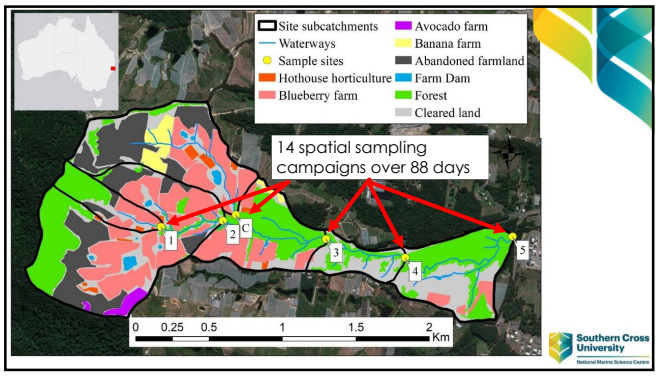


Kg Inorganic N km^{-2} watershed yr^{-1}

Hearnes Lake Catchment






Site subcatchments
Waterways
Sample sites
Hothouse horticulture
Blueberry farm
Avocado farm
Banana farm
Abandoned farmland
Farm Dam
Forest
Cleared land
14 spatial sampling campaigns over 88 days
1
2
C
3
4
5
0 0.25 0.5 1 1.5 2 Km
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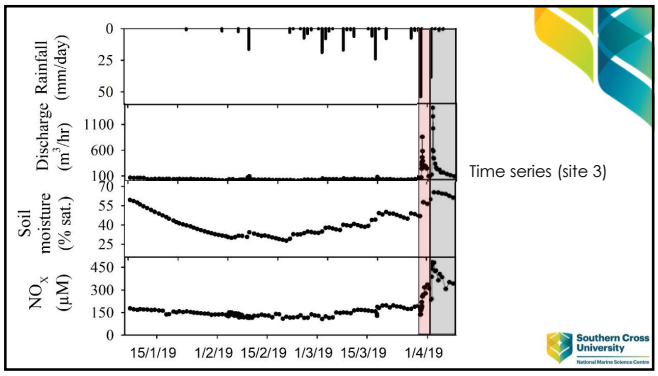
Temporary laboratory set up next to creek
Constant flow through supply of fresh creek water


Rainfall (mm/day)
Discharge (m3/hr)
Soil moisture (% sat.)
NOx (µM)
15/1/19 1/2/19 15/2/19 1/3/19 15/3/19 1/4/19
Time series (site 3)
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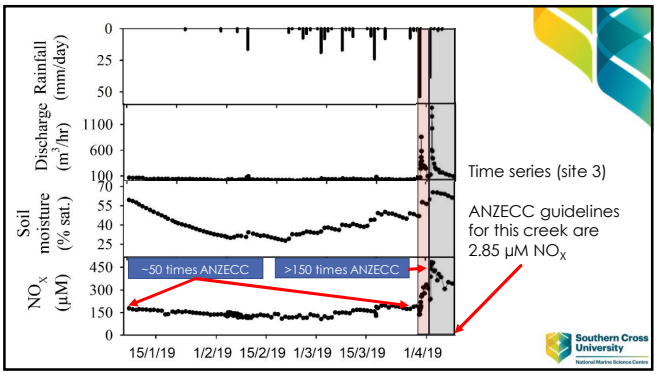
Rainfall (mm/day)
Discharge (m3/hr)
Soil moisture (% sat.)
NOx (µM)
~50 times ANZECC
>150 times ANZECC
15/1/19 1/2/19 15/2/19 1/3/19 15/3/19 1/4/19
Time series (site 3)
ANZECC guidelines for this creek are 2.85 µM NOx
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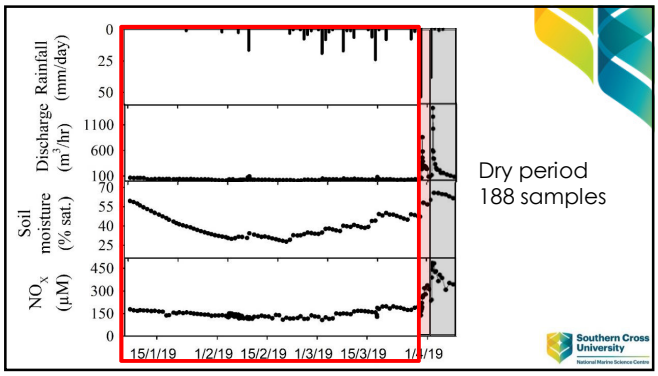
Rainfall (mm/day)
Discharge (m³/hr)
Soil moisture (% sat.)
NOx (µM)
15/1/19 1/2/19 15/2/19 1/3/19 15/3/19 1/4/19
Dry period
188 samples
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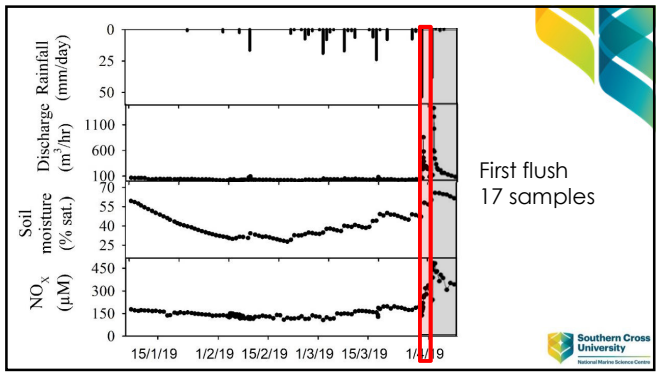
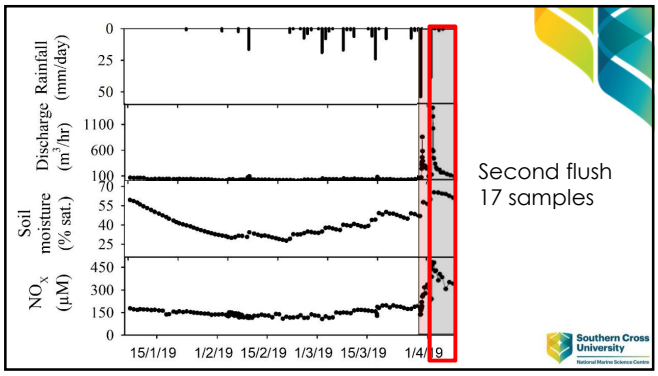
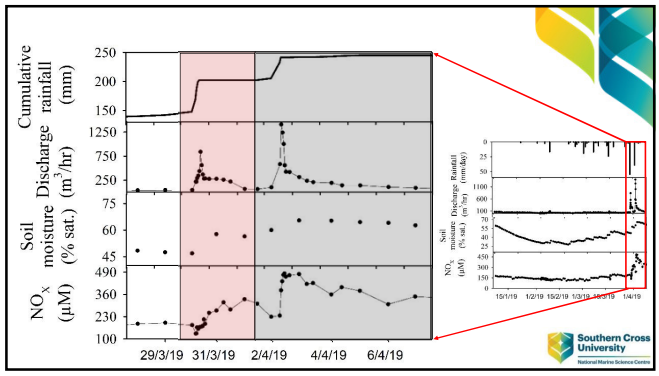

Rainfall (mm/day)
Discharge (m³/hr)
Soil moisture (% sat.)
NOx (µM)
15/1/19 1/2/19 15/2/19 1/3/19 15/3/19 1/4/19
First flush
17 samples
Southern Cross University


Rainfall (mm/day)
Discharge (m³/hr)
Soil moisture (% sat.)
NOx (µM)
15/1/19 1/2/19 15/2/19 1/3/19 15/3/19 1/4/19
Second flush
17 samples
Southern Cross University


Cumulative rainfall (mm)
Discharge (m³/hr)
Soil moisture (% sat.)
NOx (µM)
29/3/19 31/3/19 2/4/19 4/4/19 6/4/19
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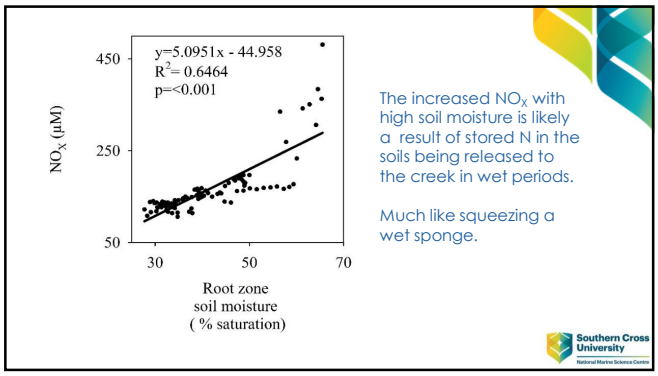
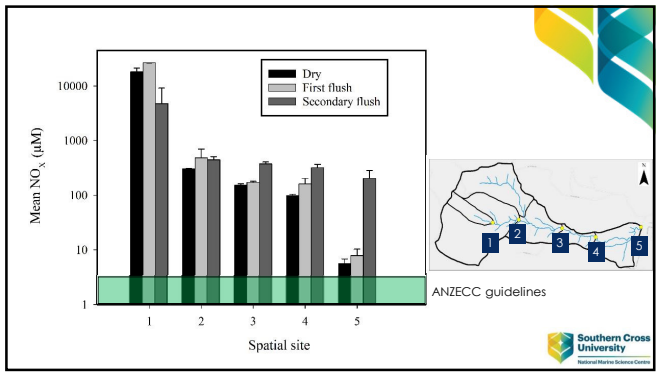
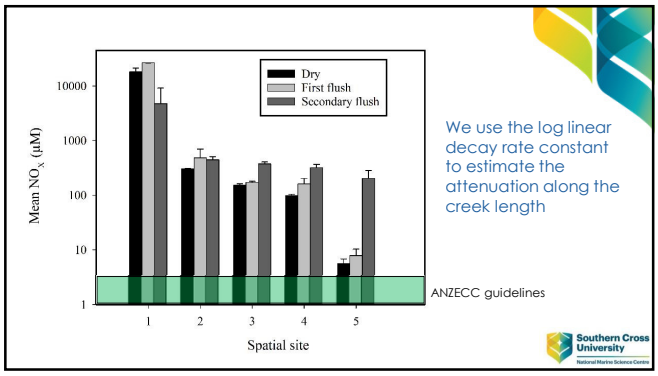


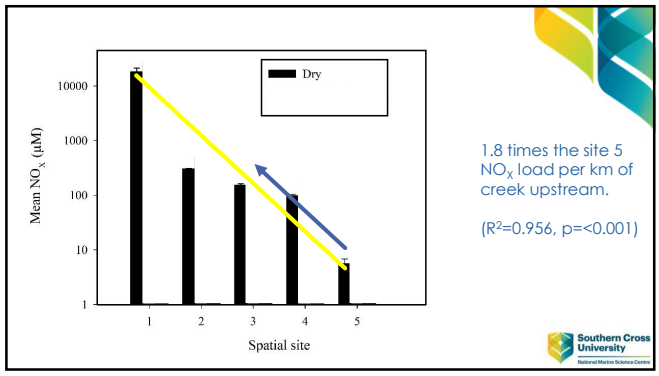
The increased NO_X with high soil moisture is likely a result of stored N in the soils being released to the creek in wet periods.

Much like squeezing a wet sponge.



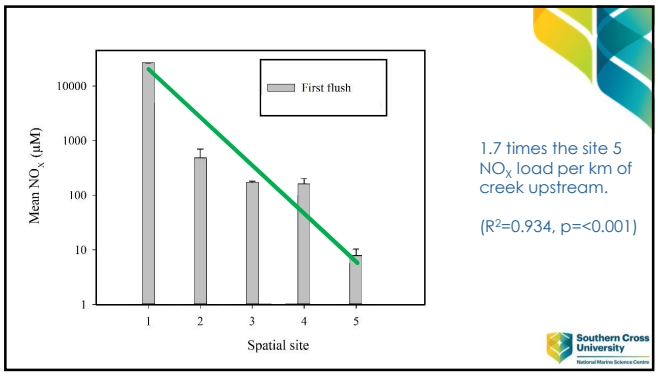


We use the log linear decay rate constant to estimate the attenuation along the creek length



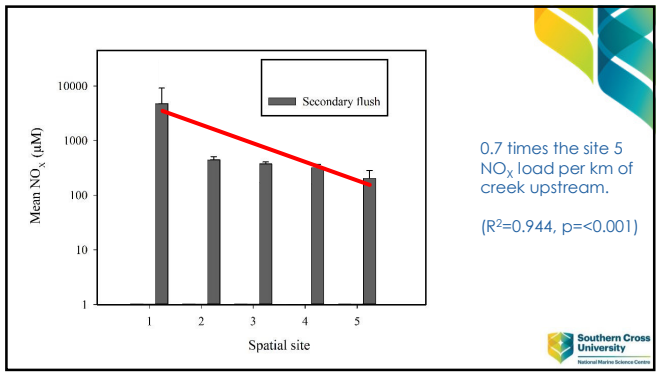
1.8 times the site 5 NO_X load per km of creek upstream.

(R^2=0.956, p=<0.001)



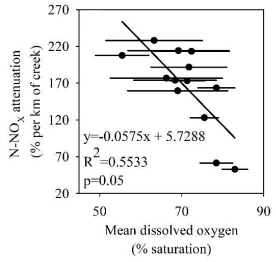
1.7 times the site 5 NO_X load per km of creek upstream.

(R^2=0.934, p=<0.001)



0.7 times the site 5 NO_X load per km of creek upstream.

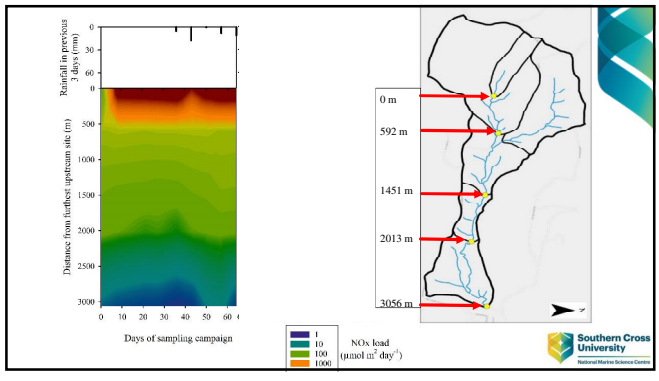
(R^2=0.944, p=<0.001)

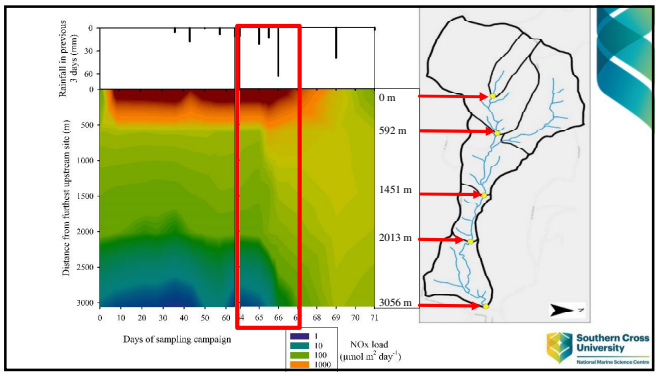


Attenuation is influenced by creek dissolved oxygen

Denitrification of NO_X along the creek length is likely the cause of the attenuation

Dissolved oxygen increases with increases in flow




Rainfall in previous 3 days (mm)
Distance from furthest upstream site (m)
0 m
592 m
1451 m
2013 m
3056 m
Days of sampling campaign
NOx load (μmol m² day⁻¹)
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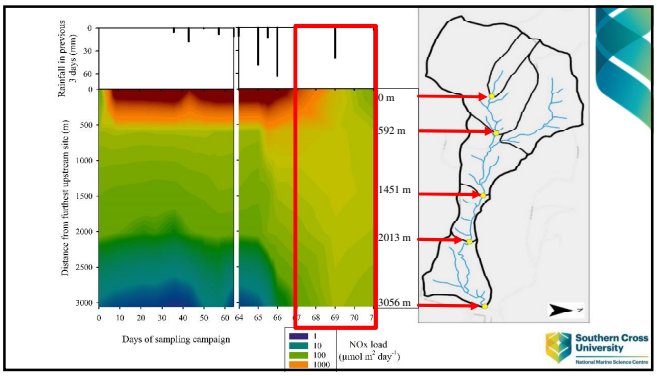
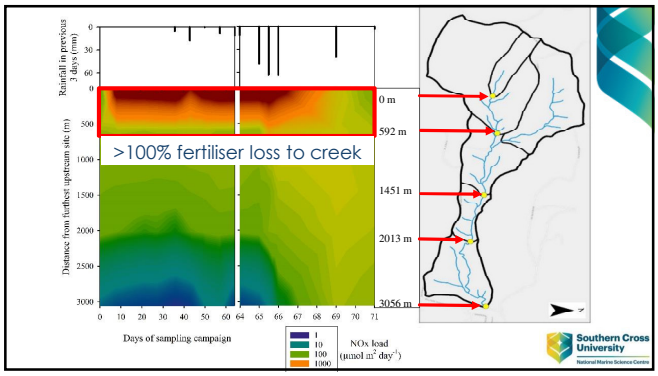

Rainfall in previous 3 days (mm)
Distance from furthest upstream site (m)
0 m
592 m
1451 m
2013 m
3056 m
Days of sampling campaign
NOx load (μmol m² day⁻¹)
Southern Cross University


Rainfall in previous 3 days (mm)
Distance from furthest upstream site (m)
>100% fertiliser loss to creek
0 m
592 m
1451 m
2013 m
3056 m
Days of sampling campaign
NOx load (μmol m² day⁻¹)
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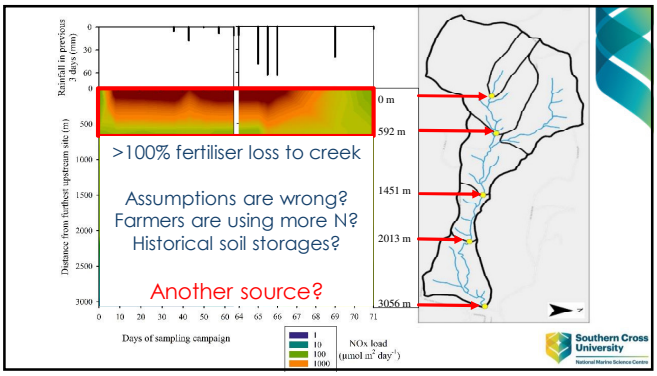
Rainfall in previous 3 days (mm)
Distance from furthest upstream site (m)
>100% fertiliser loss to creek
Assumptions are wrong?
Farmers are using more N?
Historical soil storages?
Another source?
0 m
592 m
1451 m
2013 m
3056 m
Days of sampling campaign
NOx load (μmol m² day⁻¹)
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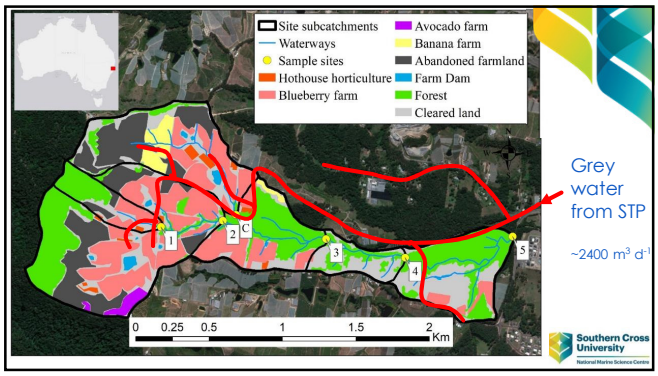

Summary

NO_x was ~50 times ANZECC guidelines in dry periods and >150 times guidelines in rain at the time series site.

Significant nitrate attenuation between Site 1 (~5000 times ANZECC) and Site 5 (~17 times ANZECC).

The origin of NO_x is likely the coupled influences of episodic flushing of soil N, application of sewage greywater and fertilisers, as well as denitrification and nitrification instream.

The high variation in the observations between pre and post rain indicates that in Australian waterways, there is a strong influence of periodic hydrology.

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Site 2 vs Control Site