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Assessment of nitrogen attenuation in the subsurface environment of Manawatu River Catchment, New Zealand

Land Use and Water Quality Conference,
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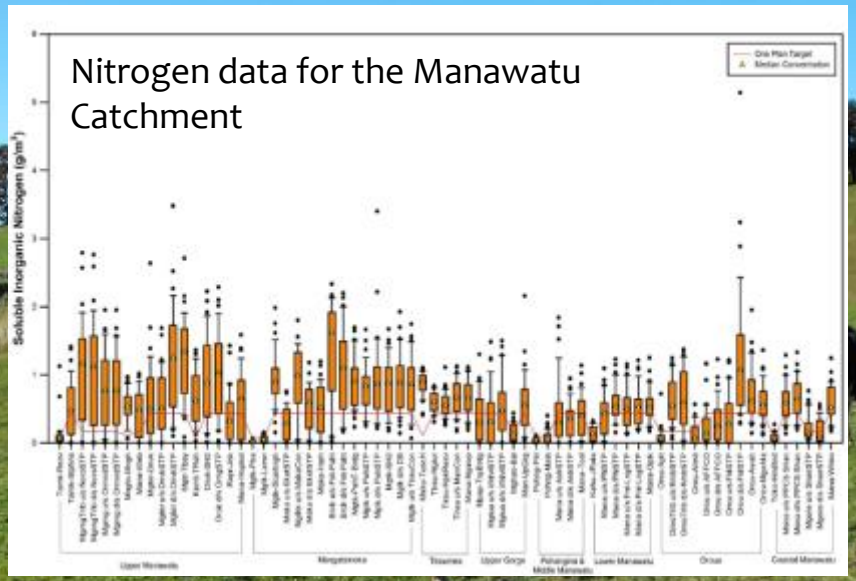
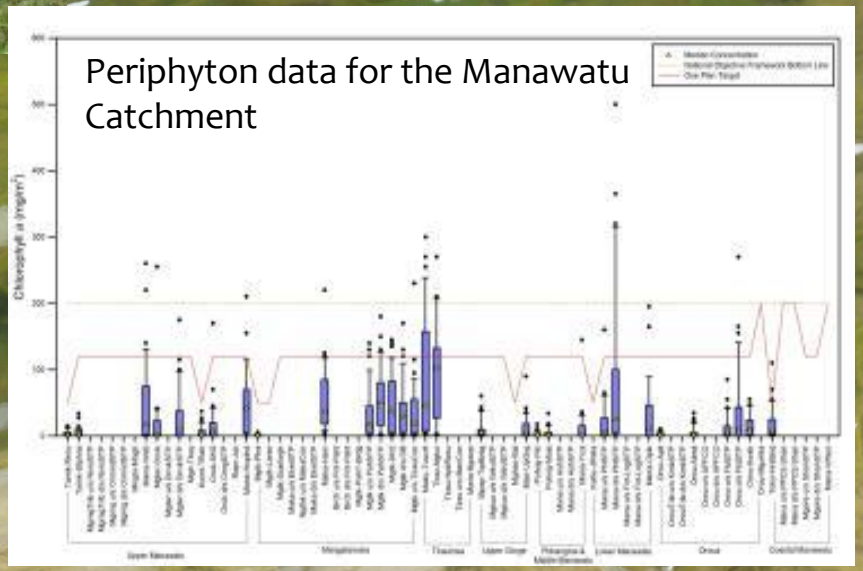
Productive Farms - Economic Benefits and Social Welfare



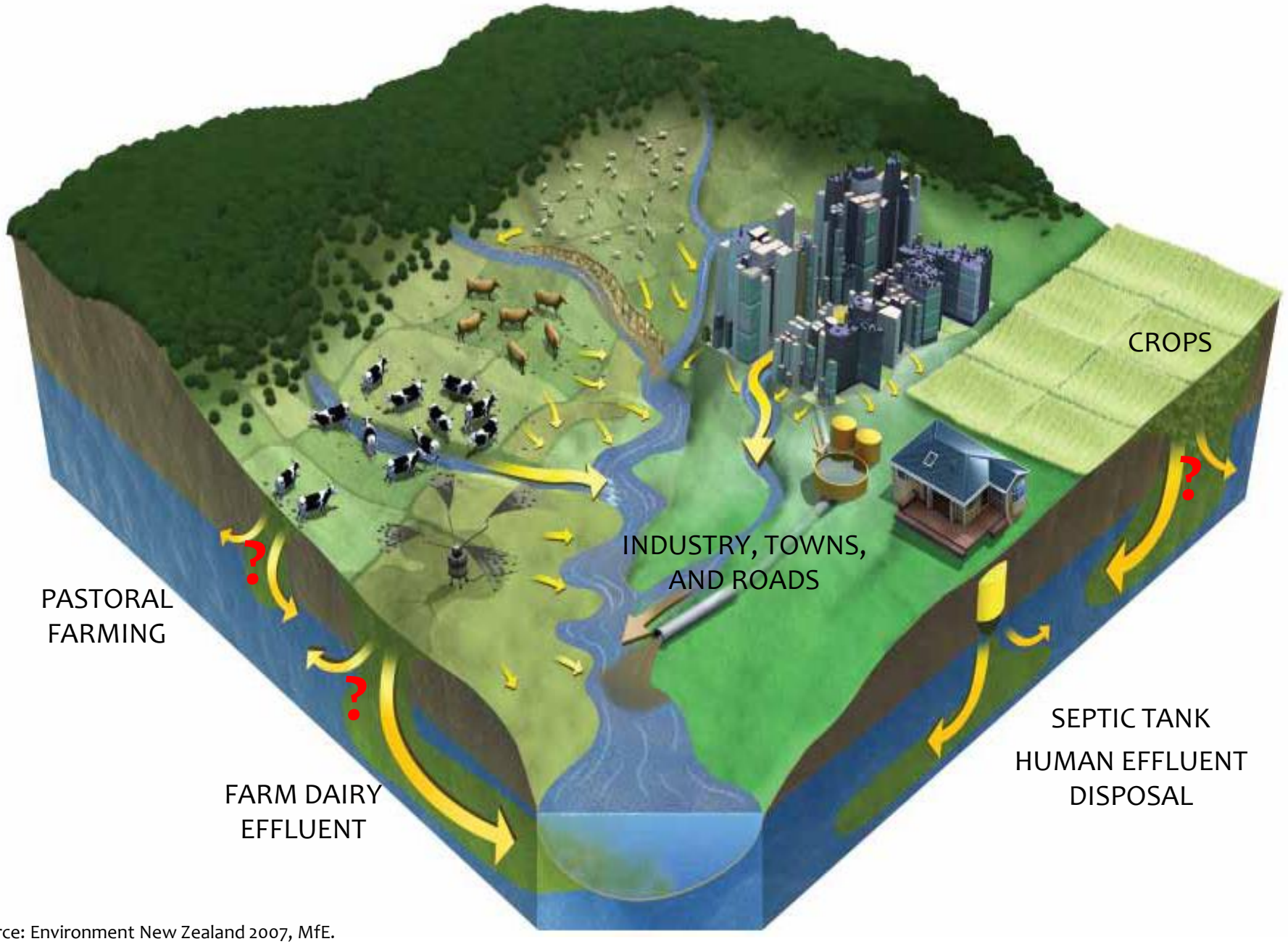
Source: Roygard et al., 2015



Source: Roygard et al., 2015

Reduce Negative Environmental Impacts – Improve Water Quality

Sources and contributions to nutrient loadings?



Source: Environment New Zealand 2007, MfE.

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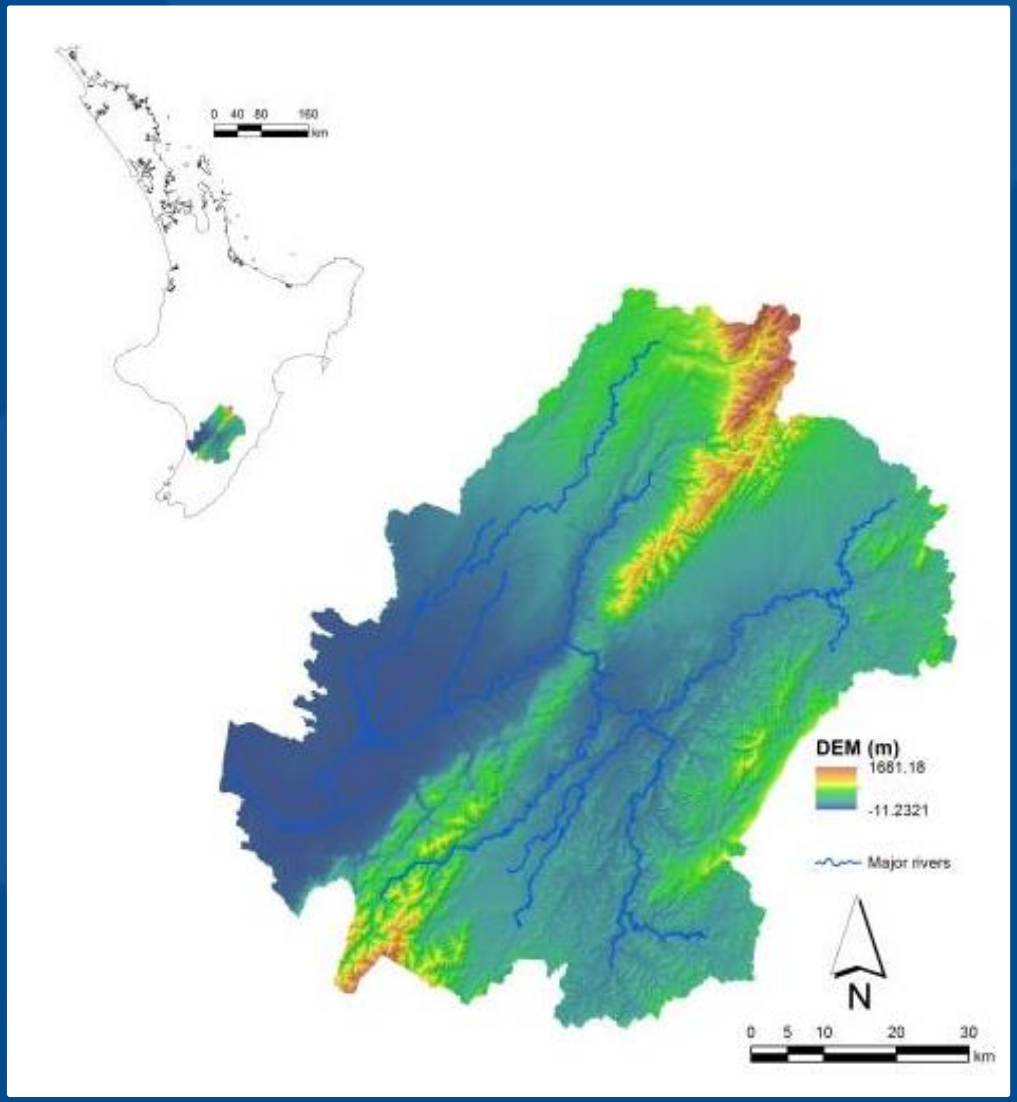
Study Area

Manawatu River catchment

- High nitrogen concentrations in surface waters
- > 95% of nitrogen load comes from agricultural areas
- Lack of understanding of nitrogen transport and transformation in the subsurface environment



Study area and experimental sites

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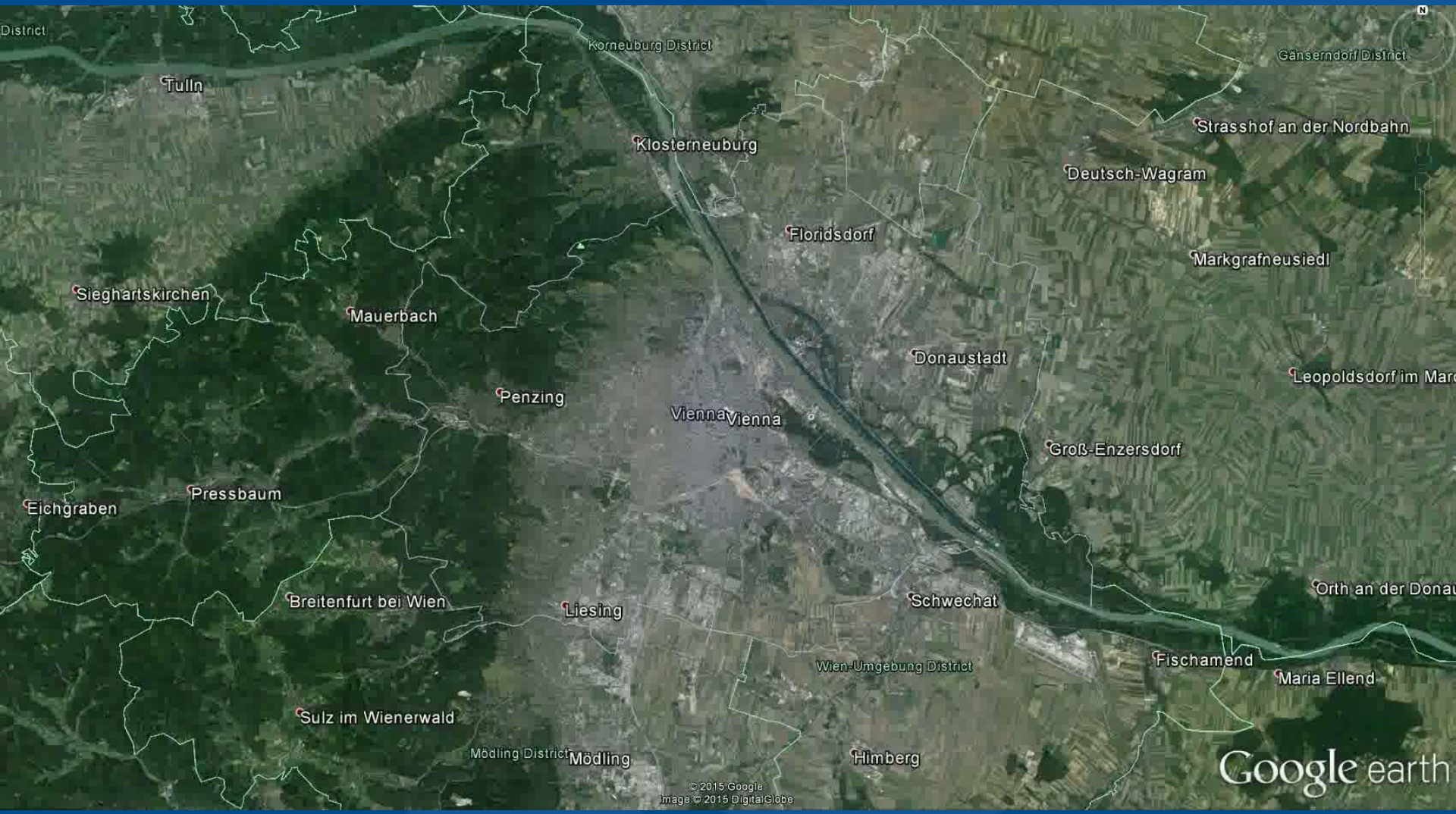

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Nitrogen (N) attenuation factor

N attenuation factor (AF_n)

$= (N_{rootzone} - N_{river}) / N_{rootzone}$

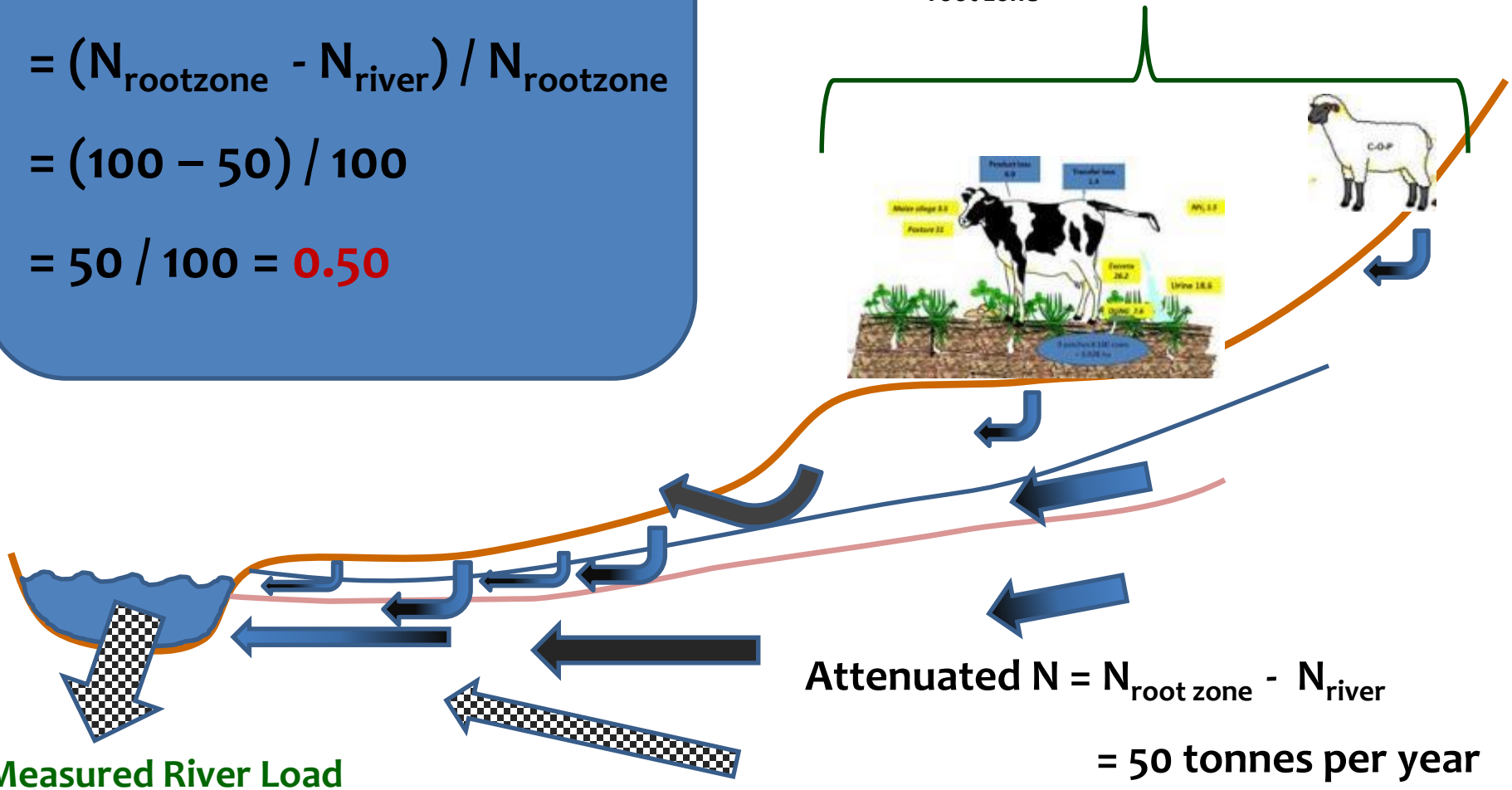
$= (100 - 50) / 100$

$= 50 / 100 = 0.50$

OVERSEER®

Predicts catchment N loss from Root zone

$N_{root\ zone}$ = 100 tonnes per year



Attenuated N = $N_{root\ zone}$ - N_{river}

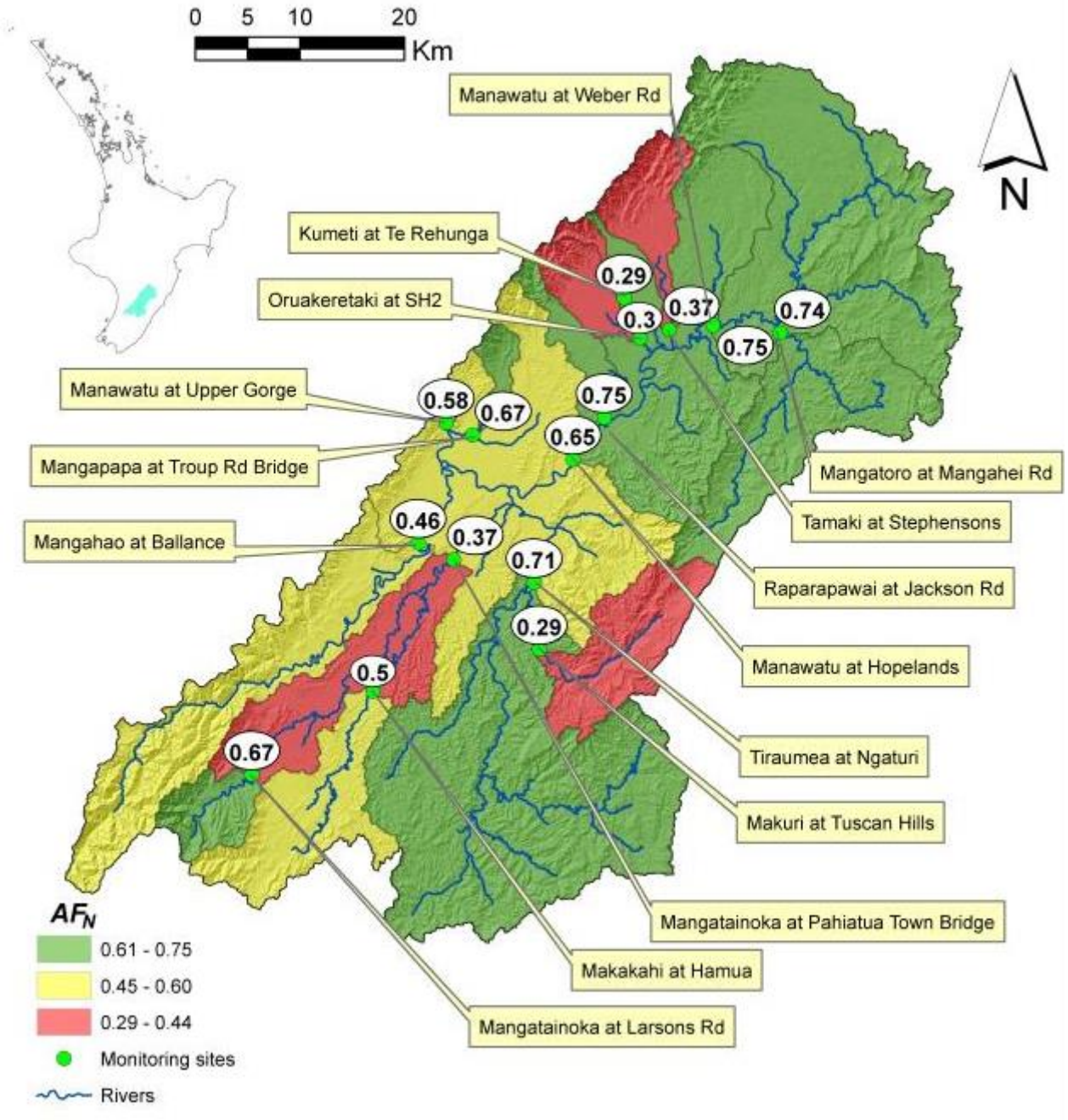
= 50 tonnes per year

Measured River Load

N_{river} = 50 tonnes per year

Source: Singh et al., 2014

Map of N attenuation factors* – Tararua GWMZ, Manawatu



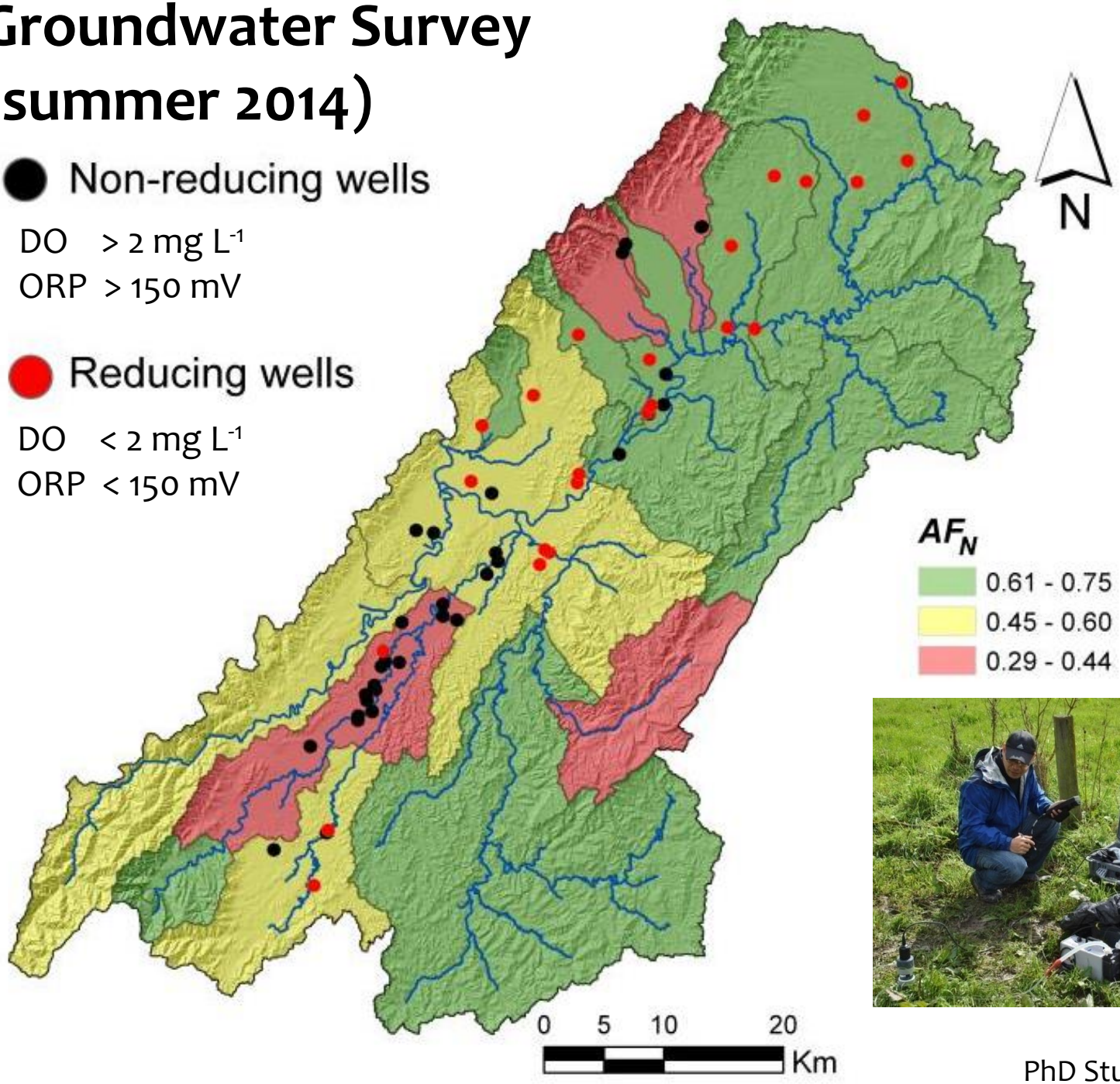
'0' - indicates no nitrogen reduction,

'1' - indicates 100% nitrogen reduction

* Indicative assessment based on the OVERSEER predicted average nitrogen leaching rates (kg ha^{-1} yr^{-1}) from the major landuses, and measured average nitrogen load (kg yr^{-1}) in river is the sub-catchments.

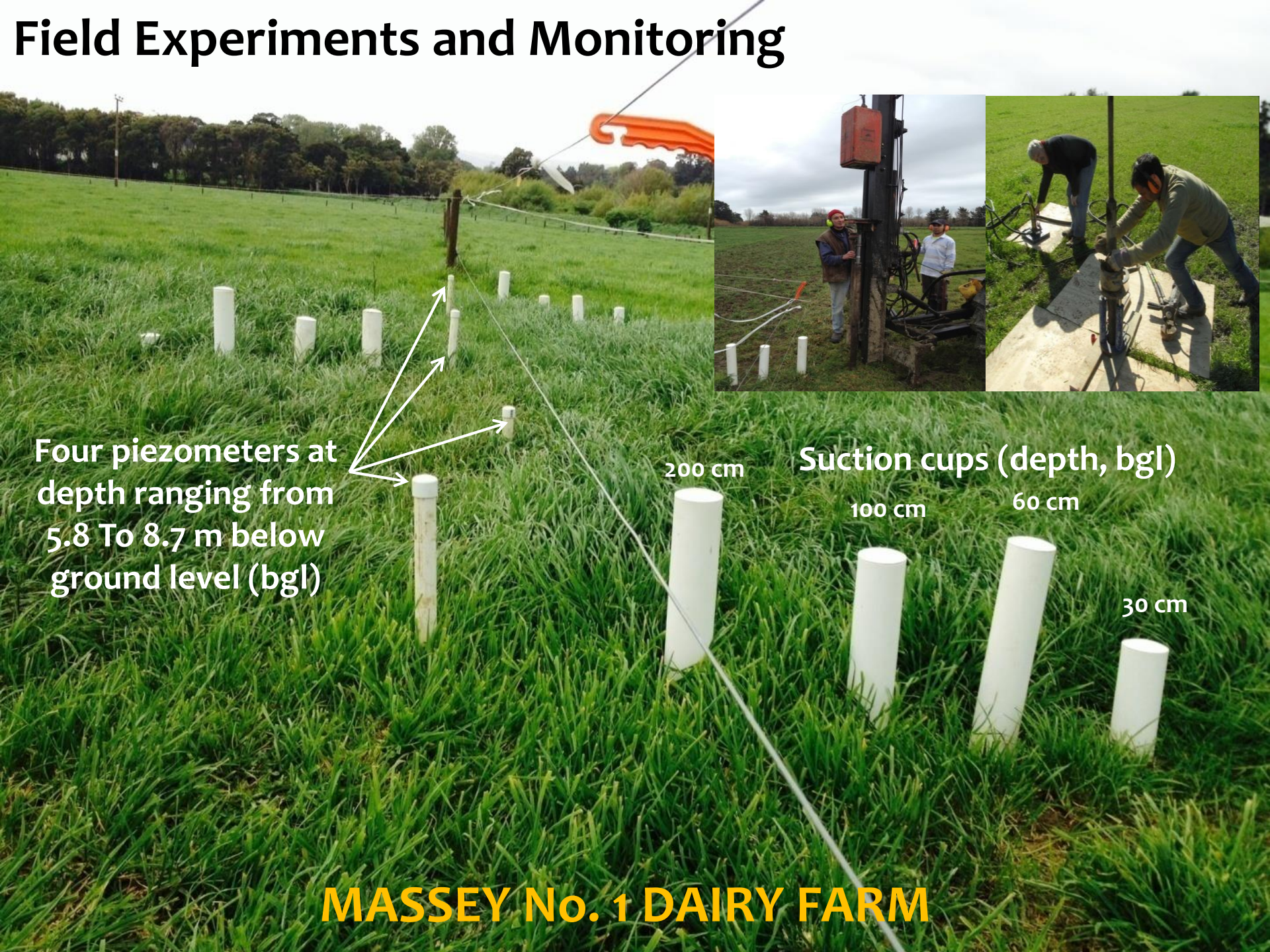
Source: Ahmed Elwan, PhD Student, Massey University

Groundwater Survey (summer 2014)

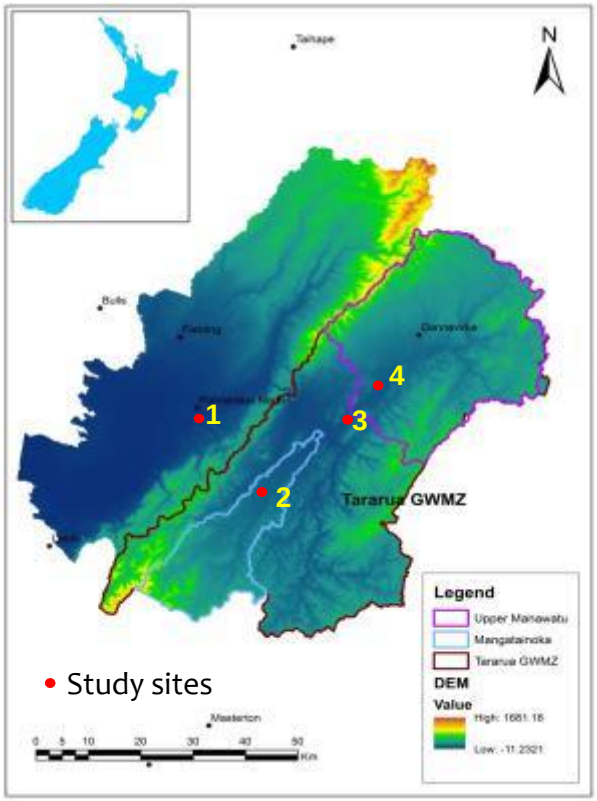


Source: Aldrin Rivas,
PhD Student, Massey University

Field Experiments and Monitoring



Field Experiments and Monitoring

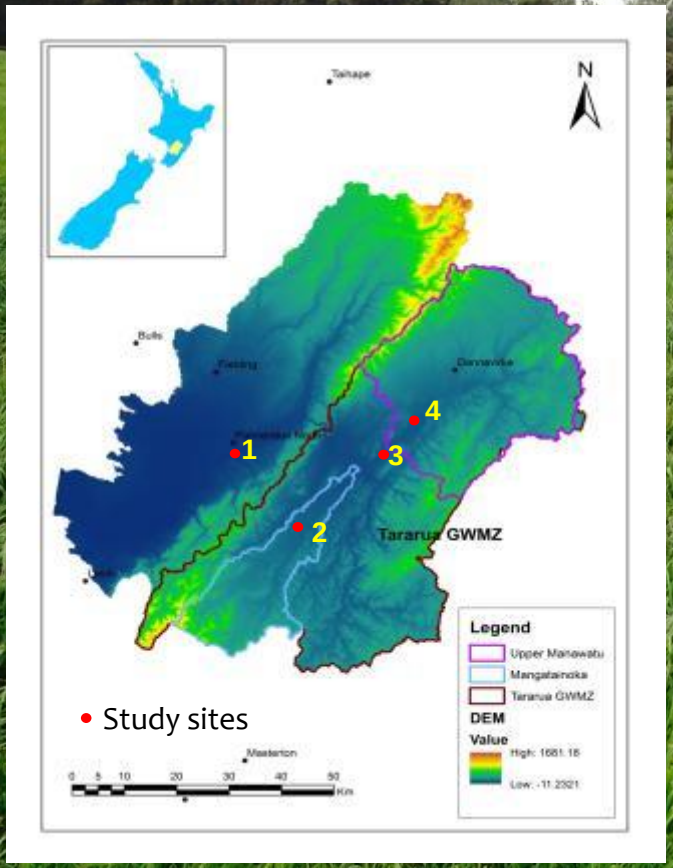


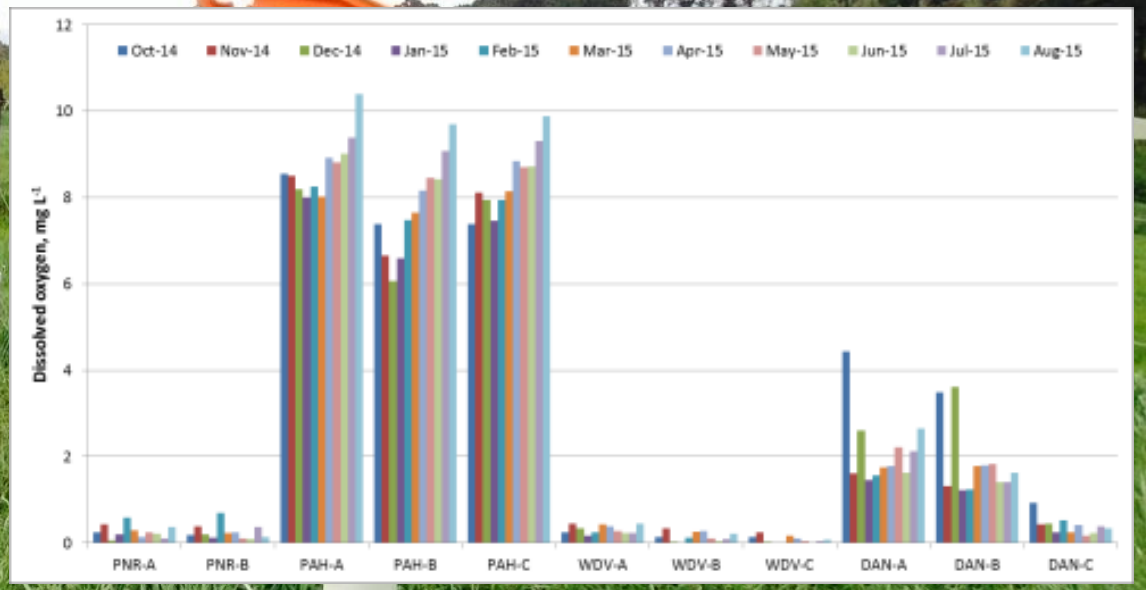
1. Massey No. 1 Dairy Farm
2. Pahiatua site
3. Woodville site
4. Dannevirke site

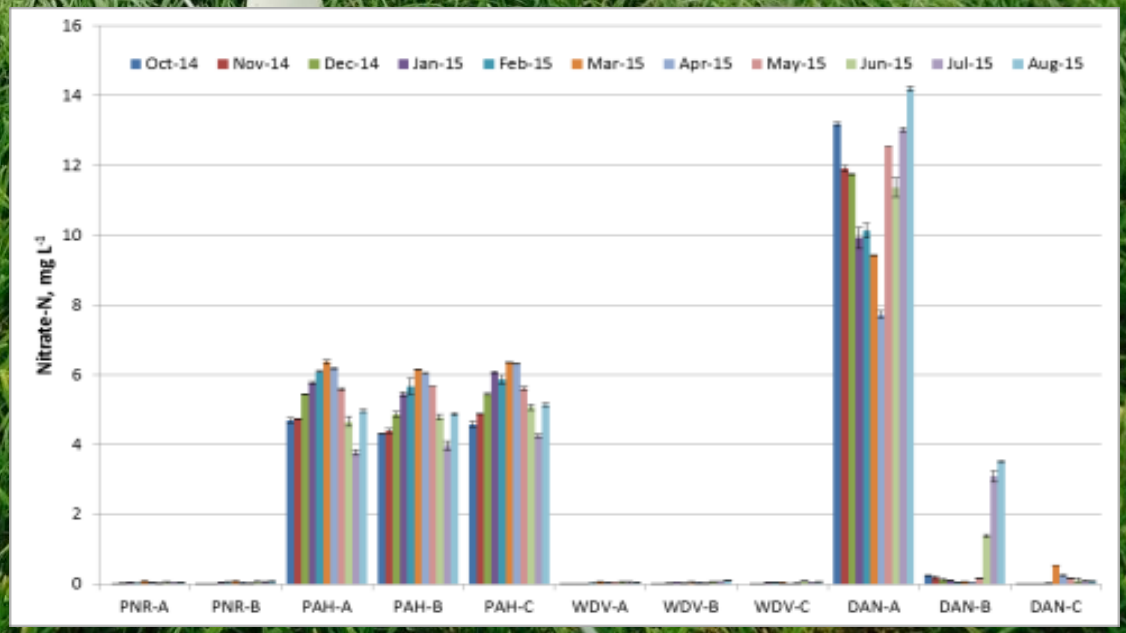
Site	Land use	Depth of piezometers (m bgl)	Rock type	Soil series and type
1	Dairy	6.5 7.5	Al	Manawatu fine sandy loam
2	Dairy	4.4 5.4 6.4	(Lo)/Gr	Kopua stony silt loam
3	Beef and sheep	5.0 6.0 7.5	Al	Kairanga silt loam and clay loam
4	Dairy	4.5 6.0 7.5	Al (OR Lo/Gr?)	Kairanga silt loam and clay loam (OR Takapau silt loam?)

Source: Aldrin Rivas,
PhD Student, Massey University

Field Experiments and Monitoring

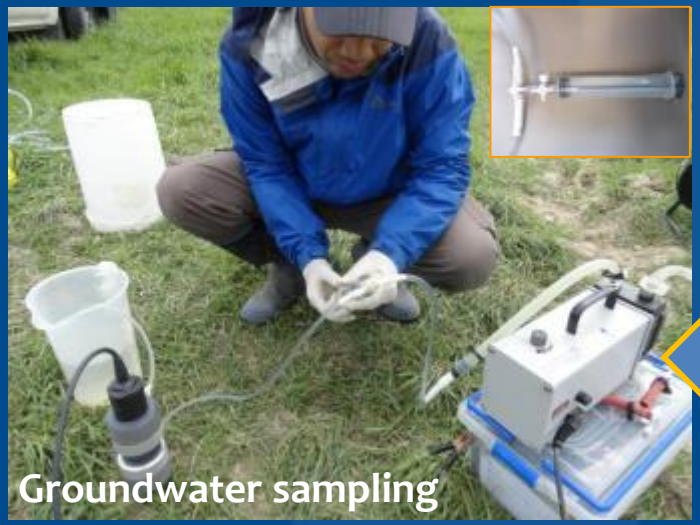




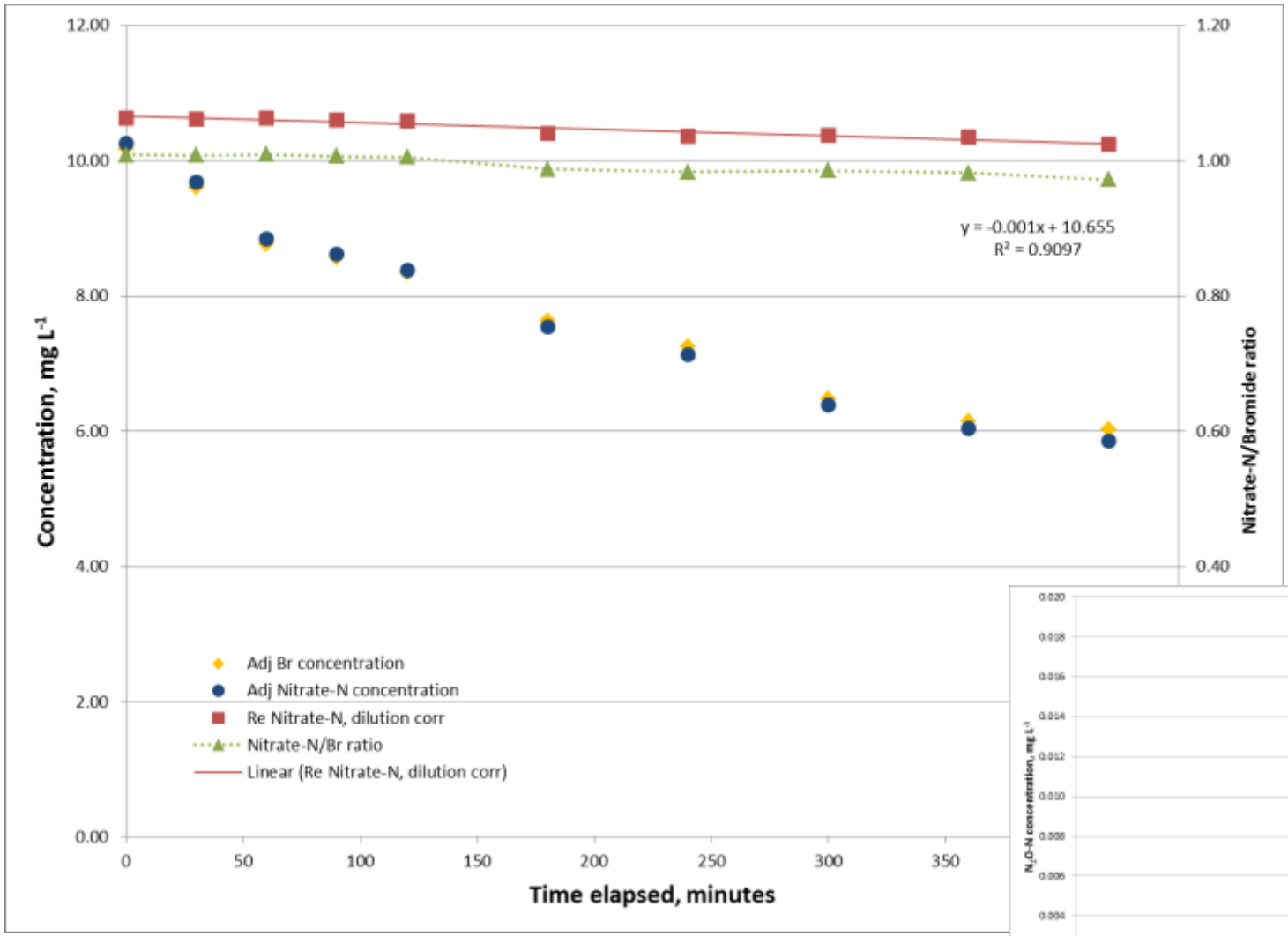


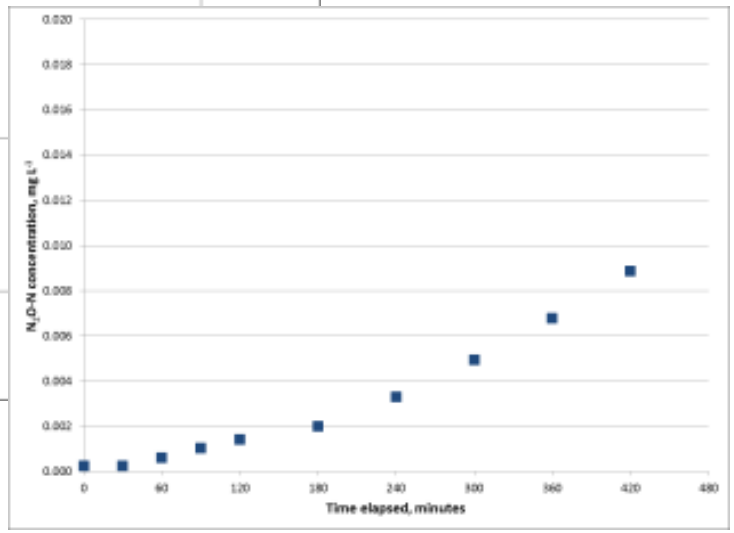
Source: Aldrin Rivas,
PhD Student, Massey University

Single Well 'Push-Pull' Tests:



Single Well 'Push-Pull' Test at Woodville site



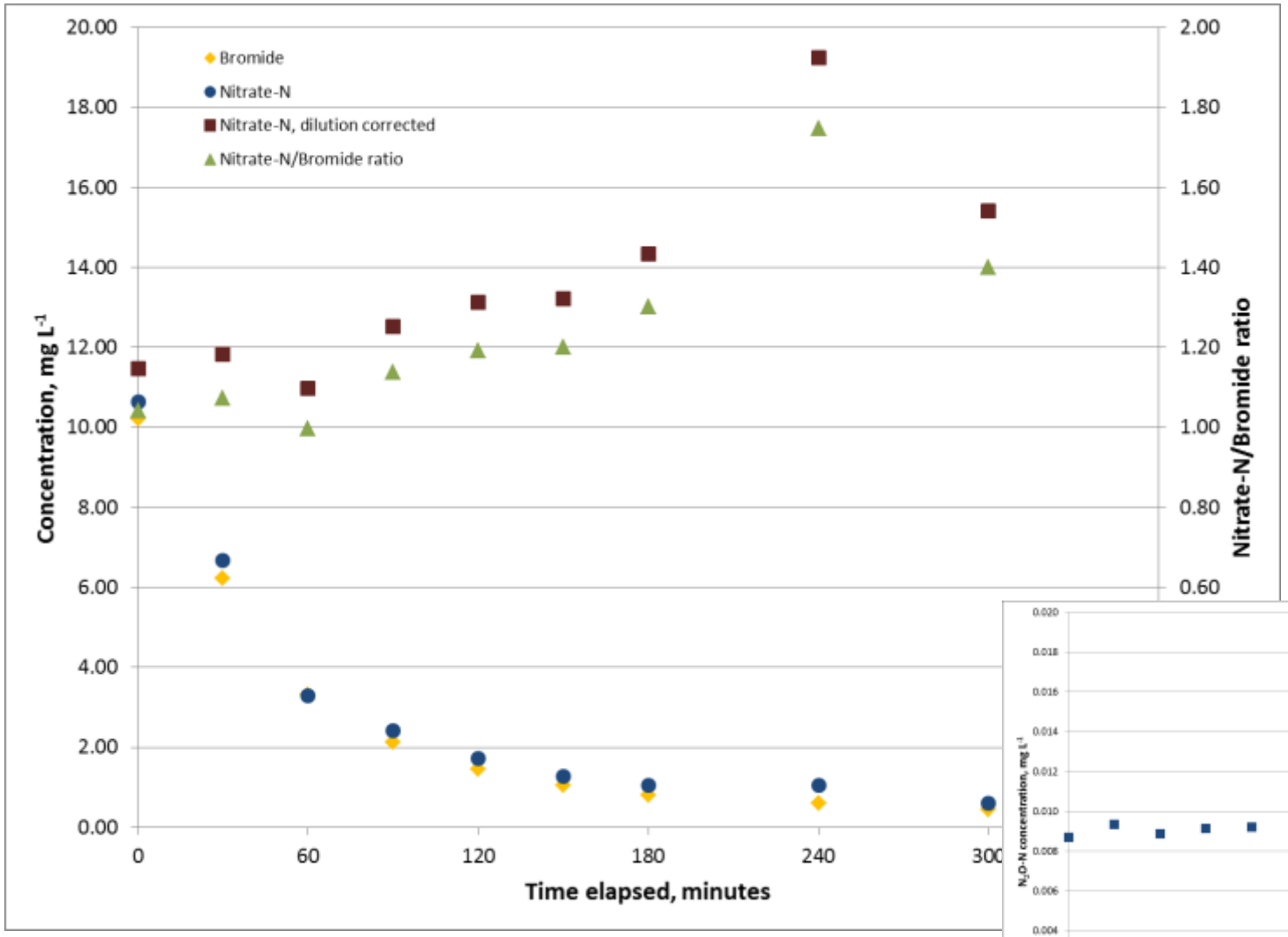


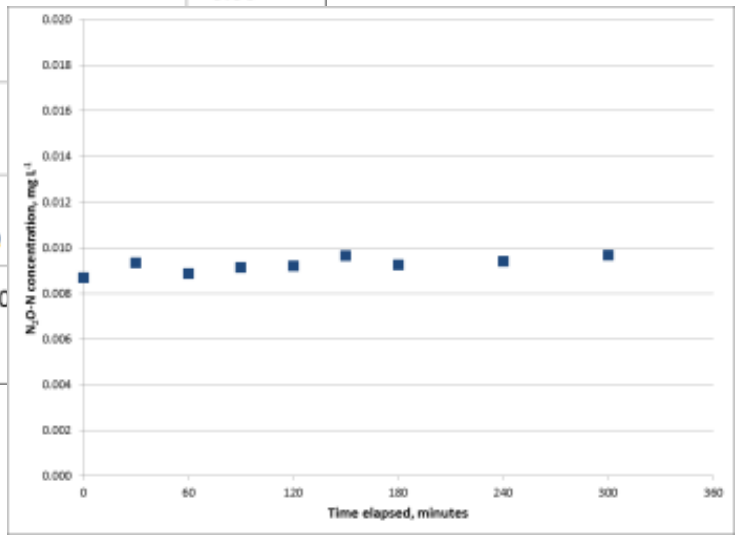
Push-pull test C

Test solution volume: 100 L
Target concentrations: 10 mg L^{-1} Br^-; 10 mg L^{-1} NO_3^--N; 50 ml L^{-1} acetylene
Test duration: 7 hours; JANUARY 2015

Source: Aldrin Rivas,
PhD Student, Massey University

Single Well 'Push-Pull' Test at Pahiatua site





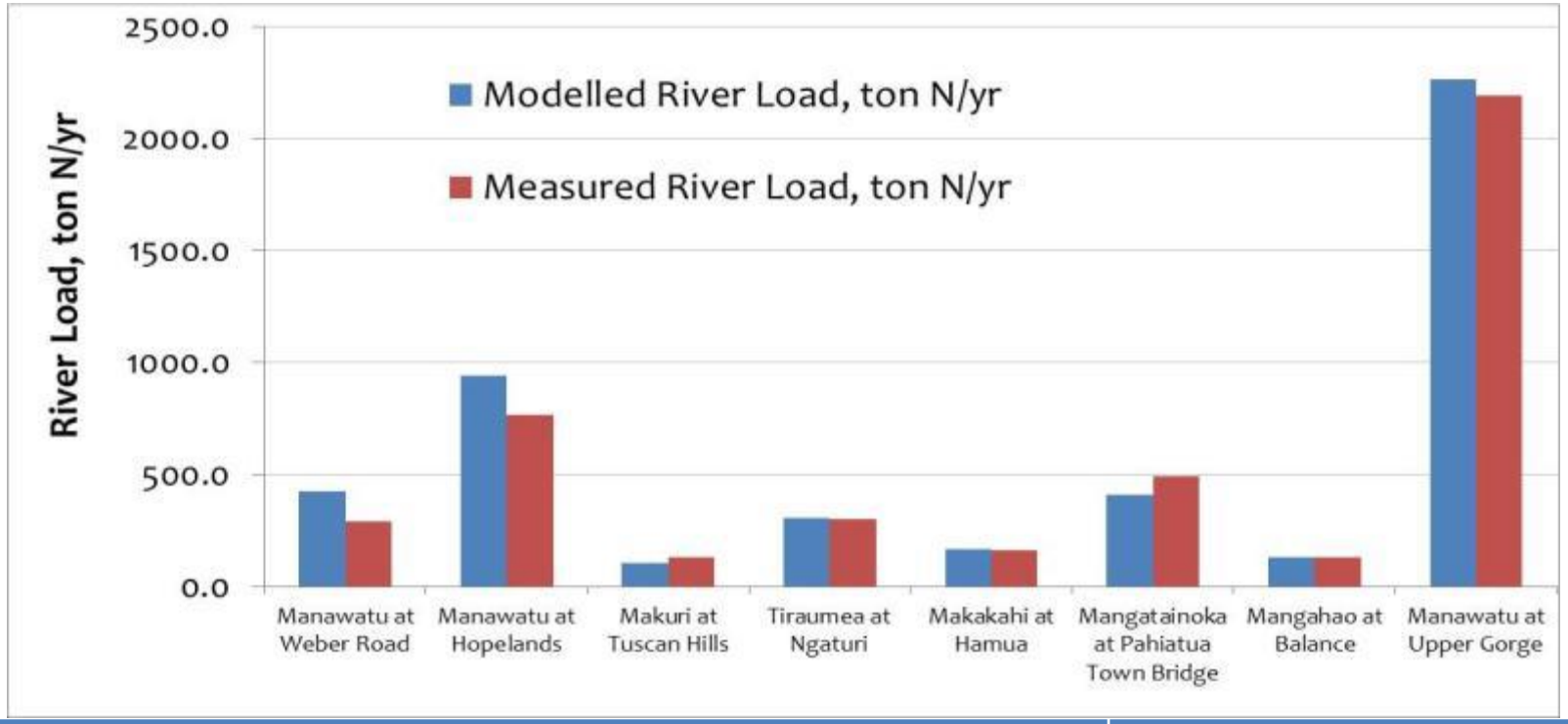
Push-pull test A

Test solution volume: 60 L
Target concentrations: 10 mg L^{-1} Br^-; 10 mg L^{-1} NO_3^--N; 50 ml L^{-1} acetylene
Test duration: 5 hours; MARCH 2015

Source: Aldrin Rivas,
PhD Student, Massey University

Research hypothesis - A preliminary hydrogeologic based model to predict river nitrogen loads

$$River\ N\ load = \sum LU\_RT\_Area * Ave\ RZLeaching_{LU} * AFn_{RT}$$



Main Rock Types	Assigned *AFn*
Gravels, Greywacke, Conglomerate, Coquina, Limestone	Low (~0.20-0.30)
Debris, Sandstone	Medium (~0.50-0.60)
Gravels (with mud, peat or lignite), Mudstone, Claystone	High (~0.90)

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Concluding Remarks

Our monitoring, experiments and analysis for upper Manawatu River catchment suggests that

- ✓ **nitrogen loads measured in the river are significantly smaller than the estimates of nitrogen leached from the root zone;**
- ✓ **denitrification in subsurface environment appears as a key NO_3-N attenuation process in the catchment;**
- ✓ **this nitrogen attenuation capacity appears to vary among the sub-catchments of the catchment.**

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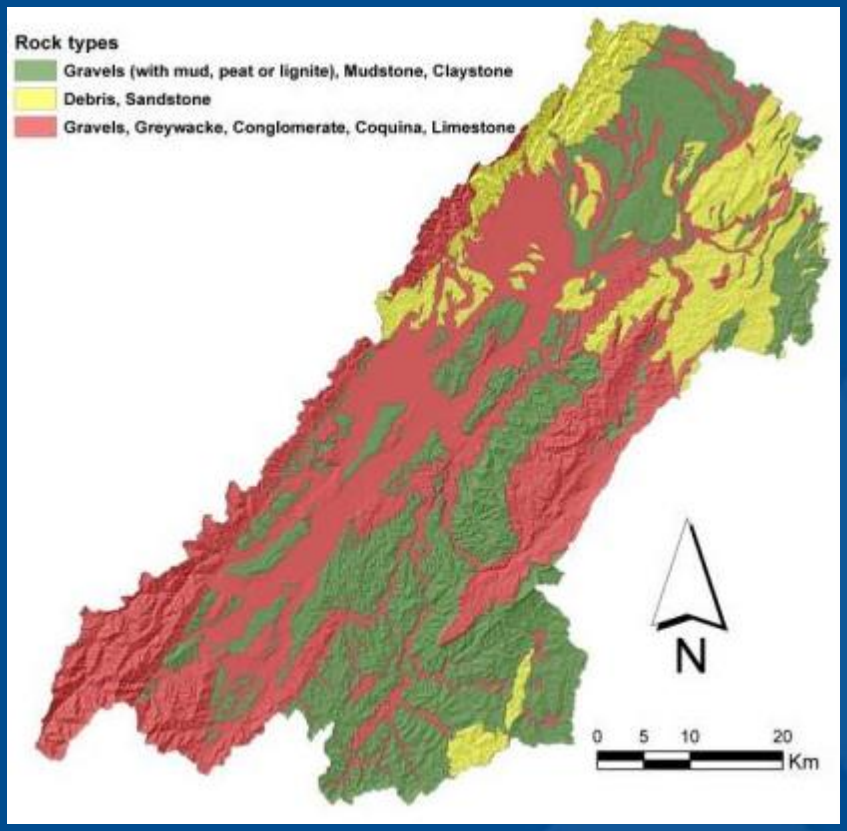
Concluding Remarks



Upper Manawatu River Catchment, New Zealand

Nitrogen Attenuation Capacity		Targeted investment in solutions, e.g.
Green	**> 80 % N reduction**	**High Capacity Areas:** Sustainable Land Use Intensification
Yellow	**50 – 80 % N reduction**	**Medium Capacity Areas:** Reduce Nitrogen Leaching via Best Effluent and Nutrient Management Practices
Red	**< 50 % N reduction**	**Low Capacity Areas:** Duration controlled grazing Cut and Carry Systems

Acknowledgements

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This funding and in-kind support is greatly appreciated.