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# Do metal mixture insults to the soil invisible majority reduce ecosystem service quality?

Awuah, K.

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<http://hdl.handle.net/10388/8742>

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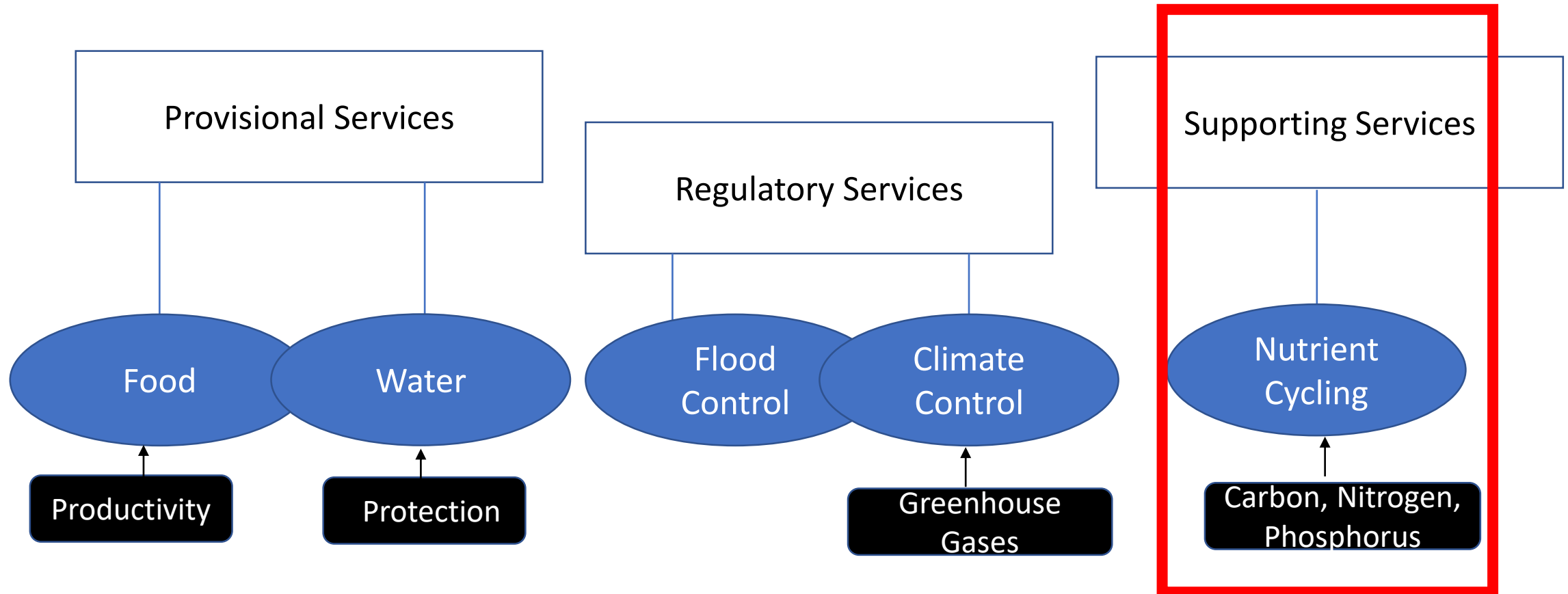


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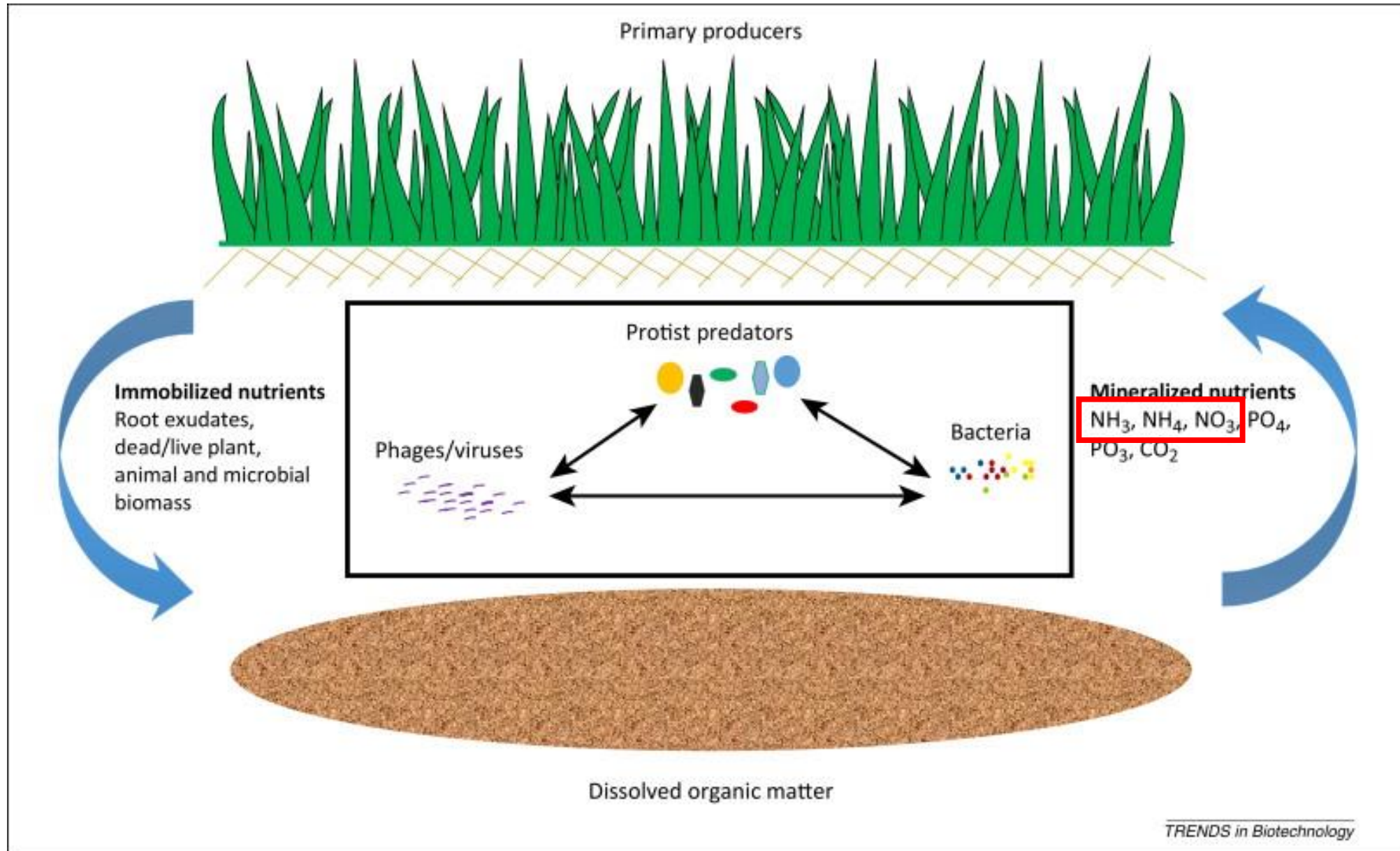
**Kobby Awuah**  
Dr. B. Hale  
Dr. S. Siciliano

# Ecosystem Services

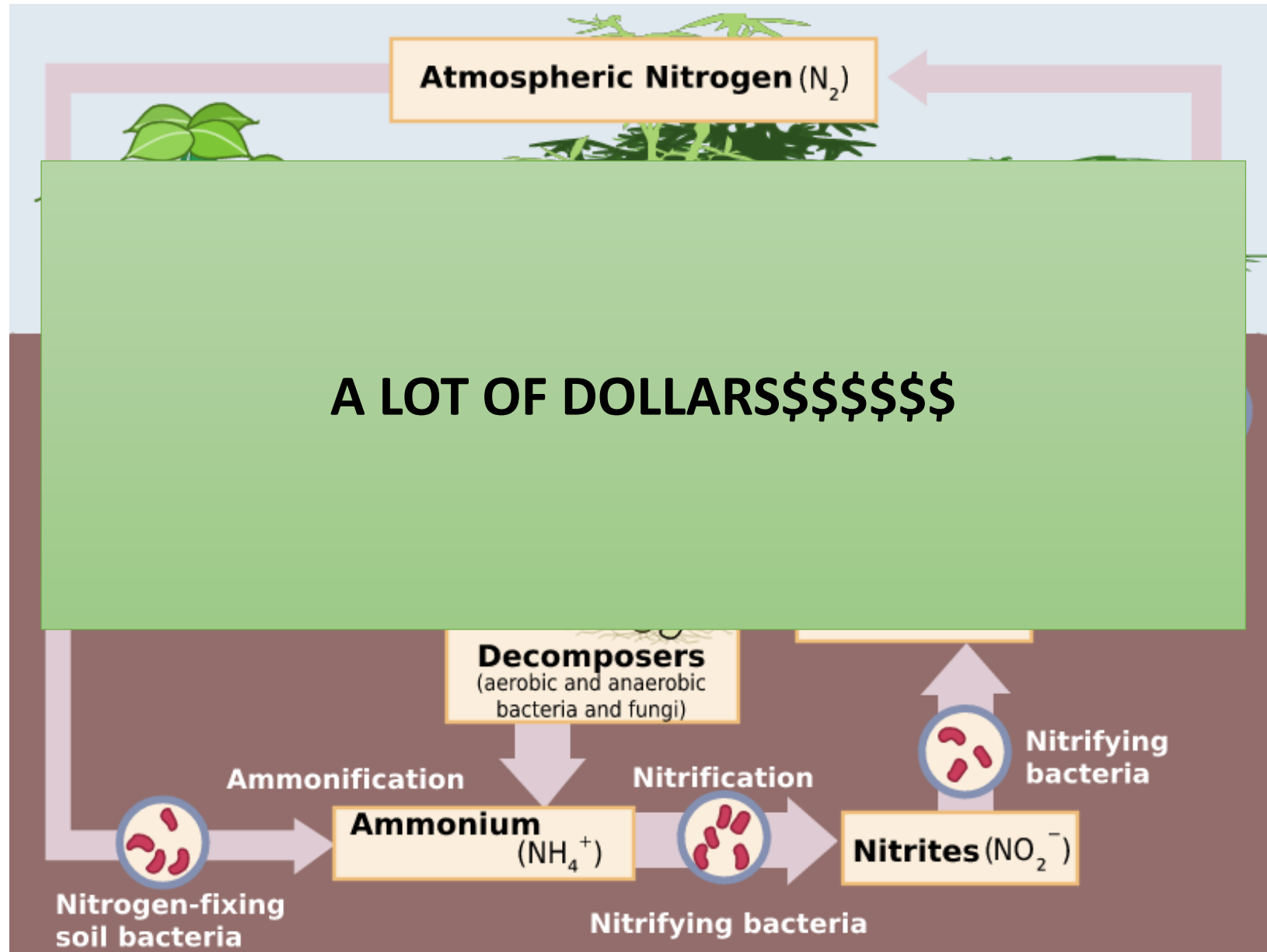
- Ecosystem services: As defined by the United Nations Environmental Program (UNEP) are the benefits people obtain from ecosystems.



# Nutrient Cycling as an Ecosystem Services (ES)

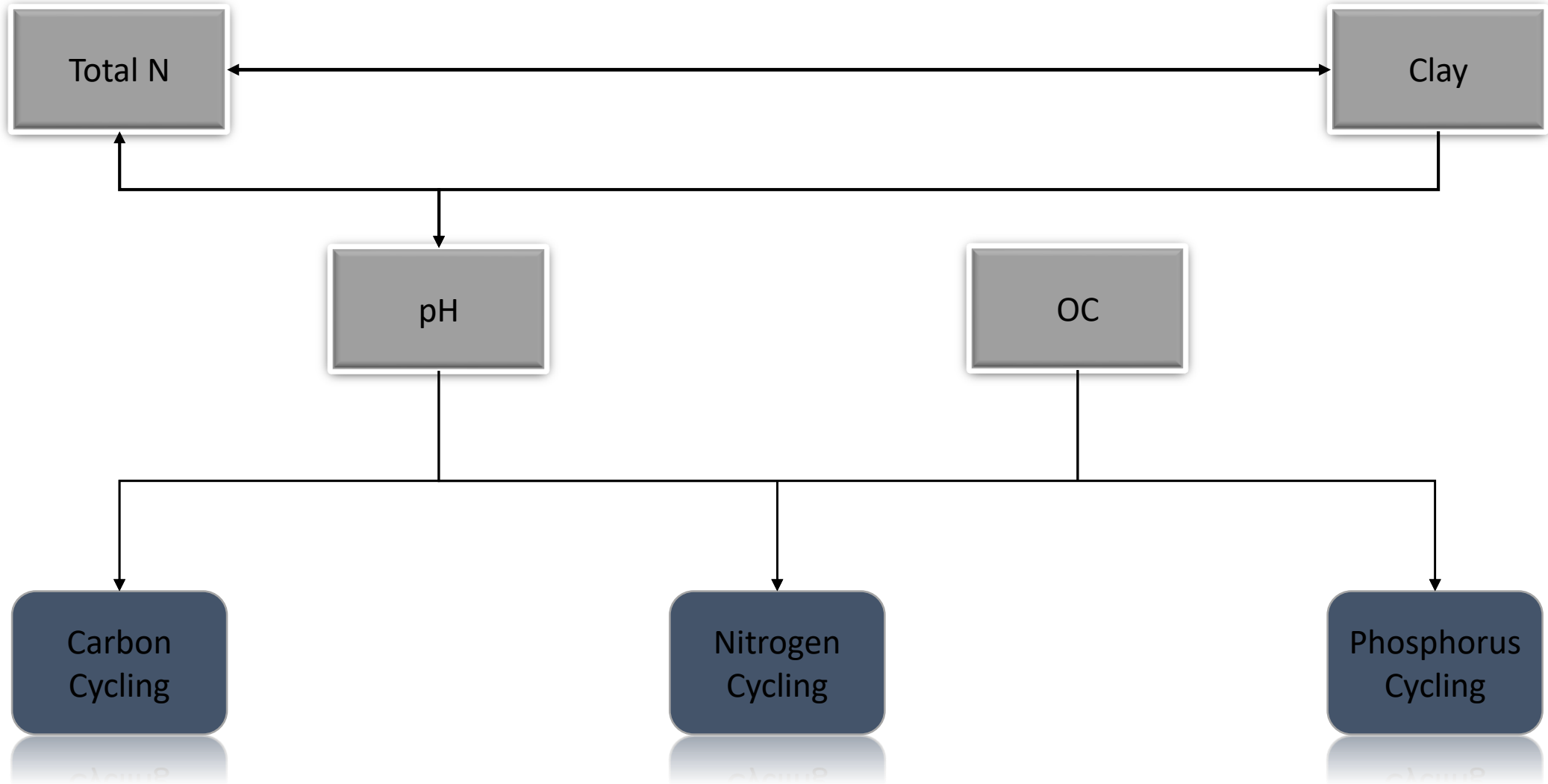


# Nitrogen Cycle



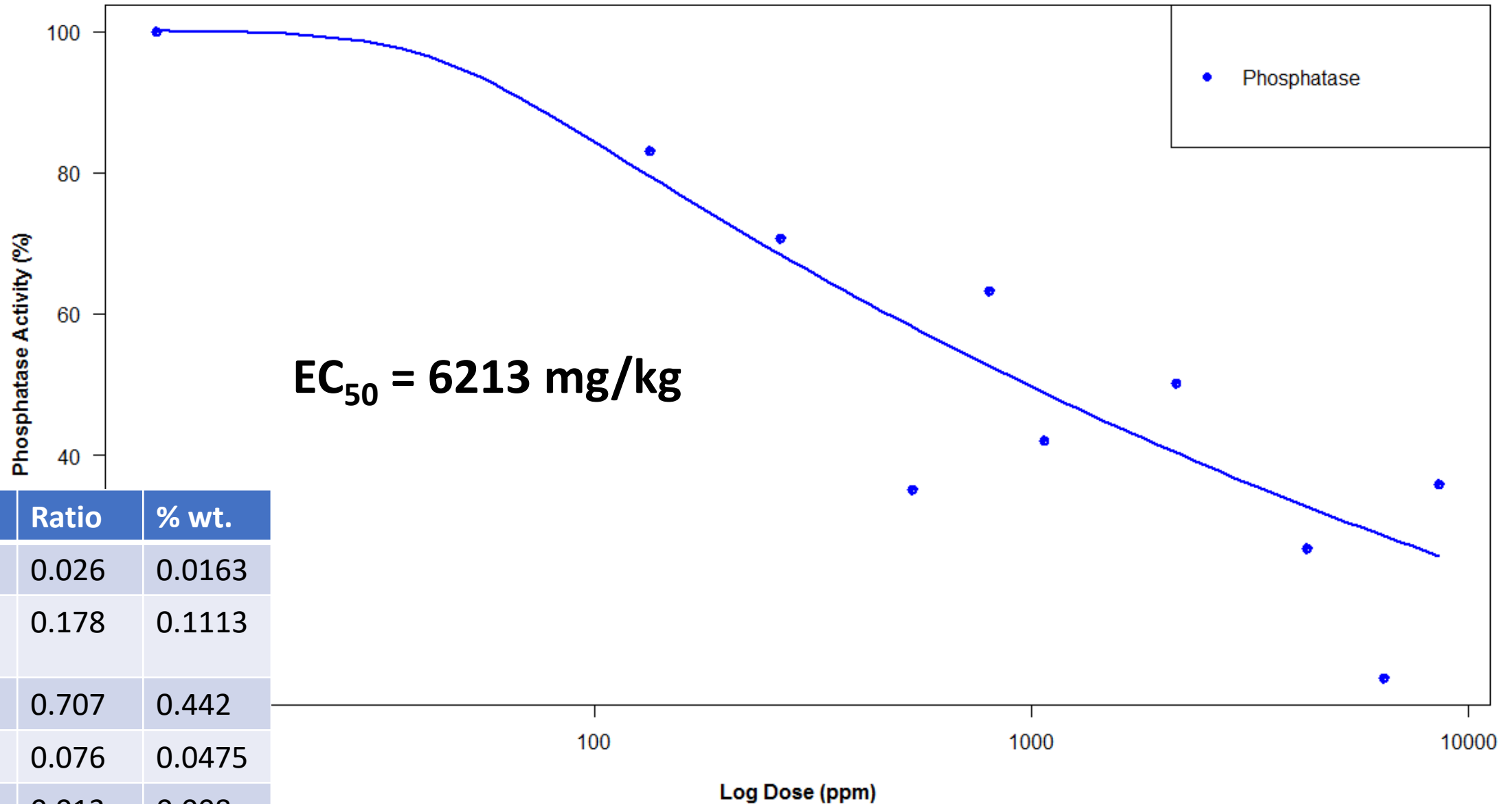
What is the economic value of these services?

# Relationship between soil properties vs Ecosystem Services



# Metals inhibit soil enzymatic activities

## Phosphatase Dose Response



**EC<sub>50</sub> = 6213 mg/kg**

Metal	Ratio	% wt.
Lead	0.026	0.0163
Copper	0.178	0.1113
Nickel	0.707	0.442
Zinc	0.076	0.0475
Cobalt	0.013	0.008

# Objective and Hypothesis Testing

- **To determine whether sub lethal metal mixture concentrations to soil microbes impair ecosystem service quality.**

**$H_0$ : Sub lethal metal mixture concentrations to soil microbes do not impair ecosystem service quality.**



# Materials and Methods

- 47 Soils with varying properties.
- Representing different Canadian ecological zones.

Soil Properties	pH	%Clay	%OC	Total-N mg/10cm <sup>2</sup> /24h
Average	6.8	2.4	4.2	2.0
Standard Deviation	0.8	1.4	33.7	5.3

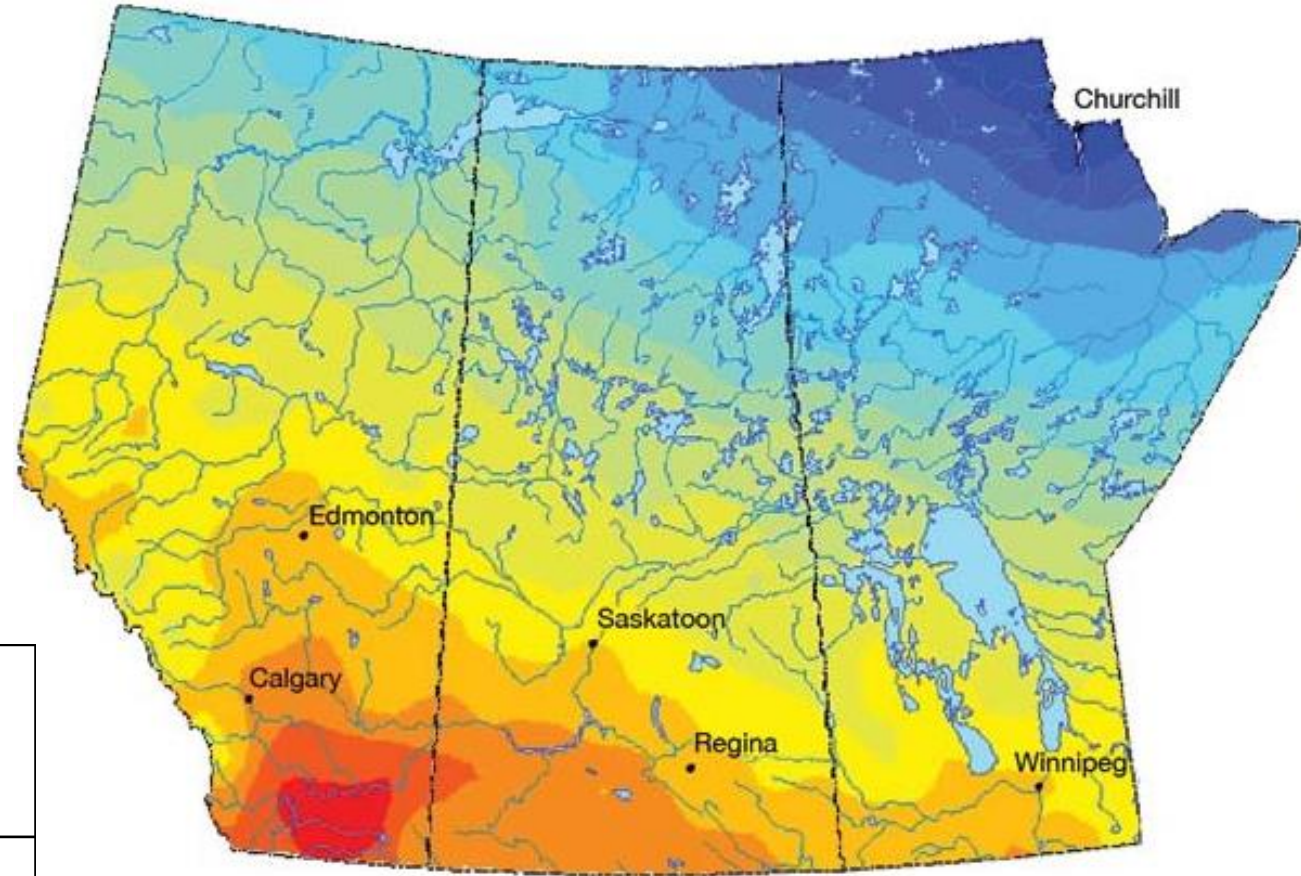


Fig. Map of Study Area

# Experimental Design

Metal	% wt
Lead	0.0163
Copper	0.1113
Nickel	0.442
Zinc	0.0475
Cobalt	0.008

No Grass

*E. lanceolatus*

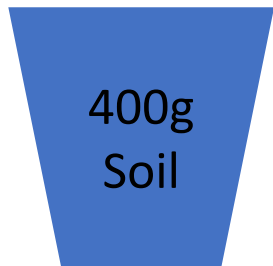
*E. lanceolatus*

0%

0%

0.625% wt

0.625% wt



A

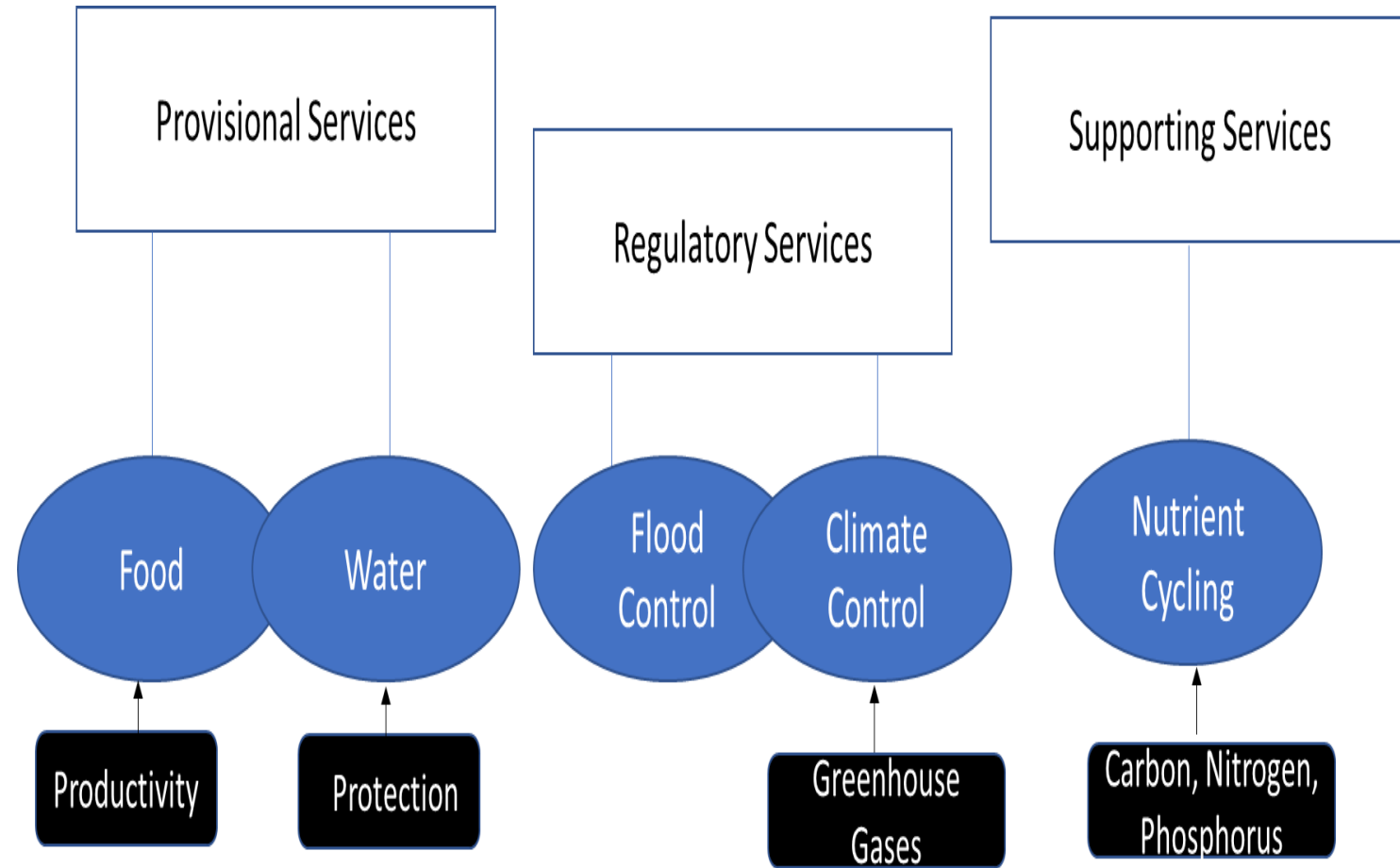
B

C

D

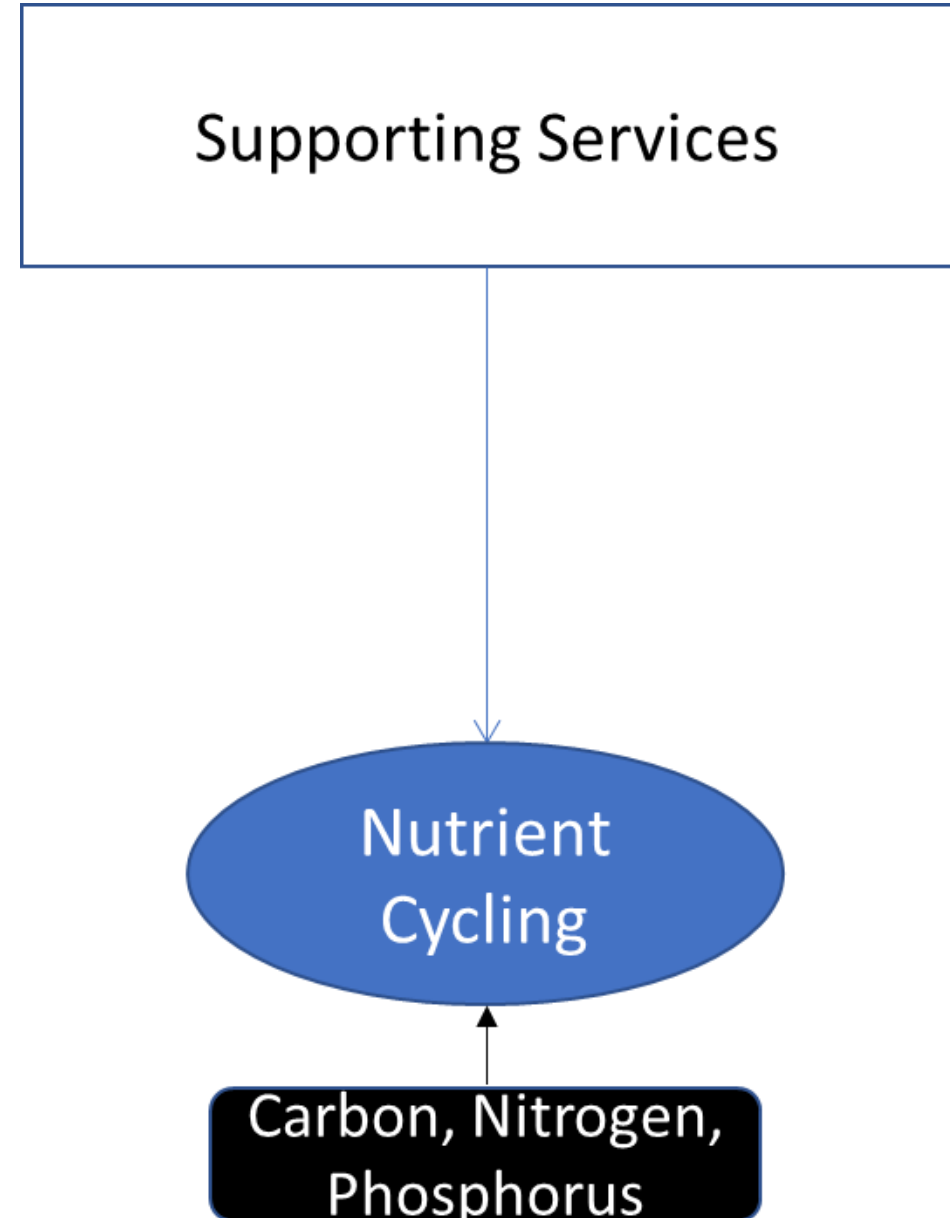
# Ecosystem Services Measured

- Ammonia monooxygenase activity (Nitrogen Cycling)
- Beta Glucosidase (Carbon Cycling)
- Acid phosphatase (Phosphorus Cycling)
- Plant crude protein (*E. lanceolatus*)
- Climate Regulation
- Groundwater Protection



# Ecosystem Services Measured

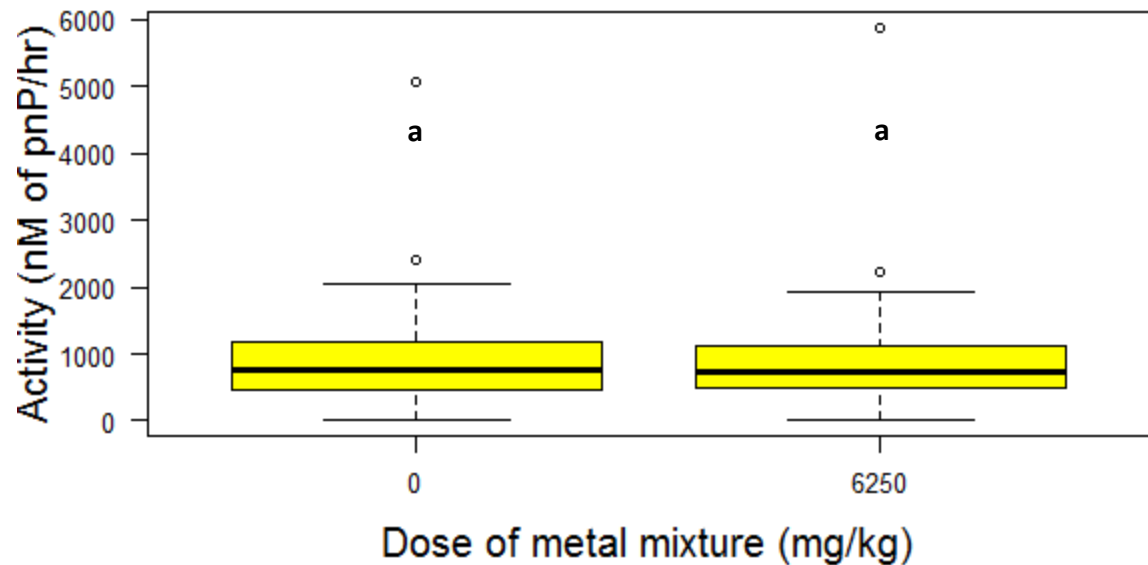
- Ammonia monooxygenase activity (Nitrogen Cycling)
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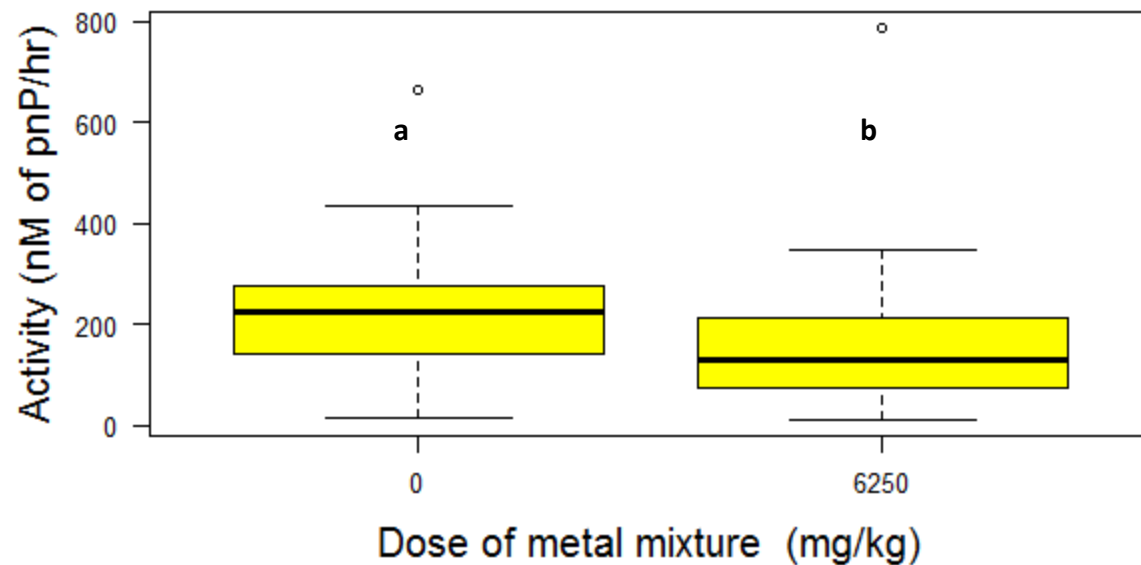
## **Results**

**Data was analyzed using R, Excel and Mplus  
(Structural Equation Modelling).**

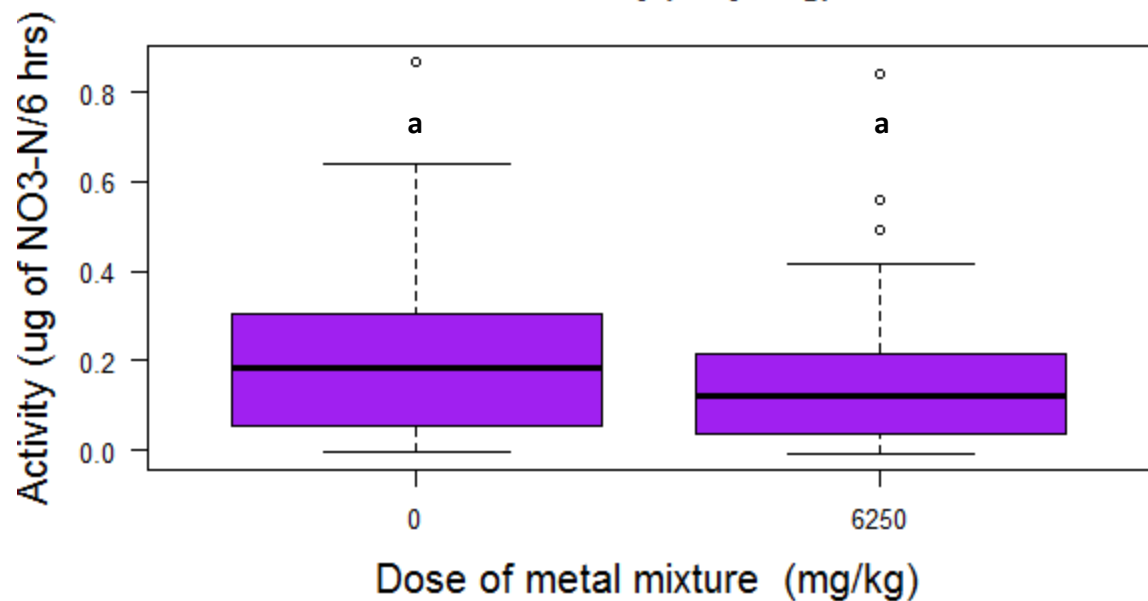
**Glucosidase Activity (C Cycling)**



**Phosphatase Activity (P Cycling)**

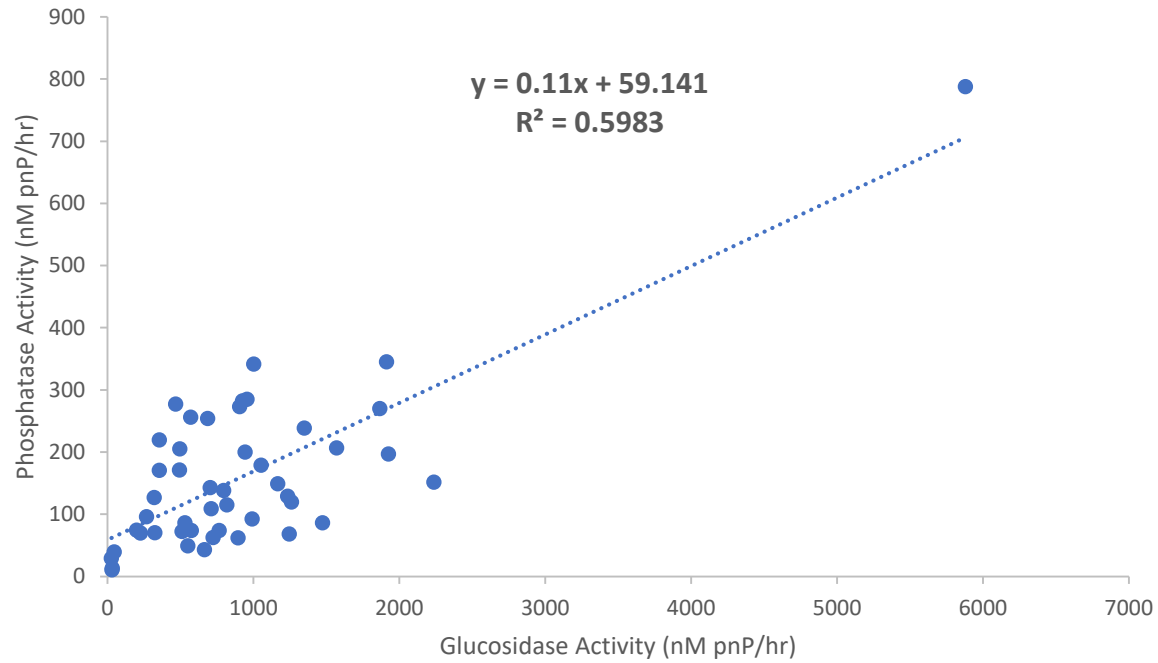


**AMO Activity (N Cycling)**

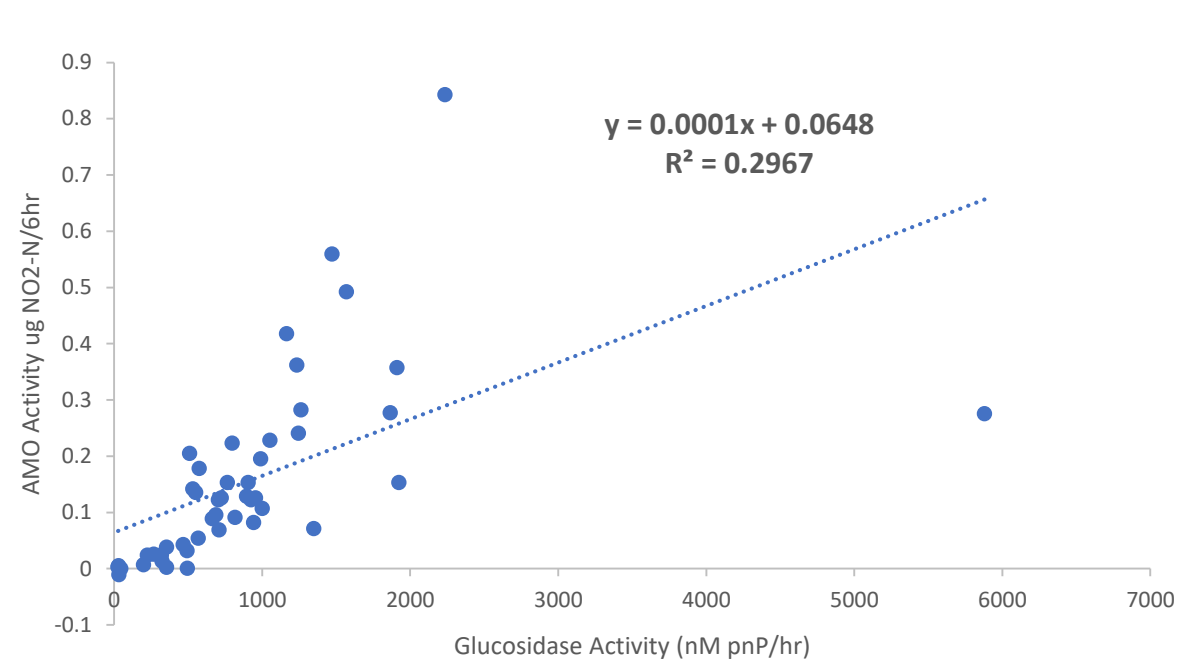


*p* value < 0.01

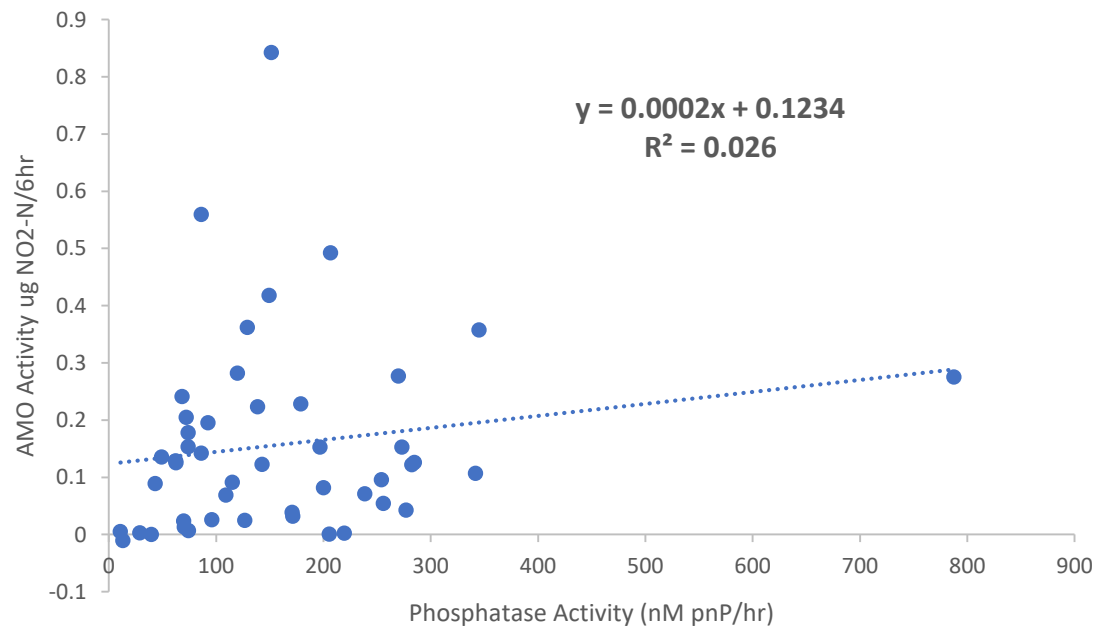
### Glucosidase vs Phosphatase Activity in Dosed soils



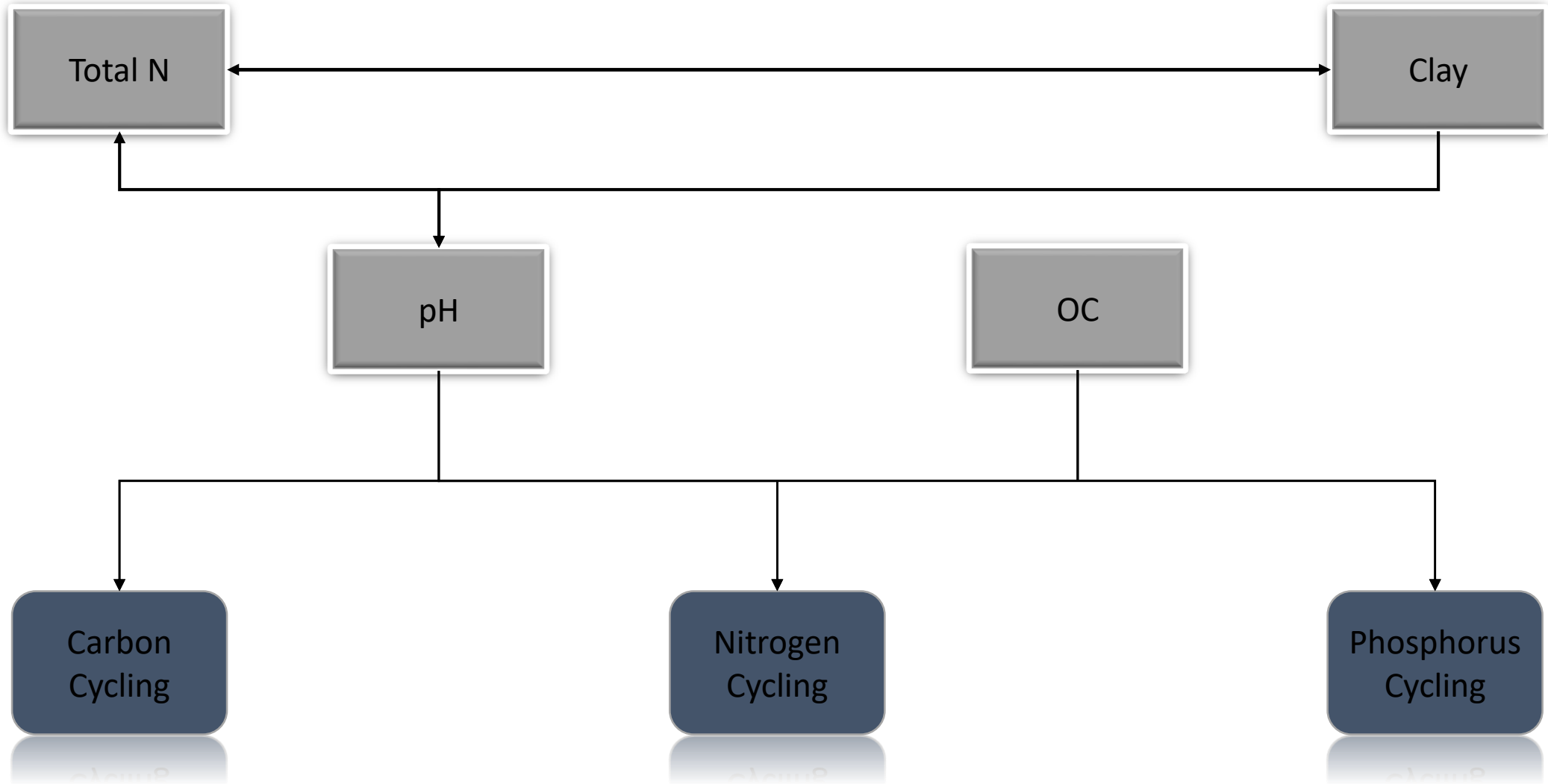
### Glucosidase vs AMO Activity in Dosed soils



### Phosphatase vs AMO Activity in Dosed soils



# Changes in conceptual model





# Models tested

- Compared differences in soils with and without metals.
- Compared differences in soils with and without grasses.
- Compared differences in soils with grasses -/+metals.

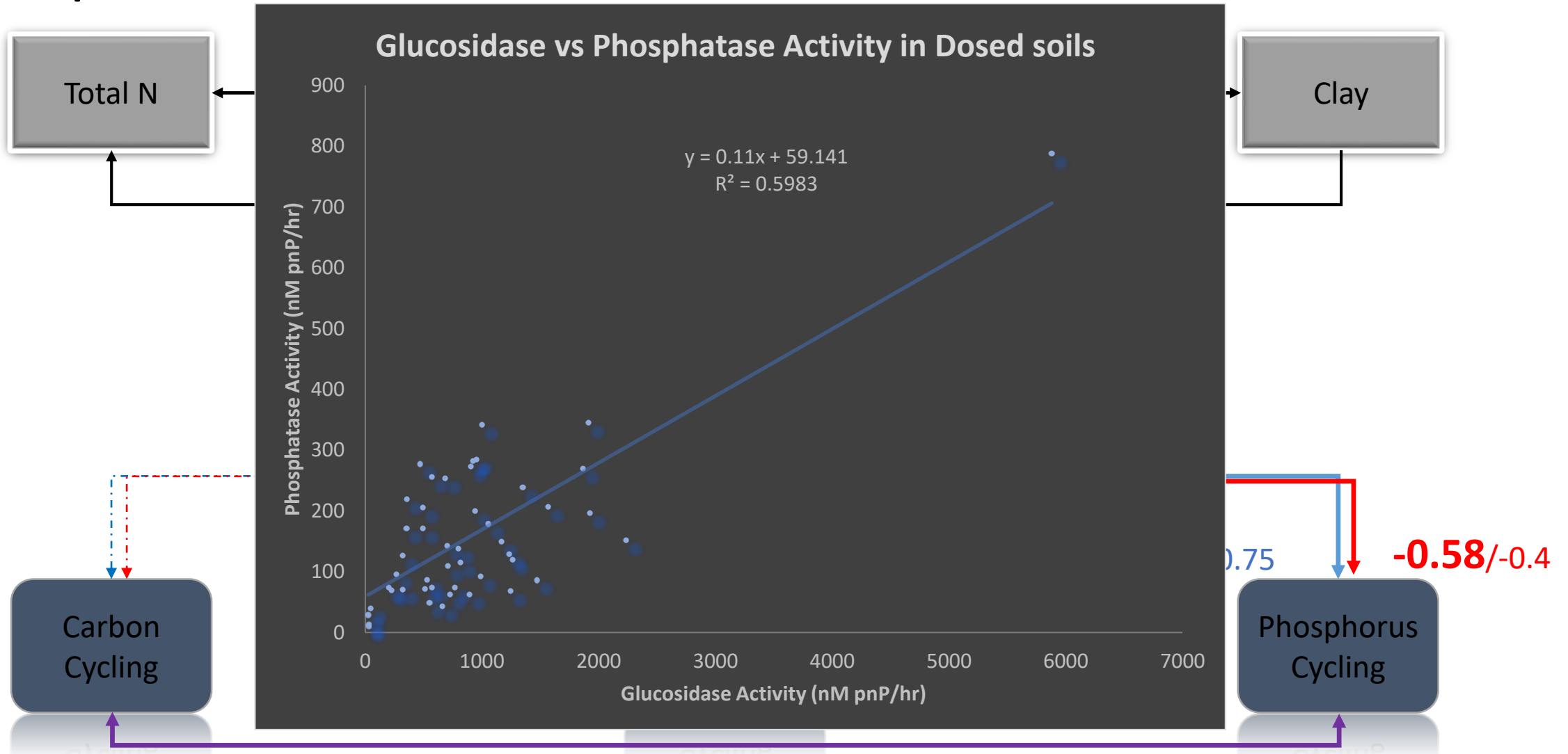
# Models tested

- ~~• Compared differences in soils with and without metals.~~
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# Models tested

- ~~• Compared differences in soils with and without metals.~~
- ~~• Compared differences in soils with and without grasses.~~
- Compared differences in soils with grasses -/+metals.

# Compares differences in soils with *E. lanceolatus* -/+metals



0.2/0.4

0.75 -0.58/-0.4

*p* value < .05

# Conclusions

- Metal mixtures reduce the quality of Ecosystem Services by;
  - ❑ increasing the relationship between pH and P cycling.
  - ❑ increasing the relationship between OC and P cycling.
  - ❑ increasing the co-relationship between P and C cycling.

# Acknowledgements



## Committee Members

- Dr. Steven Siciliano (Supervisor)
- Dr. Beverly Hale (Co-Supervisor)
- Dr. Derek Peak
- Dr. Tim Dumonceaux
- Dr. Gladys Stephenson
- Dr. David Janz (Graduate Chair)

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- Amanda Laird
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- Kayode Jegede
- Luba Vasiluk
- Mark Cousins
- Mathieu Renaud
- Siciliano Lab group

- Dr. Ryan Hangs



Questions?

**the face i make**

**when i see you leaving work earlier than me**