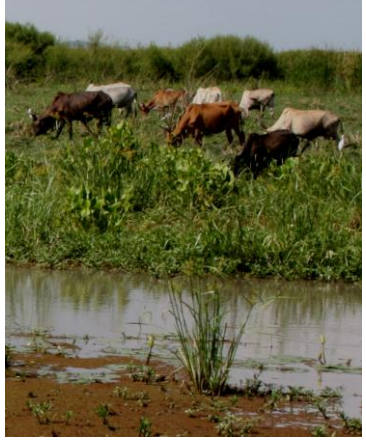




Controls of denitrification in papyrus wetlands in Kenya and Tanzania

Gretchen M. Gettel[1], Kuenzang Tshering[2], Hawa Nakitende[3]

[1]UNESCO-IHE, Institute of Water Education, Delft, The Netherlands
[2]Royal University of Bhutan, Thimphu, Bhutan
[3]National Water and Sewerage Corporation, Kampala, Uganda

UNESCO-IHE
Institute for Water Education

Ecosystem Services

How do we balance the competing demands for ecosystem services?

Figure from:
http://www.metrovancouver.org/planning/development/ecologicalhealth/Pages/default.aspx

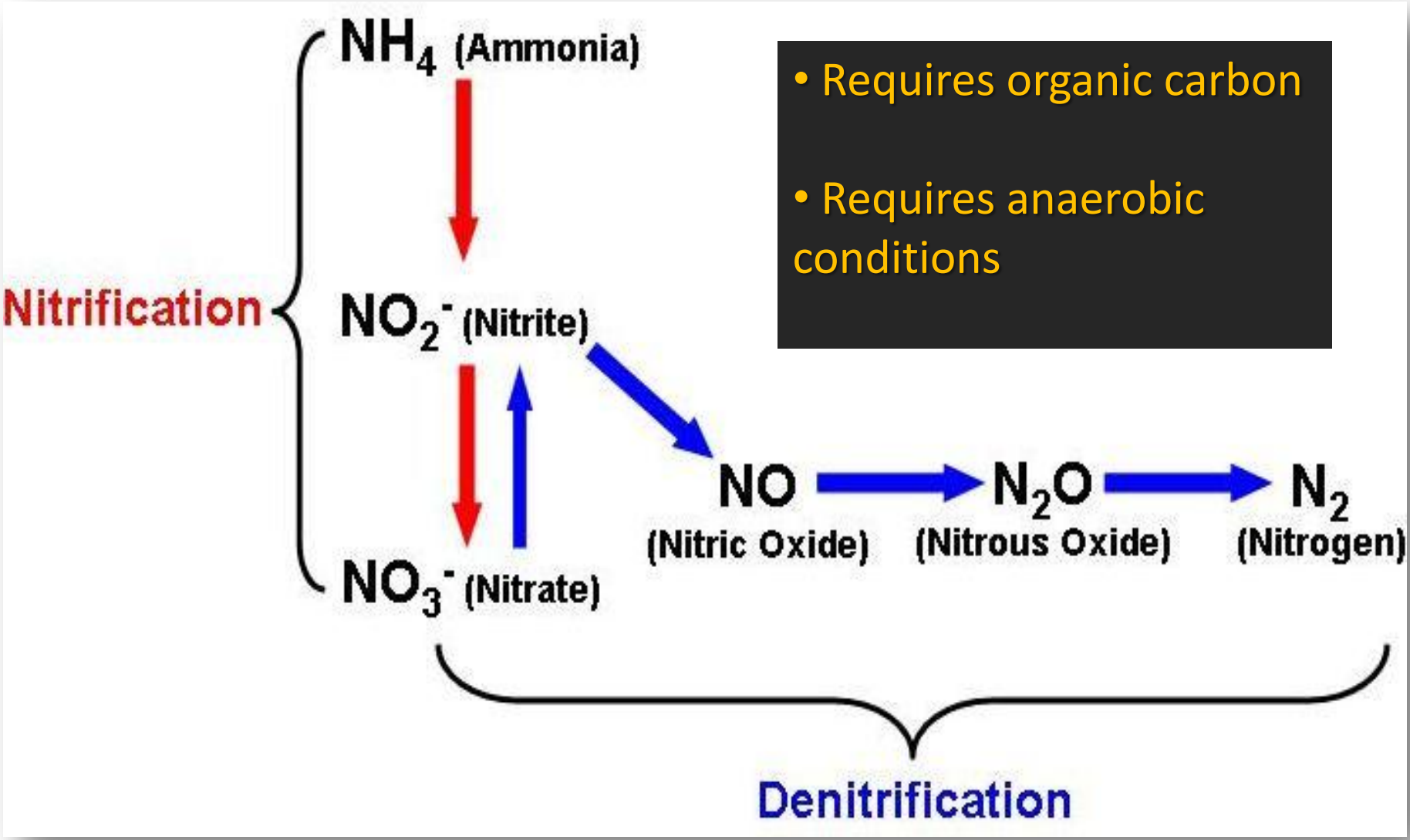
Cyperus papyrus wetlands

Cyperus papyrus wetlands

Provisioning, Regulating and Supporting Services of Papyrus Wetlands

Papyrus wetlands are at the crux of balancing provisioning and regulating services.

Denitrification as part of the Nutrient Retention



Are regulating services lost as wetlands are converted to agricultural land uses?

Objectives:

1. Assess C and N limitation of denitrification in agricultural and papyrus vegetation (Proximate controls)

2. Relate potential denitrification in natural vegetation and agricultural land uses and relate to soil characteristics (Distal controls)

Papyrus Wetland Zones (HGMUs)

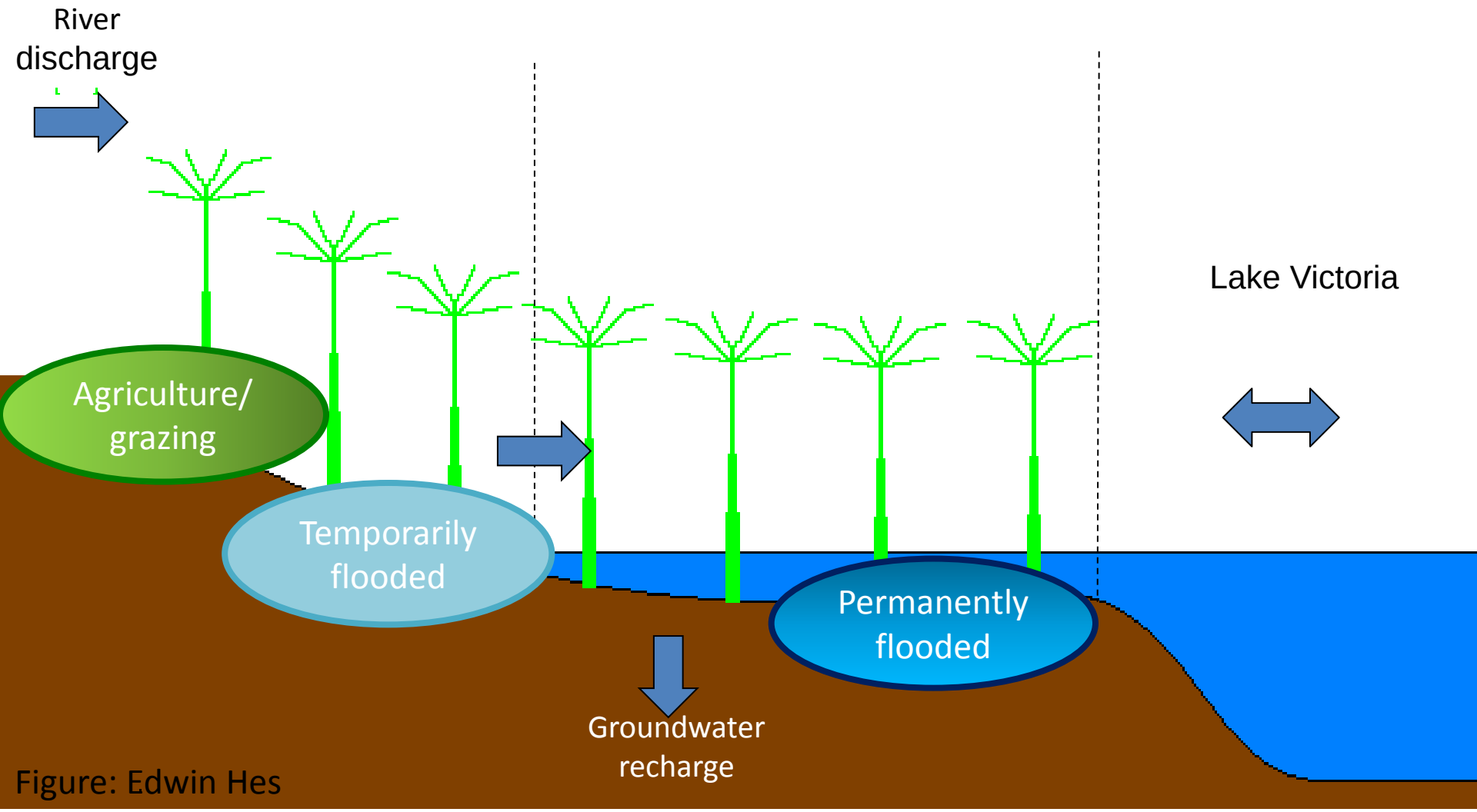
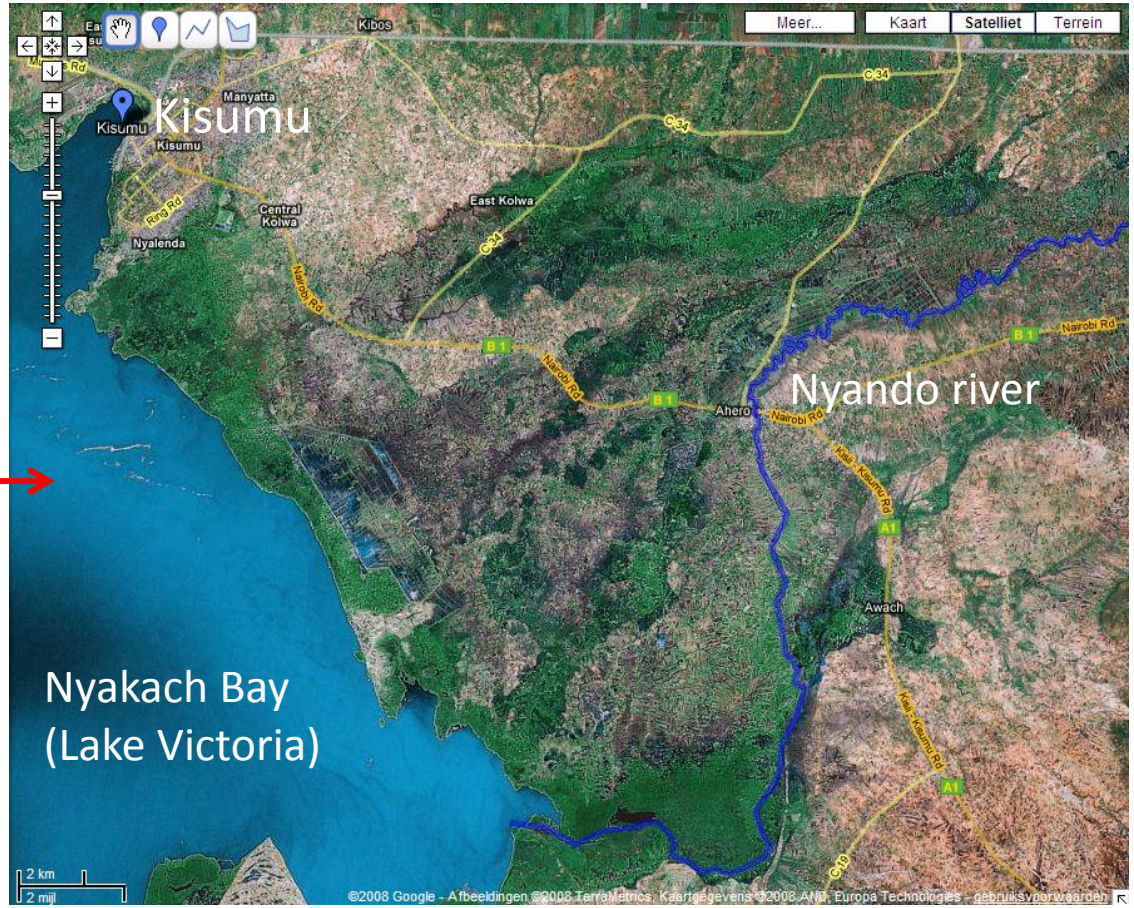


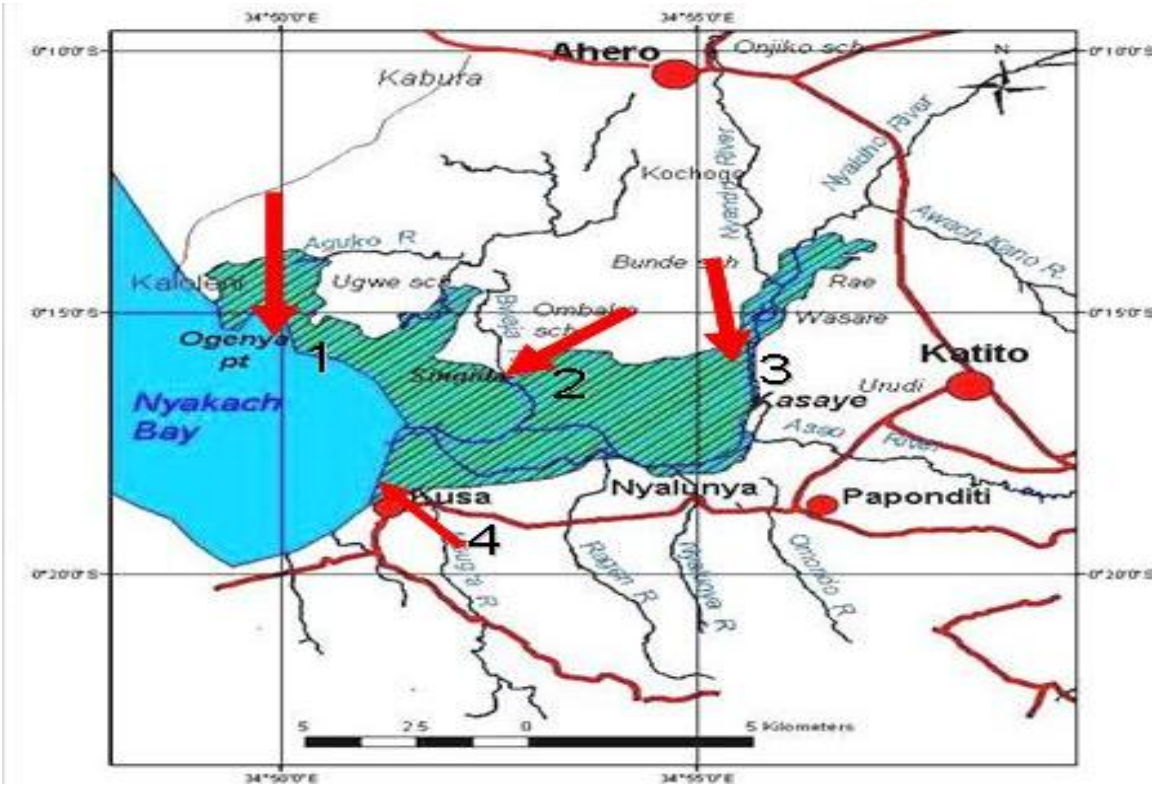
Figure: Edwin Hes

Study area: Nyando wetland, Kenya

Nyando basin : 3587 km^2
Nyando wetland : ±50 km^2

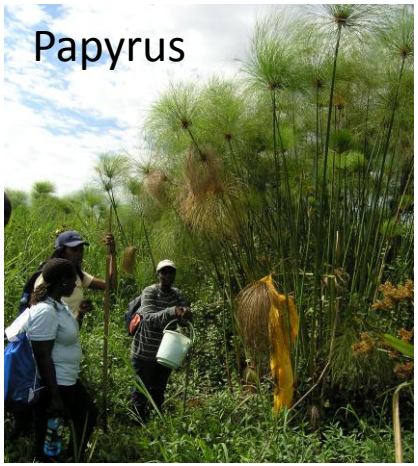


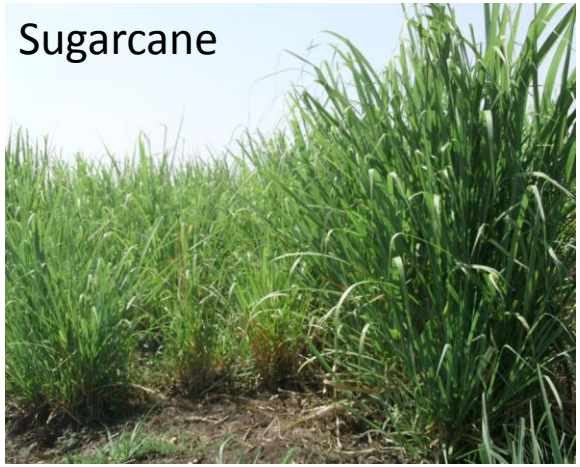
Sampling locations: Nyando River



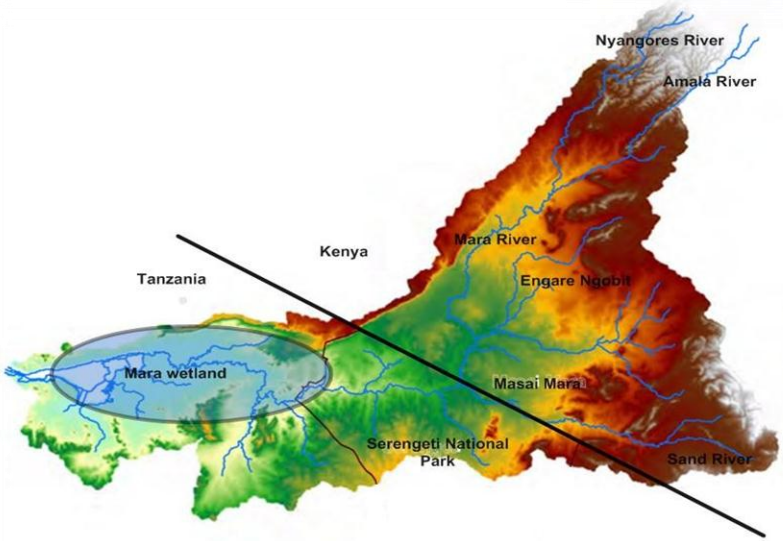
Ogyena Site – Daily influx of water from the Lake, moderately impacted

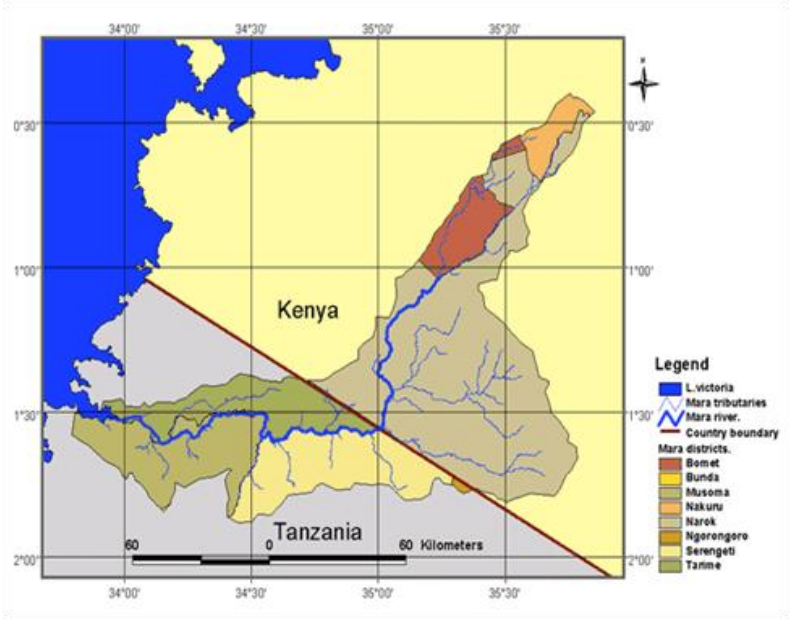
Singida Site – Floods with river during the wet season, lightly impacted

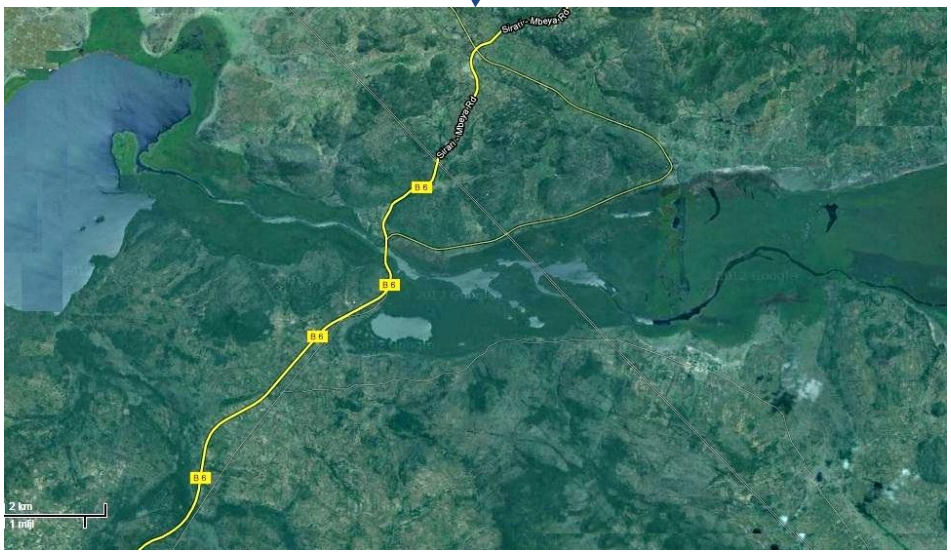




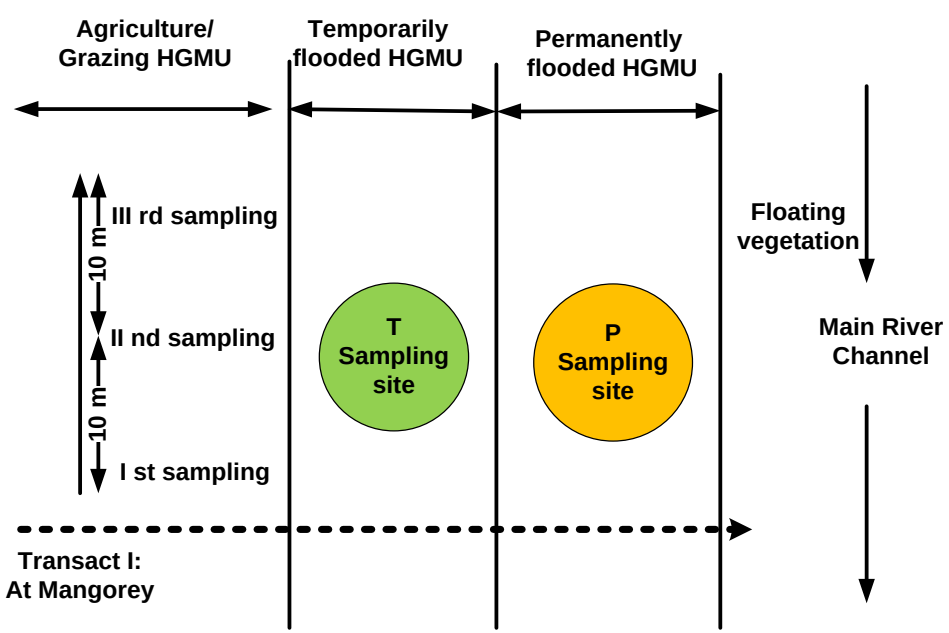
Study area: Mara wetland, Tanzania

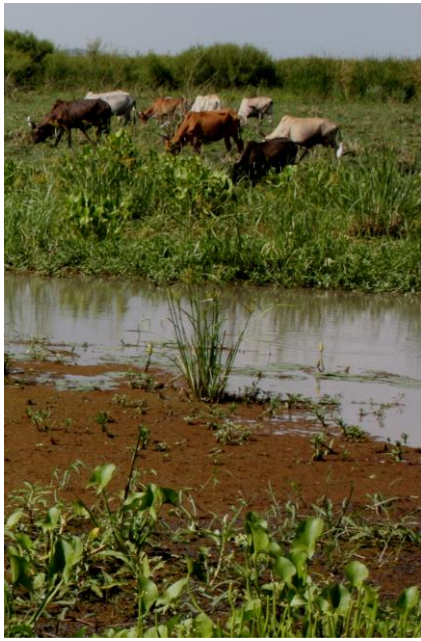




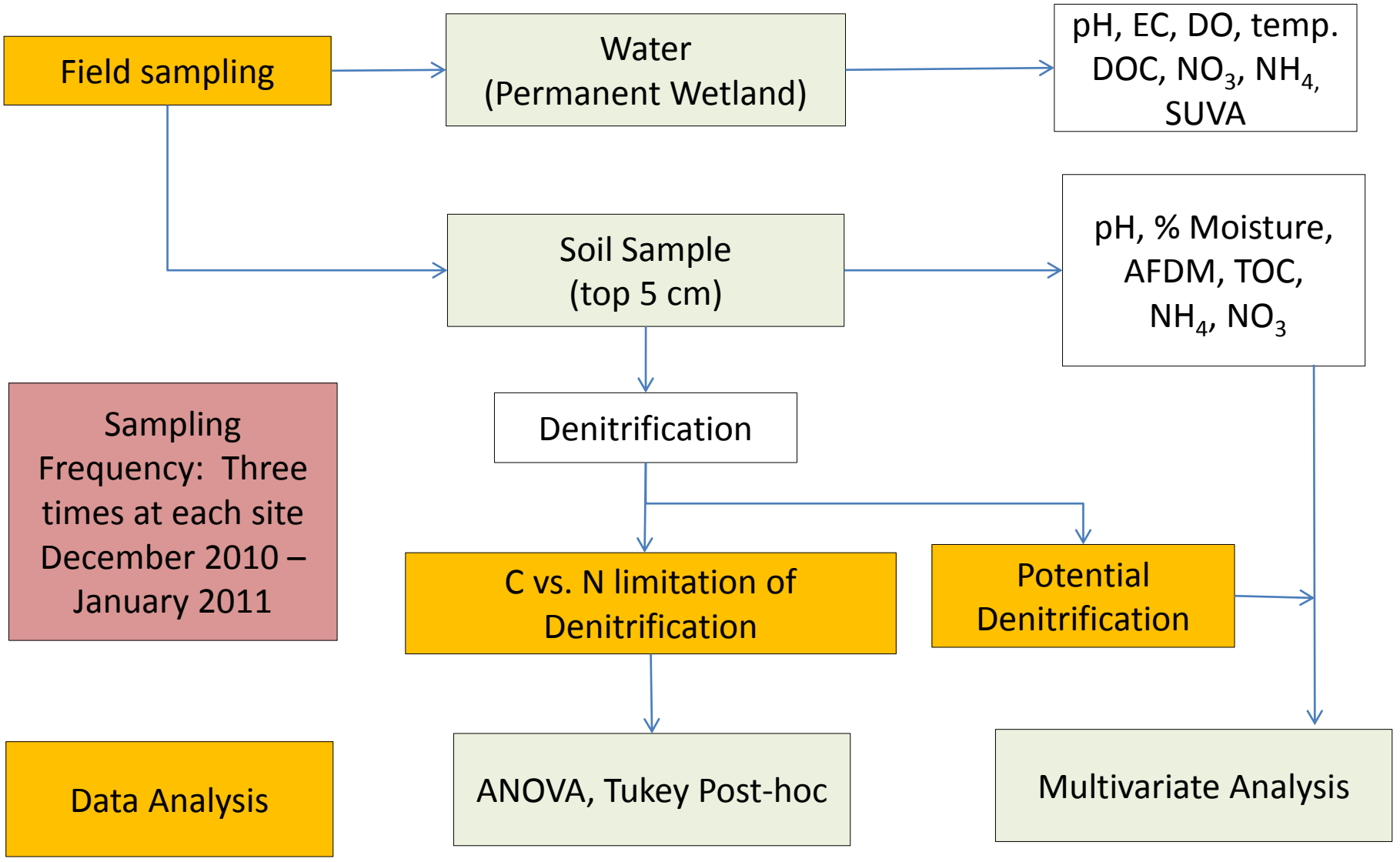


Sampling locations: Mara River

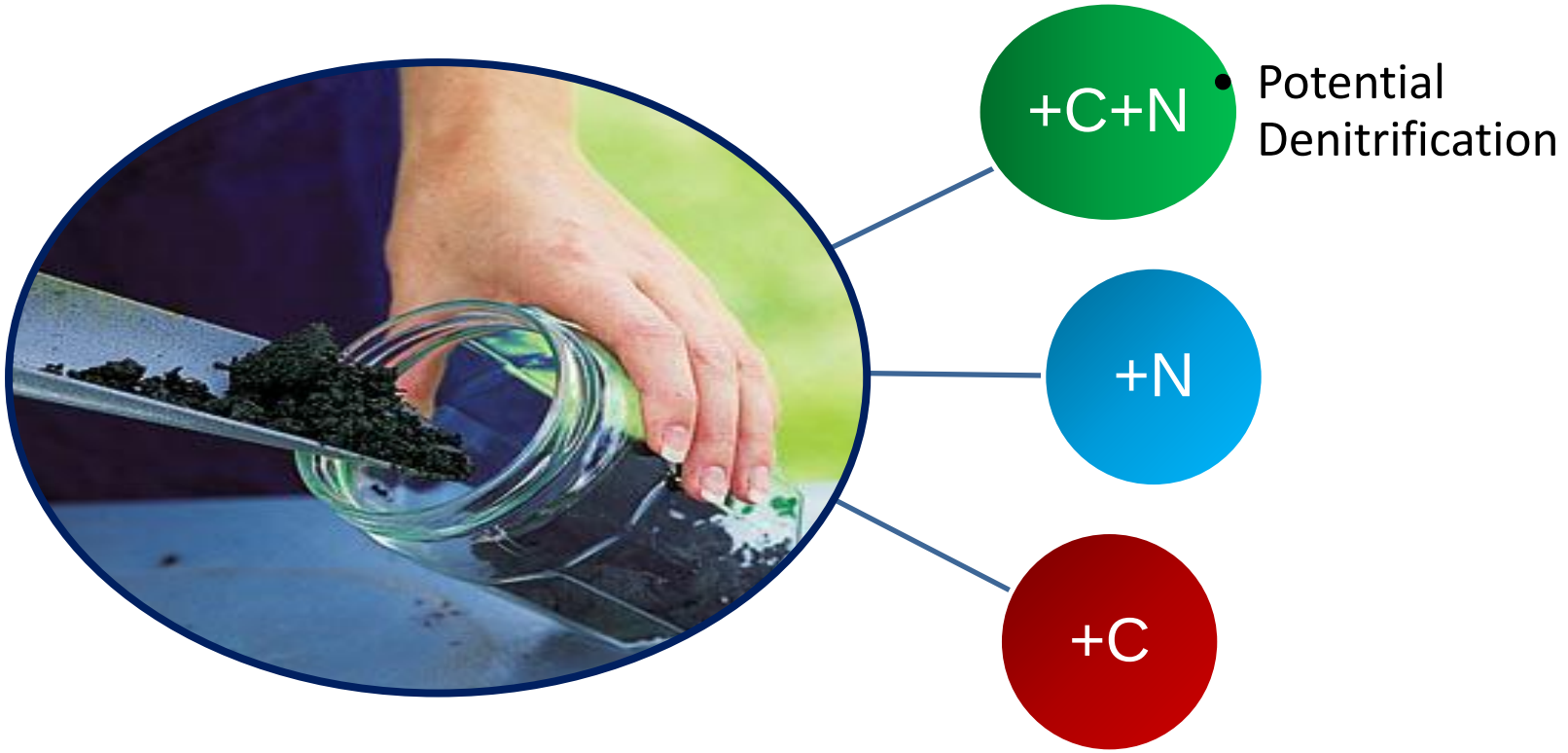




Methods:


Field sampling
Water
(Permanent Wetland)
pH, EC, DO, temp.
DOC, NO_3, NH_4,
SUVA
Soil Sample
(top 5 cm)
pH, % Moisture,
AFDM, TOC,
NH_4, NO_3
Sampling Frequency: Three times at each site December 2010 – January 2011
Denitrification
C vs. N limitation of Denitrification
Potential Denitrification
Data Analysis
ANOVA, Tukey Post-hoc
Multivariate Analysis

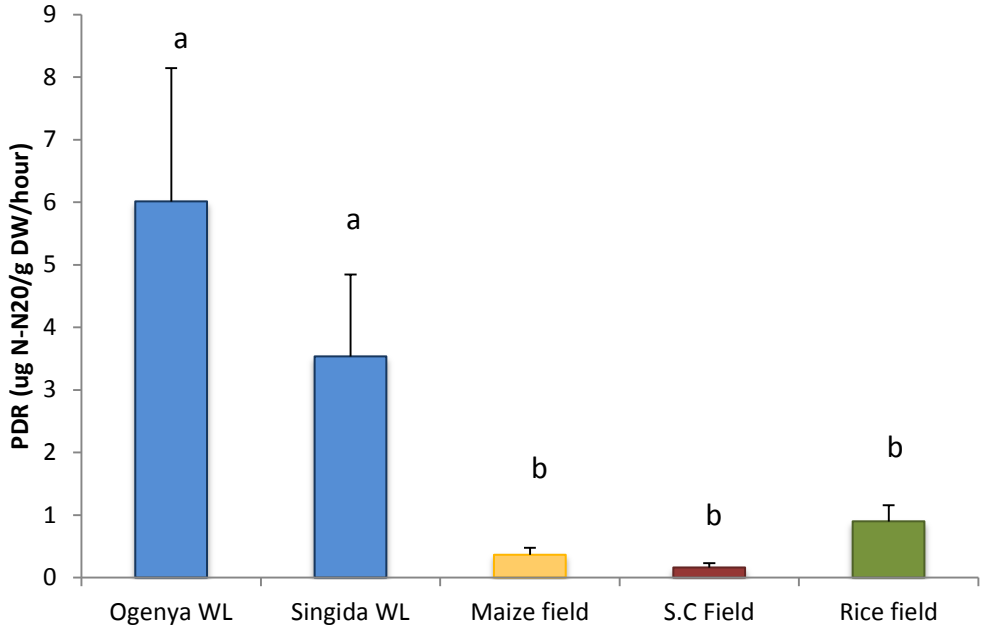
Acetylene inhibition method - DEA



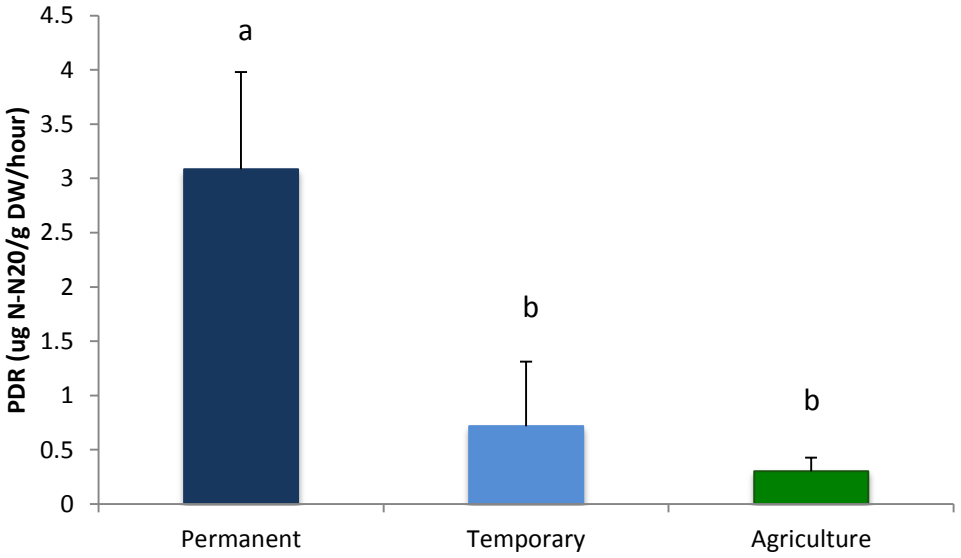
- Anaerobic conditions with chloremphenicol
- Acetylene blocks conversion of N_2O to N_2
- Denitrification rate was calculated from linear regression of N_2O produced during incubation period.
- Three replicates for each treatment

Potential Denitrification Rate

Nyando

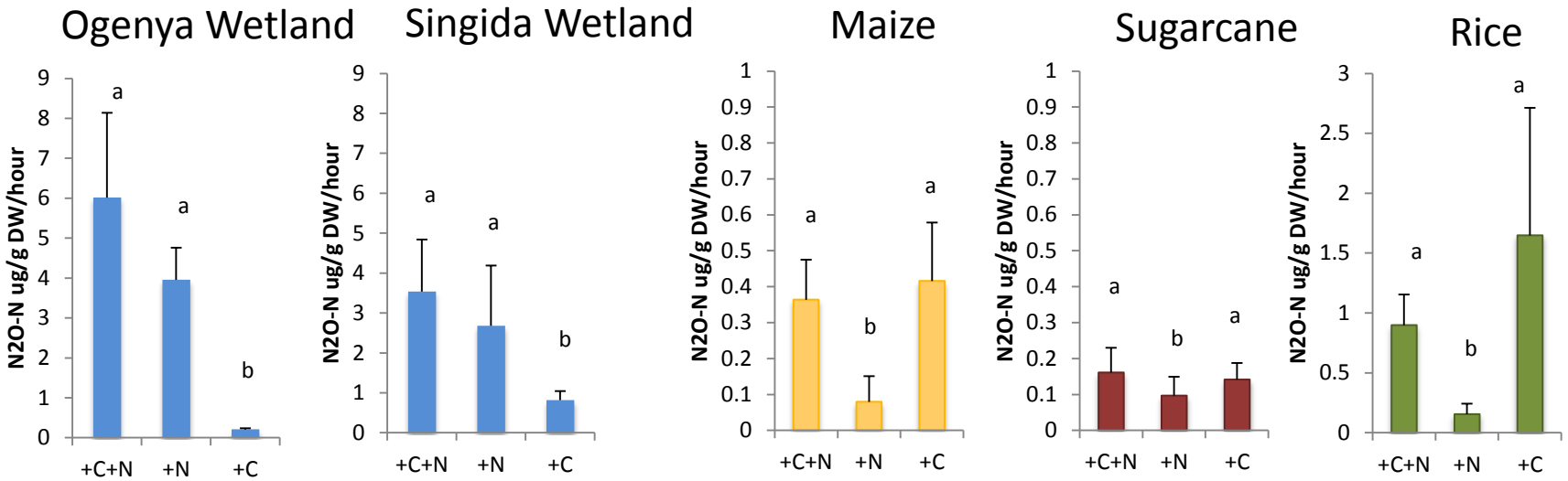


Mara



Limiting factors for potential denitrification

Nyando



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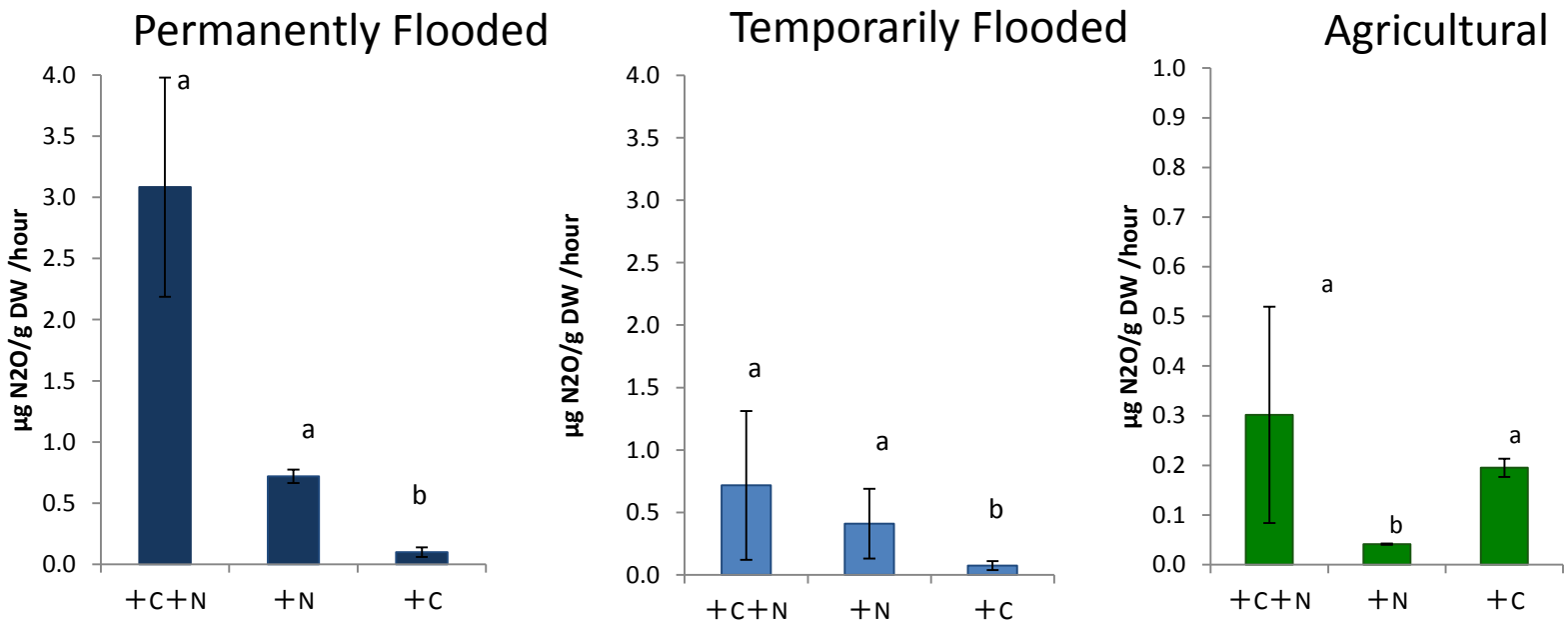
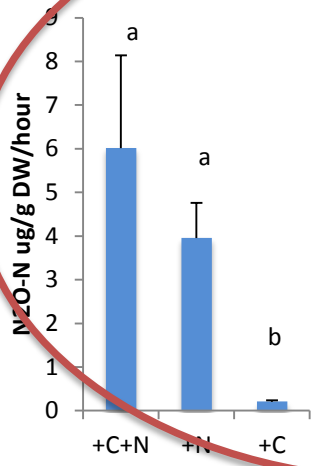


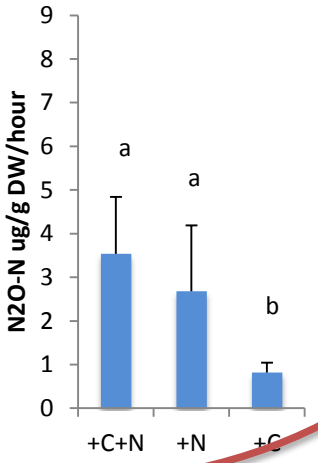
Nitrate limits PDR in Wetland Sites

Nyando

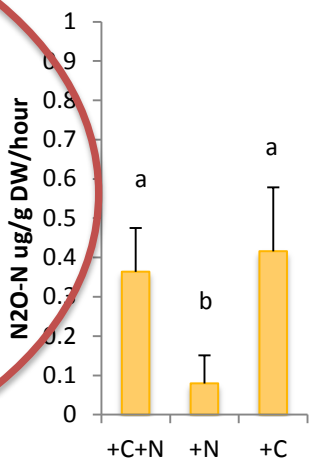
Ogenya Wetland



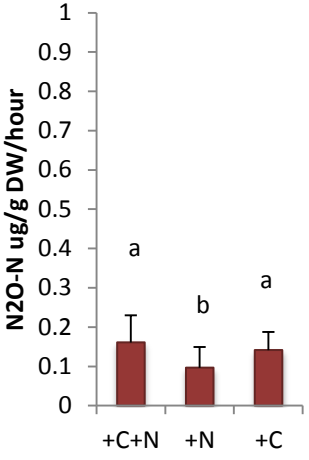
Singida Wetland



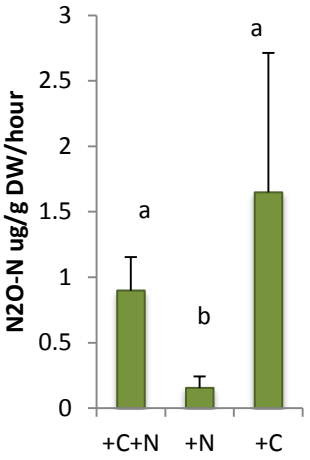
Maize



Sugarcane

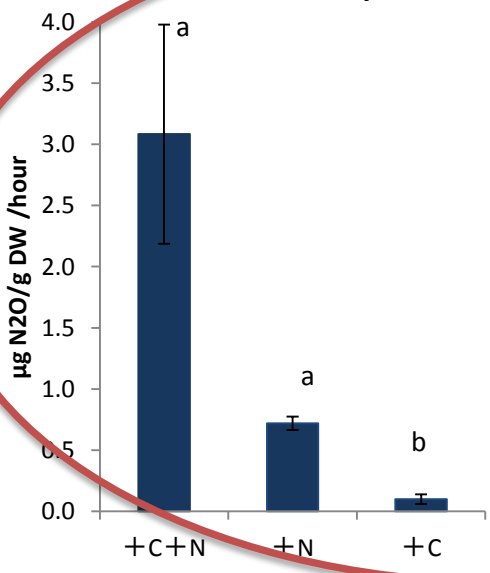


Rice

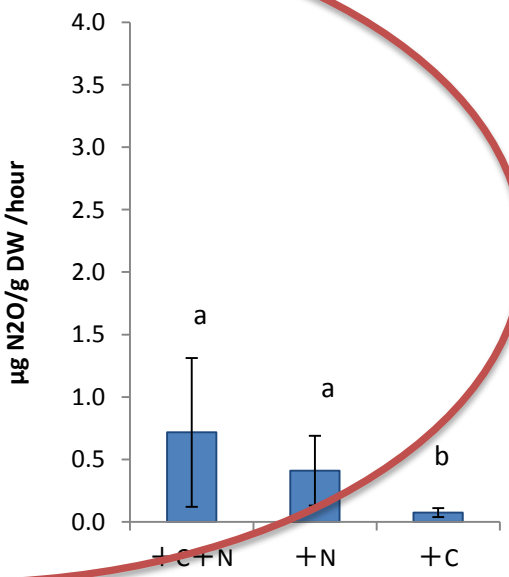


Mara

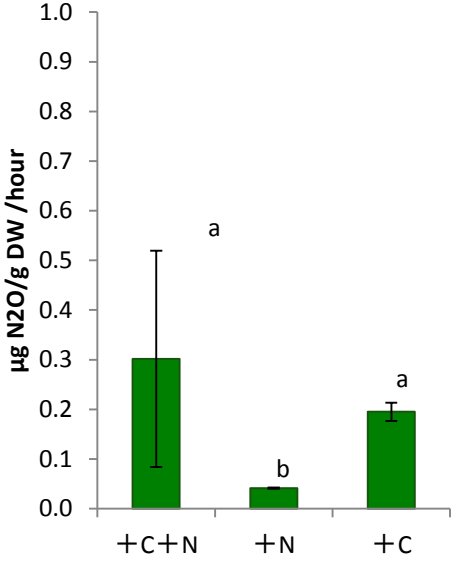
Permanently Flooded



Temporarily Flooded

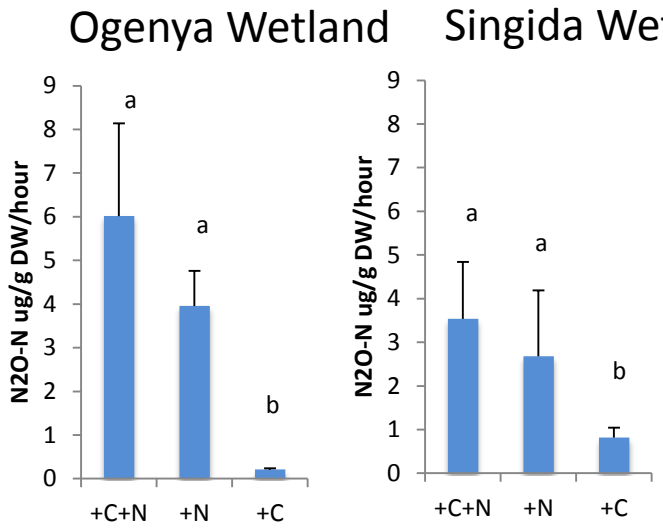


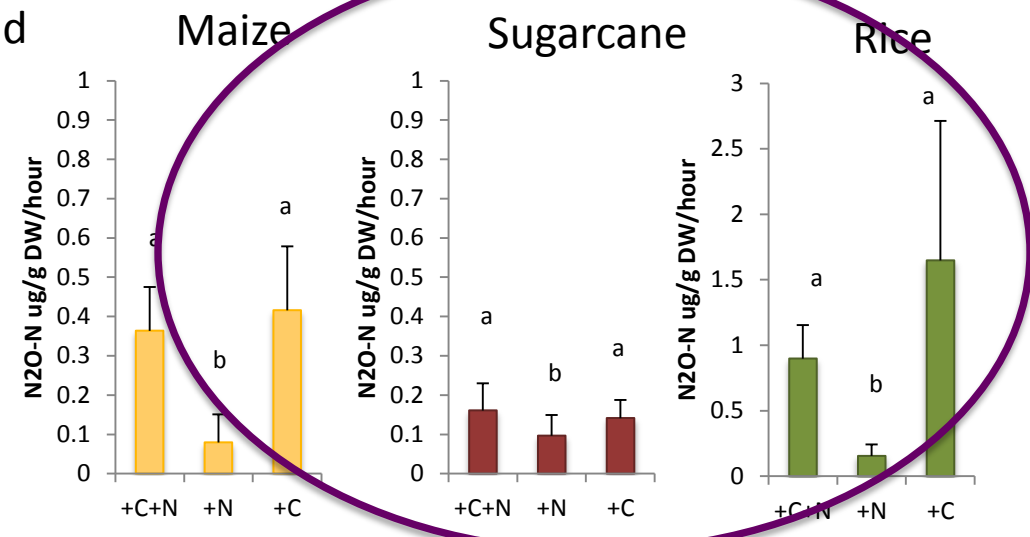
Agricultural



Carbon limits PDR in agricultural sites

Nyando





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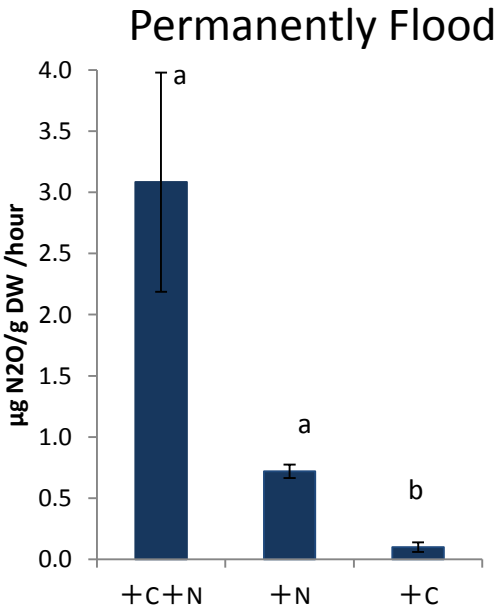
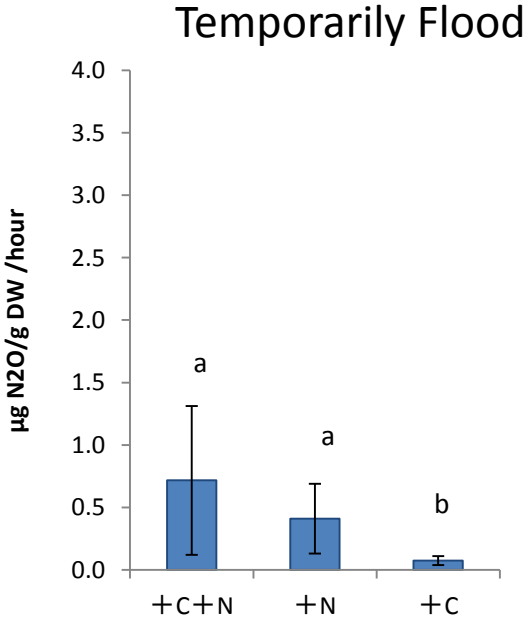
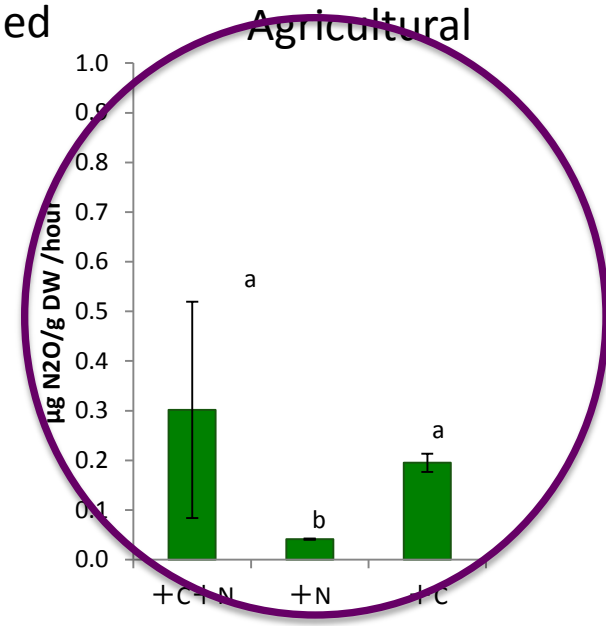


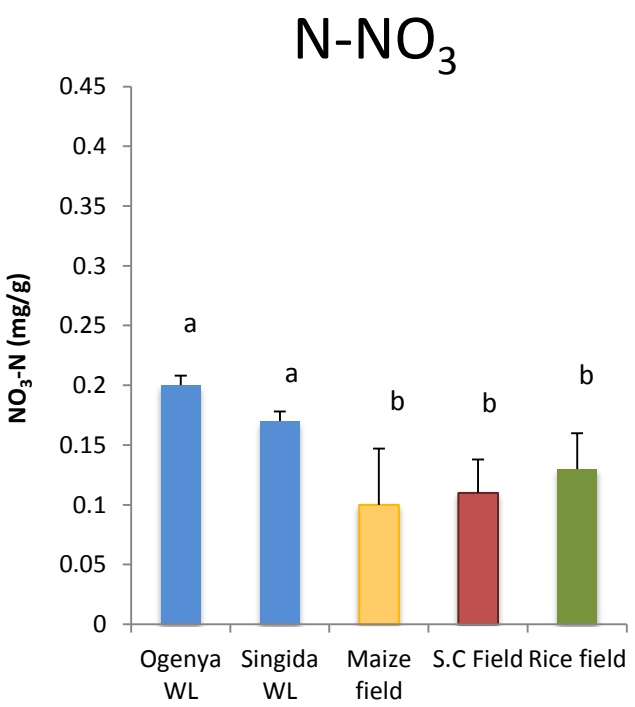


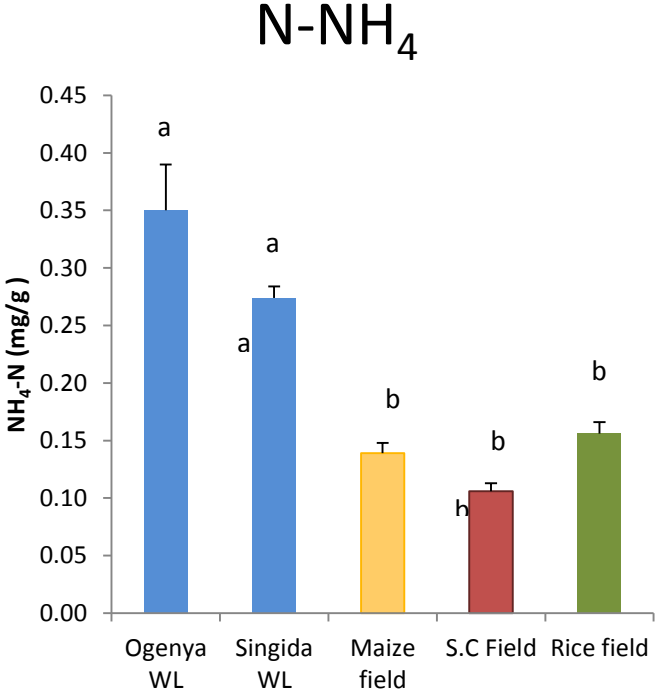


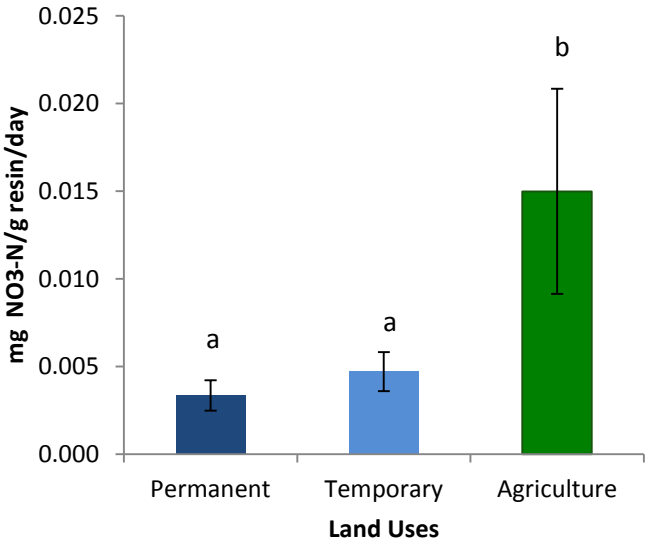
NO_3 & NH_4 among different land uses

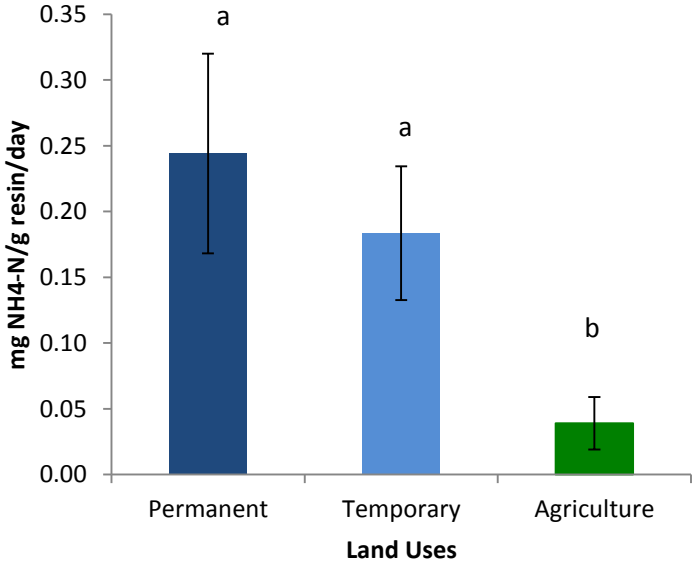
Nyando

Mara







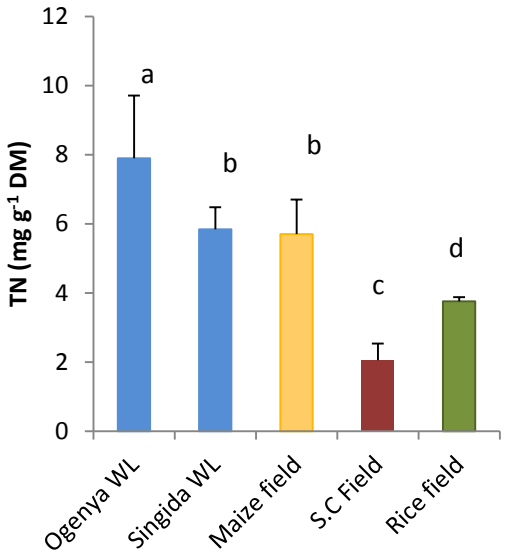


TN and TOC among different land uses

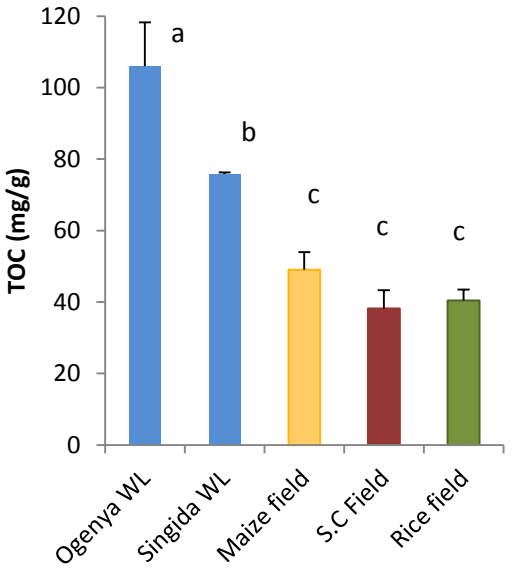
Nyando

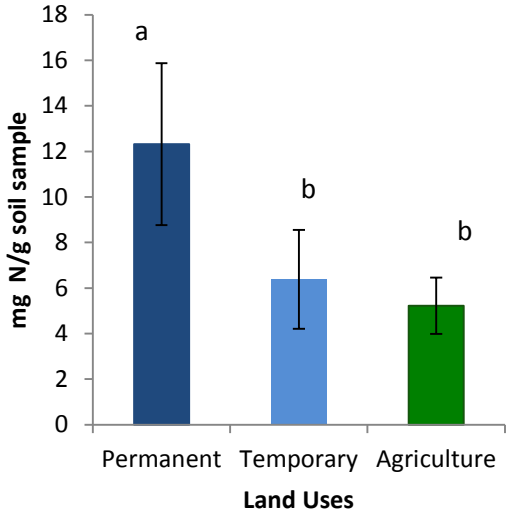
Mara

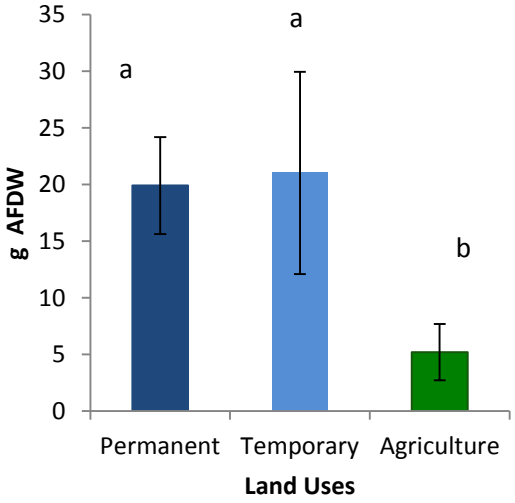
TN



TOC

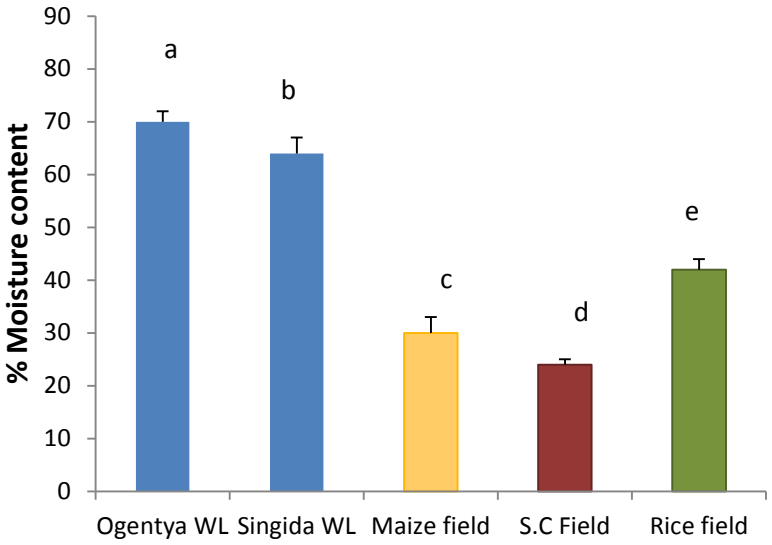






Moisture Content

Nyando



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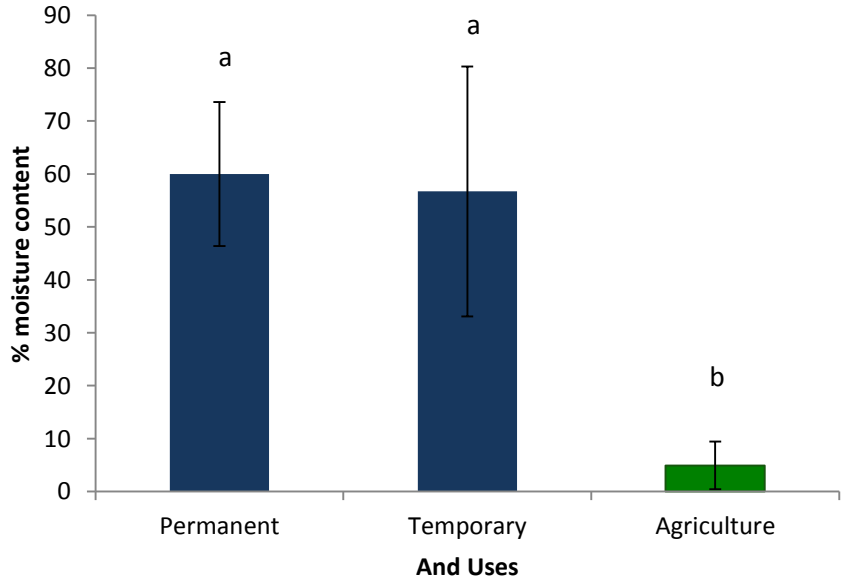
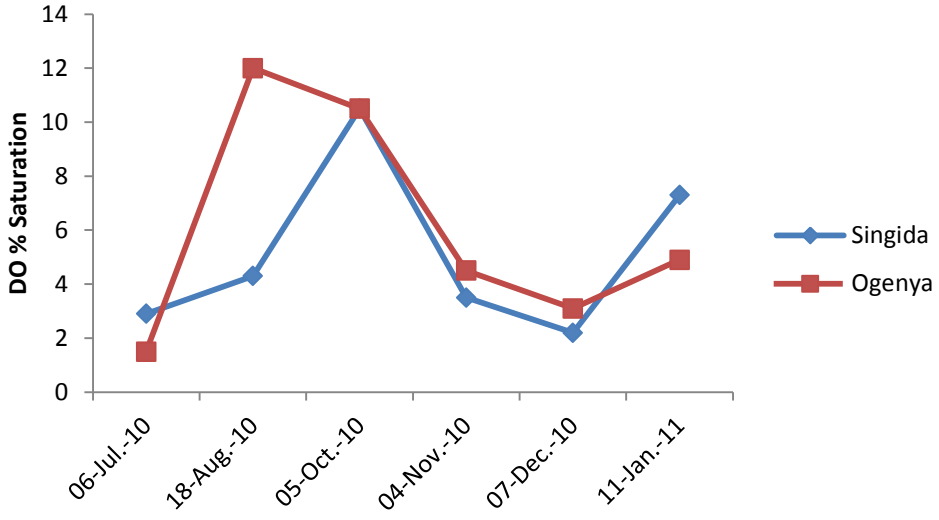


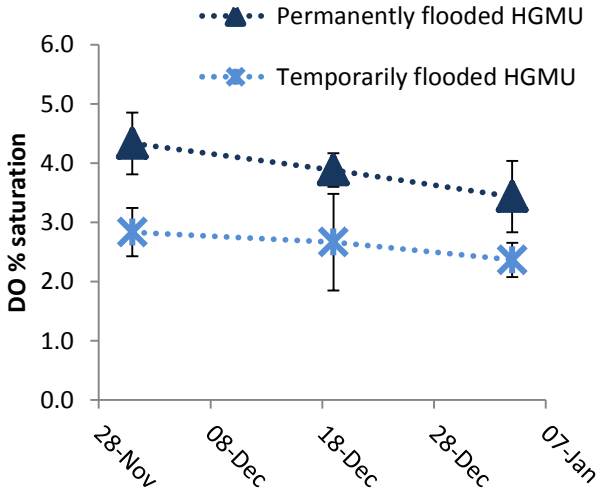
Dissolved Oxygen and SUVA in Wetland Sites

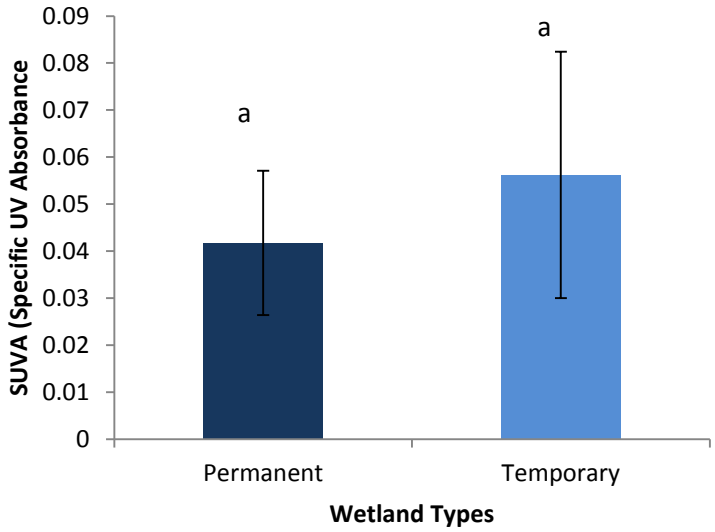
Nyando



DO ranged from 0.2 – 0.8 mg/L

Mara



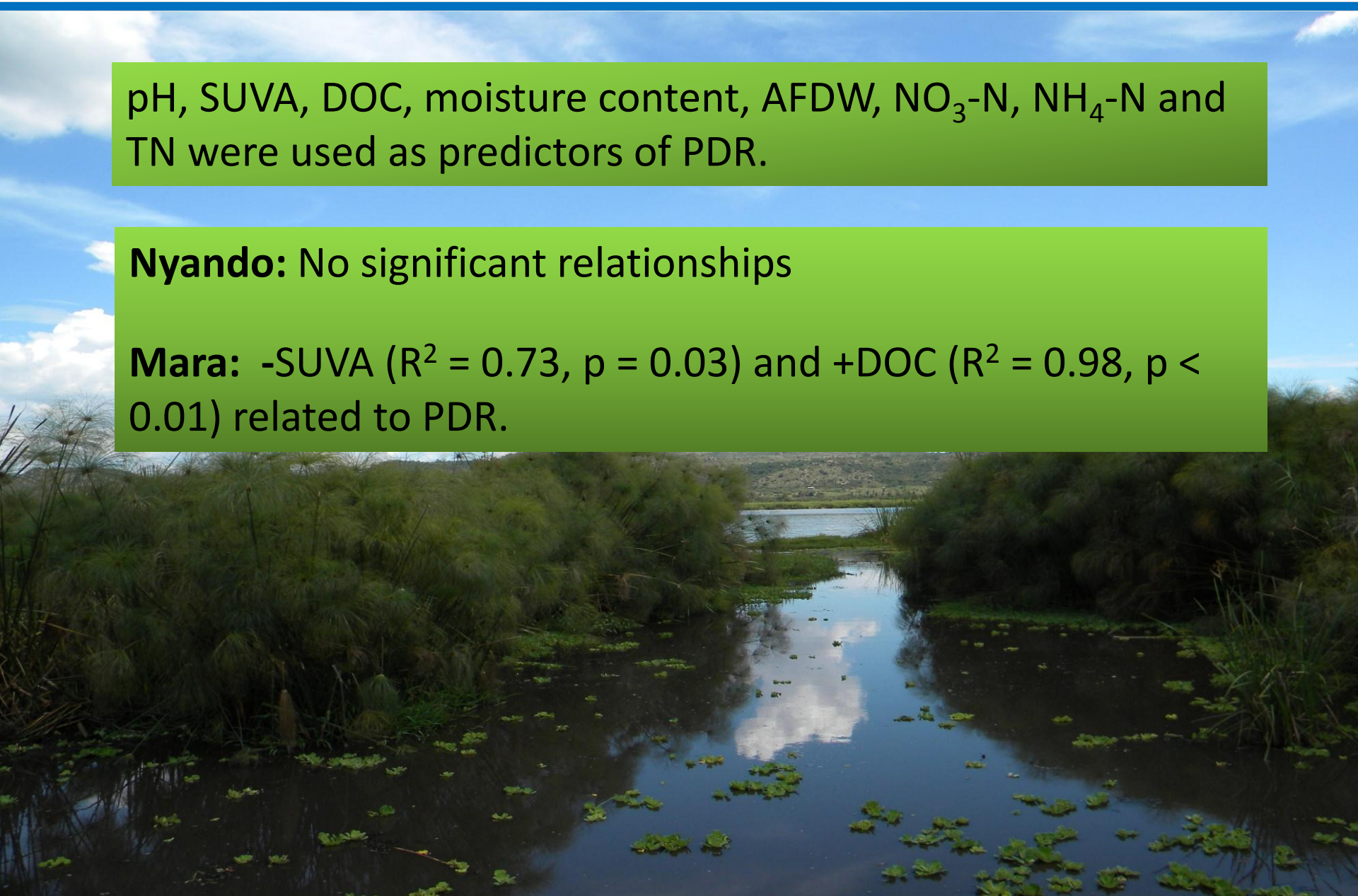


Stepwise Multivariate Analysis: Wetland Sites

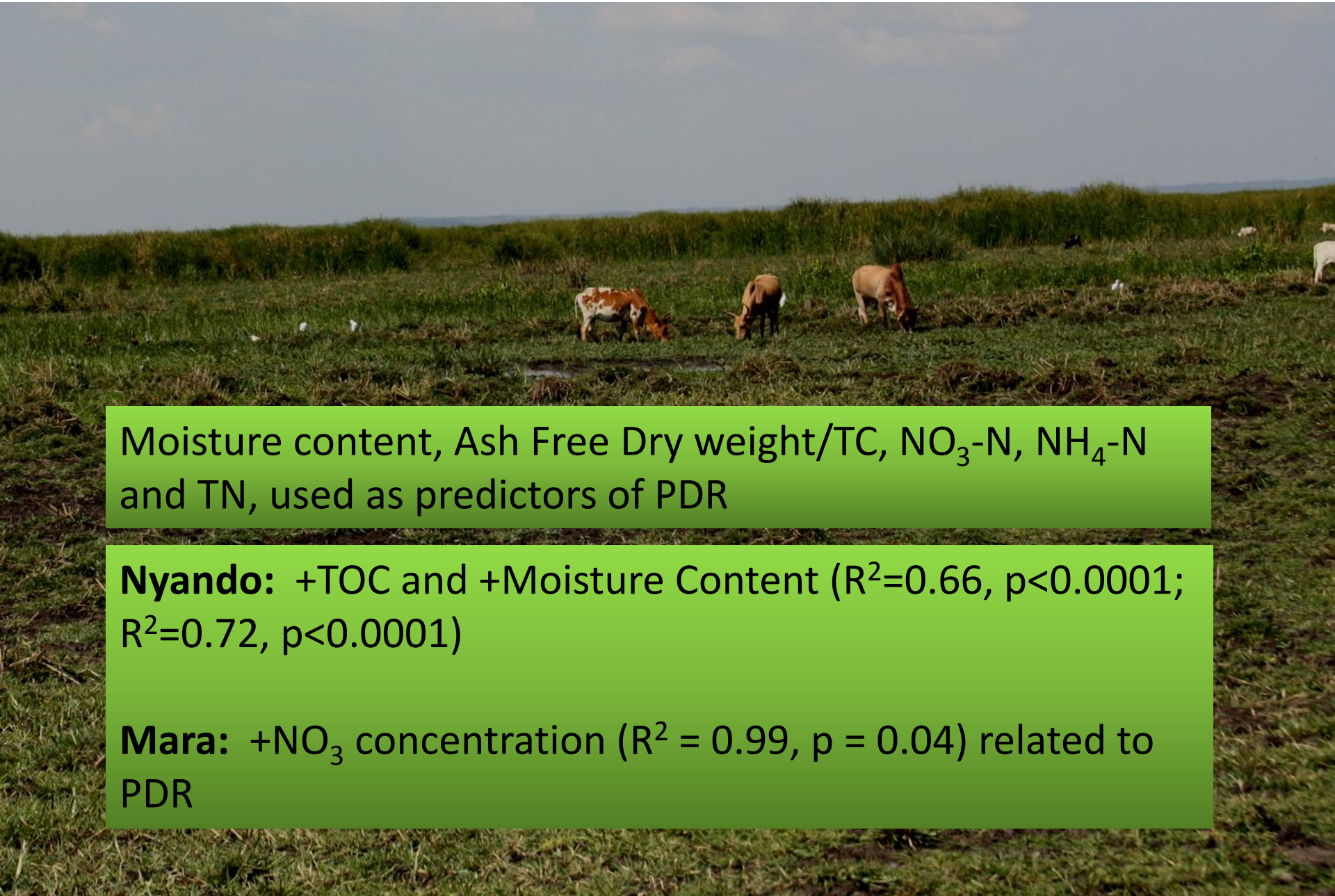
pH, SUVA, DOC, moisture content, AFDW, NO_3-N, NH_4-N and TN were used as predictors of PDR.

Nyando: No significant relationships

Mara: **-**SUVA ($R^2 = 0.73$, $p = 0.03$) and +DOC ($R^2 = 0.98$, $p < 0.01$) related to PDR.



Multivariate Regression Analysis, Agricultural Land, Mara

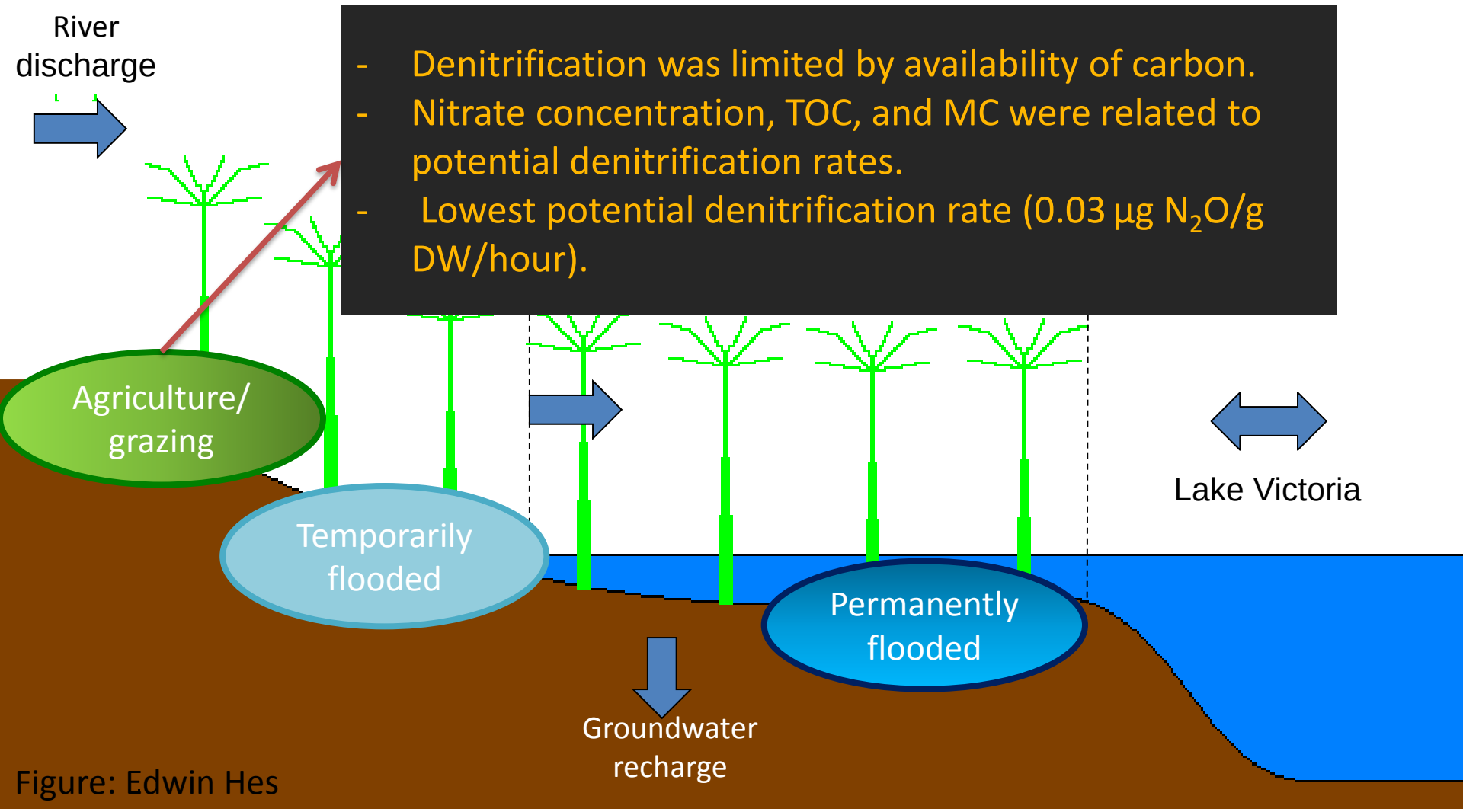


Moisture content, Ash Free Dry weight/TC, NO_3-N, NH_4-N and TN, used as predictors of PDR

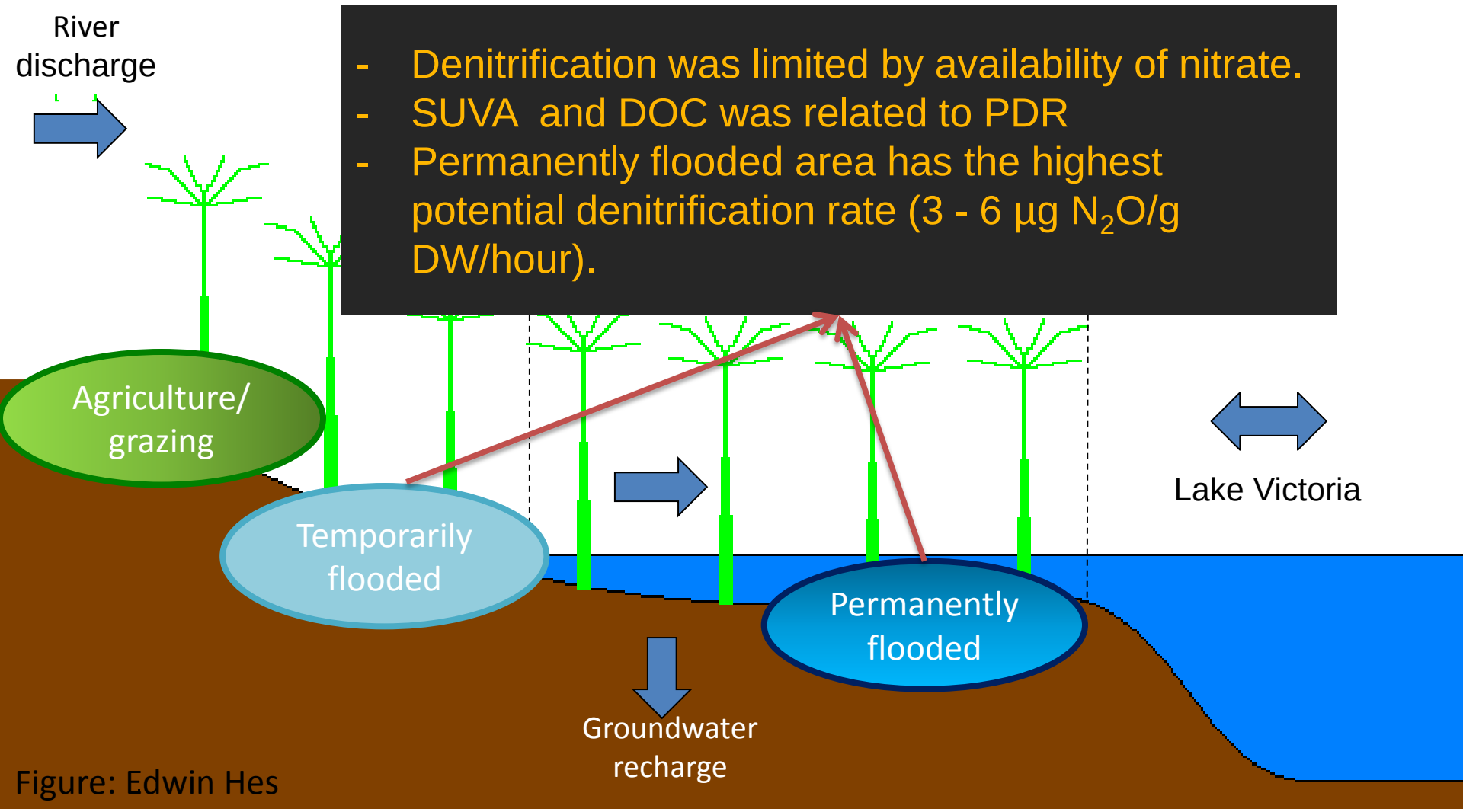
Nyando: +TOC and +Moisture Content (R^2=0.66, p<0.0001; R^2=0.72, p<0.0001)

Mara: +NO_3 concentration (R^2 = 0.99, p = 0.04) related to PDR

Conclusions: Nyando and Mara



Conclusions: Nyando and Mara



Conclusions

- Both sites showed a similar pattern of NO -limitation of denitrification in agricultural sites and C limitation in wetland sites.
- Potential denitrification is much lower in agricultural sites than wetland sites.
- Environmental controls of denitrification are variable, but are related to carbon and moisture content.
- Carbon quality may be important in understanding variation in denitrification.

Ecosystem Services

How do we balance the competing demands for ecosystem services? (Are regulating services lost in agricultural land uses?)

Figure from:
http://www.metrovancouver.org/planning/development/ecologicalhealth/Pages/default.aspx

Thank you

Dr. Julius Kipkemboi, Dr. Anne van Dam, Edwin Hes, Priscah Rongoei, Wende Kema, Saddiki Laiser, Do Phuong Hien,

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World Wildlife Fund (Dr. William Kasanga, Mr. Oscar Dimosso)
Ministry of Water and Irrigation, Musoma (Mr. Mathayo Athuman)
Lake Victoria Environmental Management Program (Mr. Omari Myanza)

UNESCO-IHE Laboratory (Fred Kruis, Lyzette Robbemot, Peter Heerings, Frank Wiegman)

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