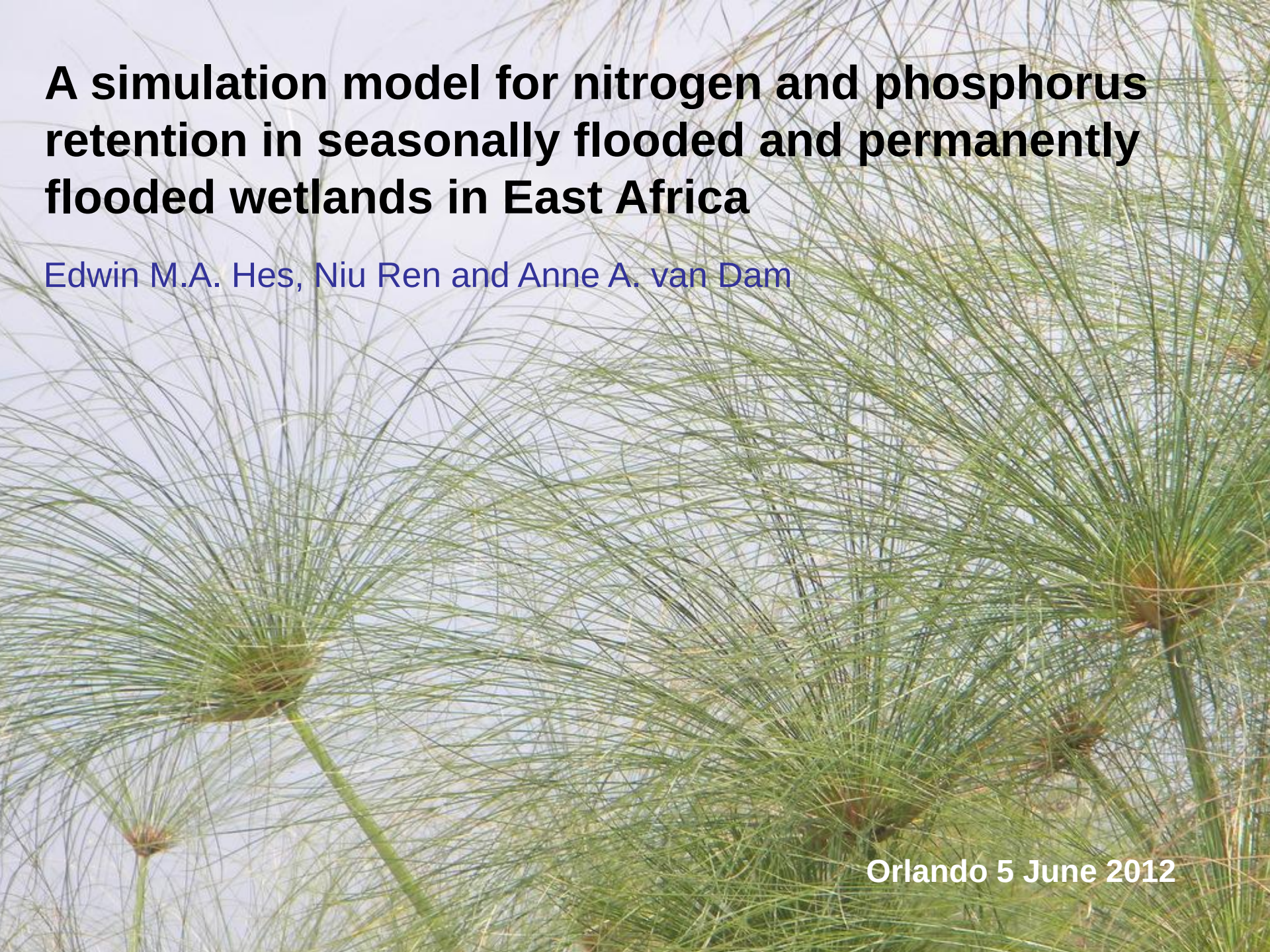
A simulation model for nitrogen and phosphorus retention in seasonally flooded and permanently flooded wetlands in East Africa

Edwin M.A. Hes, Niu Ren and Anne A. van Dam



Orlando 5 June 2012

Provisioning services

Harvest for use of the papyrus

Clearing for agriculture and or bush meat

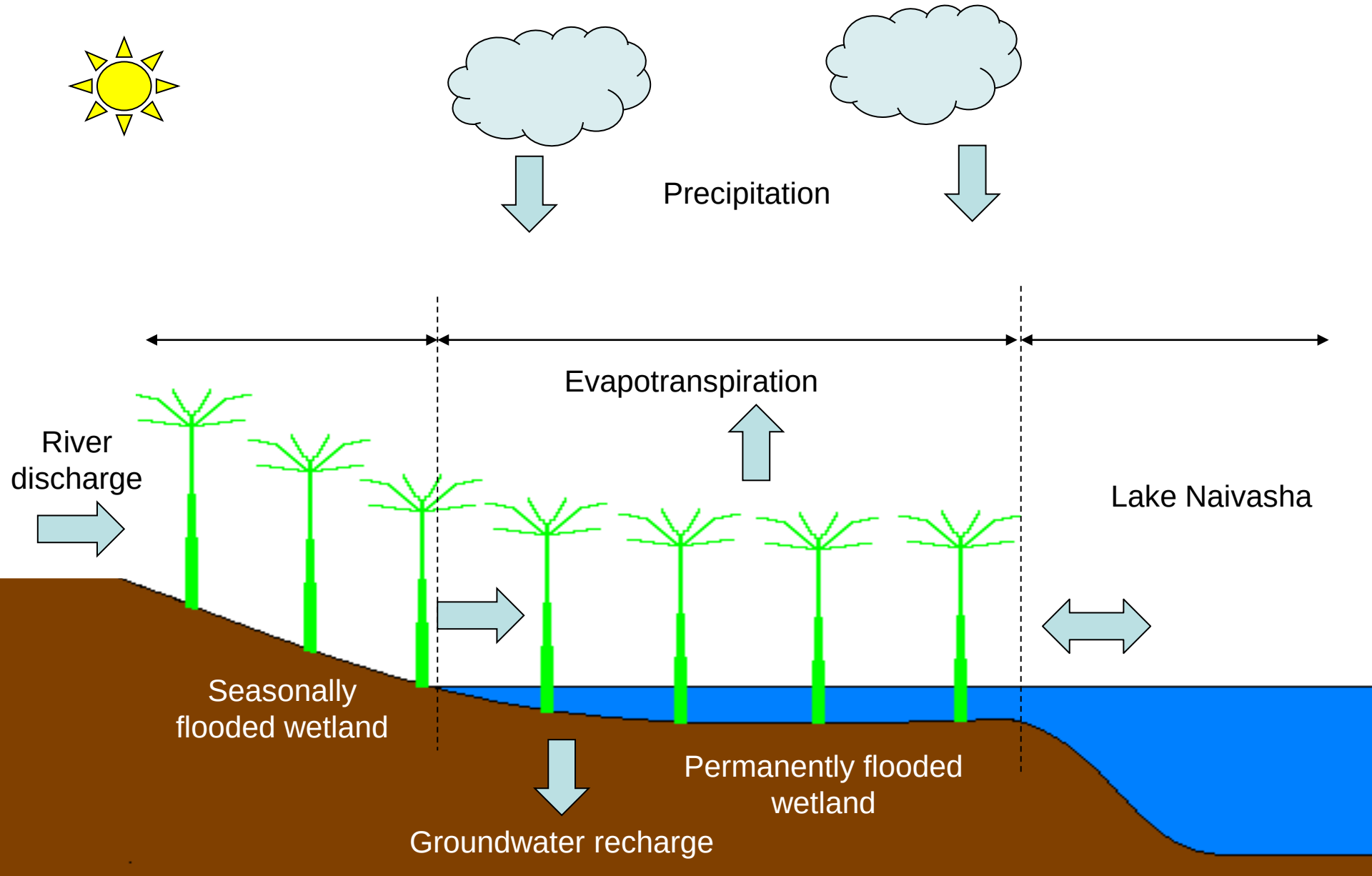
Regulating service
Nutrient cycling

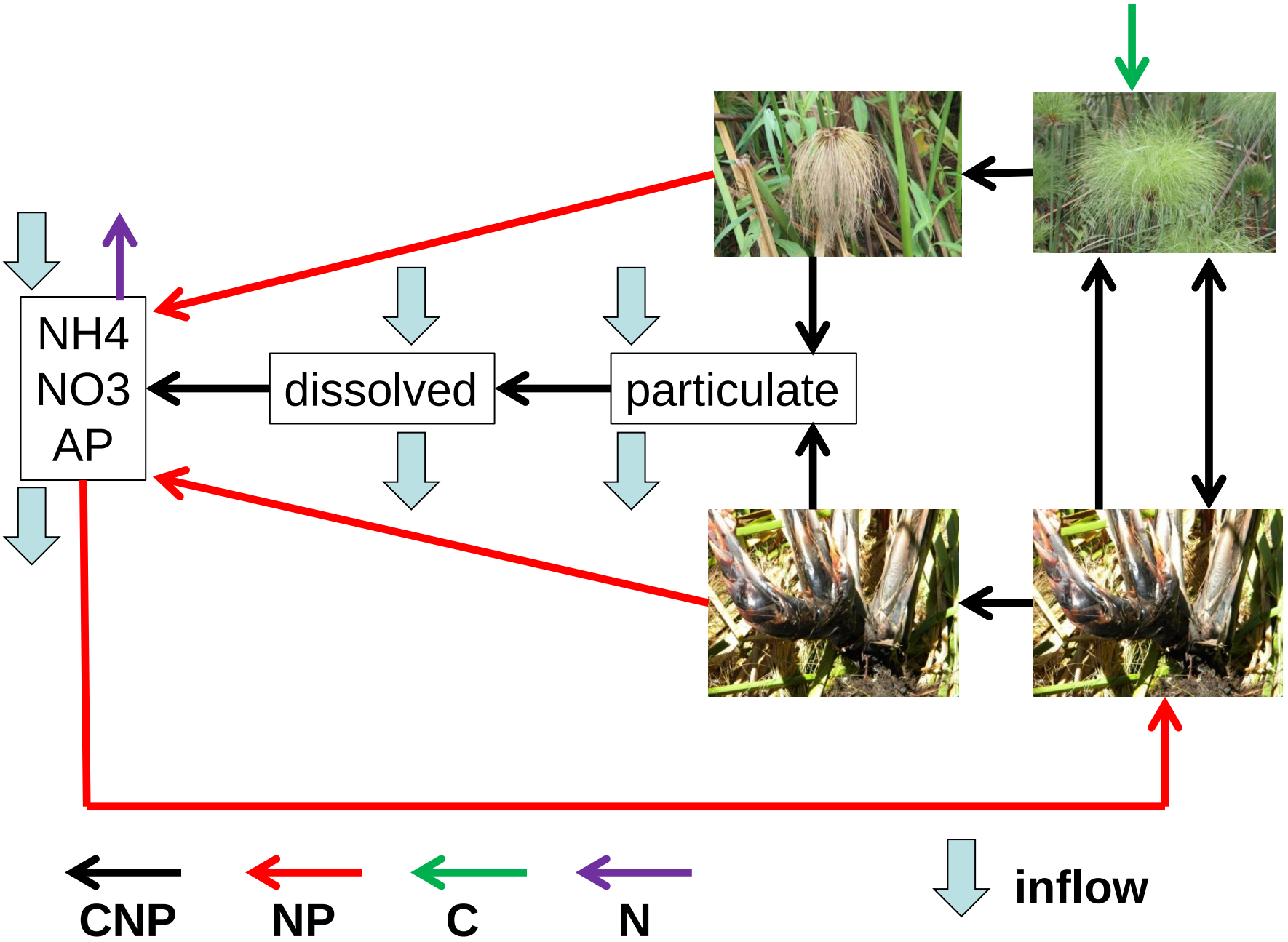
This leads to the following questions?

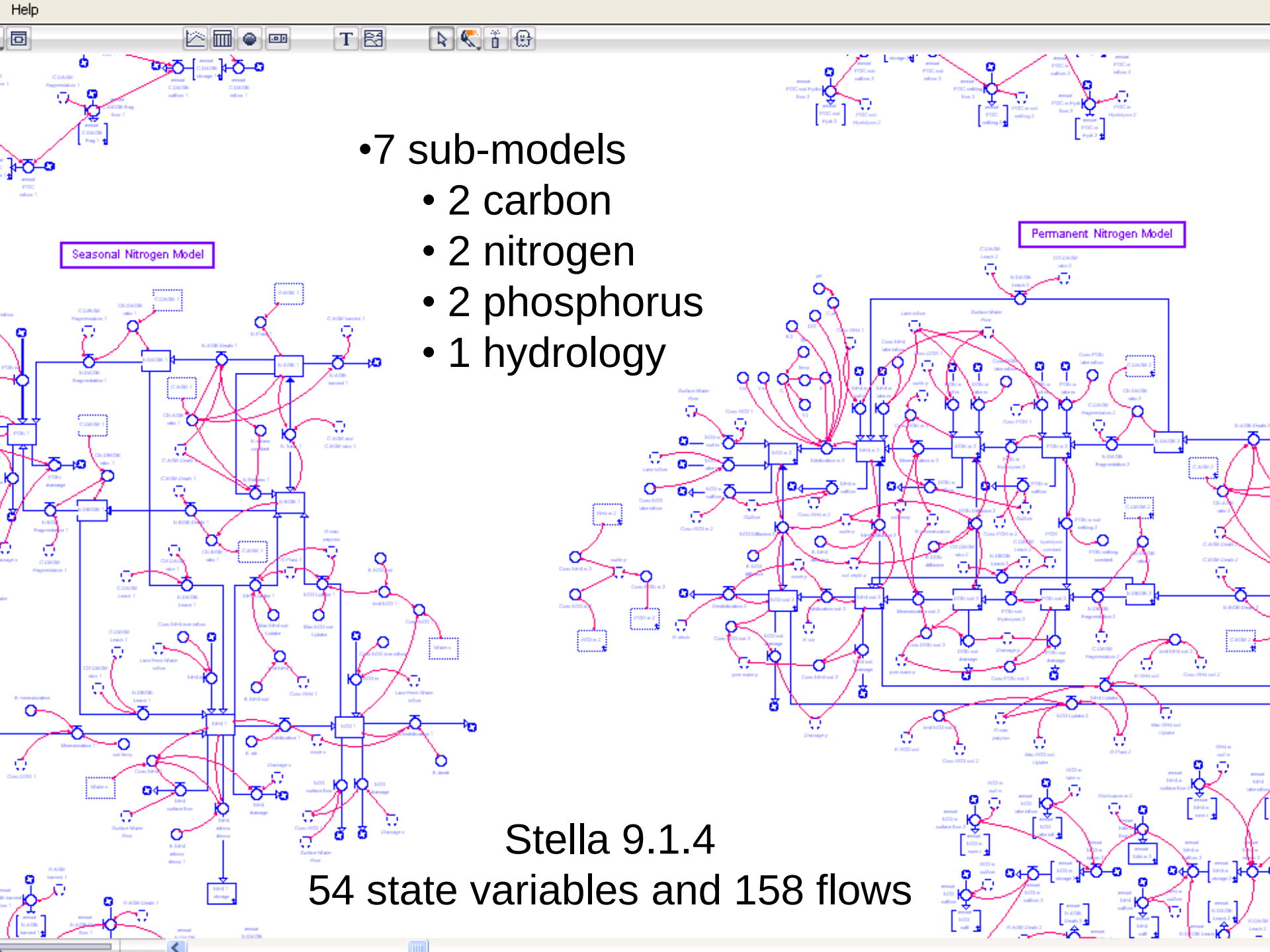
- Does harvesting influence nutrient retention?
  - Is the effect on nitrogen the same as on phosphorus?
  - Does it matter where the papyrus is harvested (permanently or seasonally flooded)?
  - Does it matter how much you harvest and how often?
- Do you need to make a trade-off?

Lake Naivasha

Conceptual model




NH4
NO3
AP
dissolved
particulate
CNP
NP
C
N
inflow



- 7 sub-models
  - 2 carbon
  - 2 nitrogen
  - 2 phosphorus
  - 1 hydrology

Stella 9.1.4

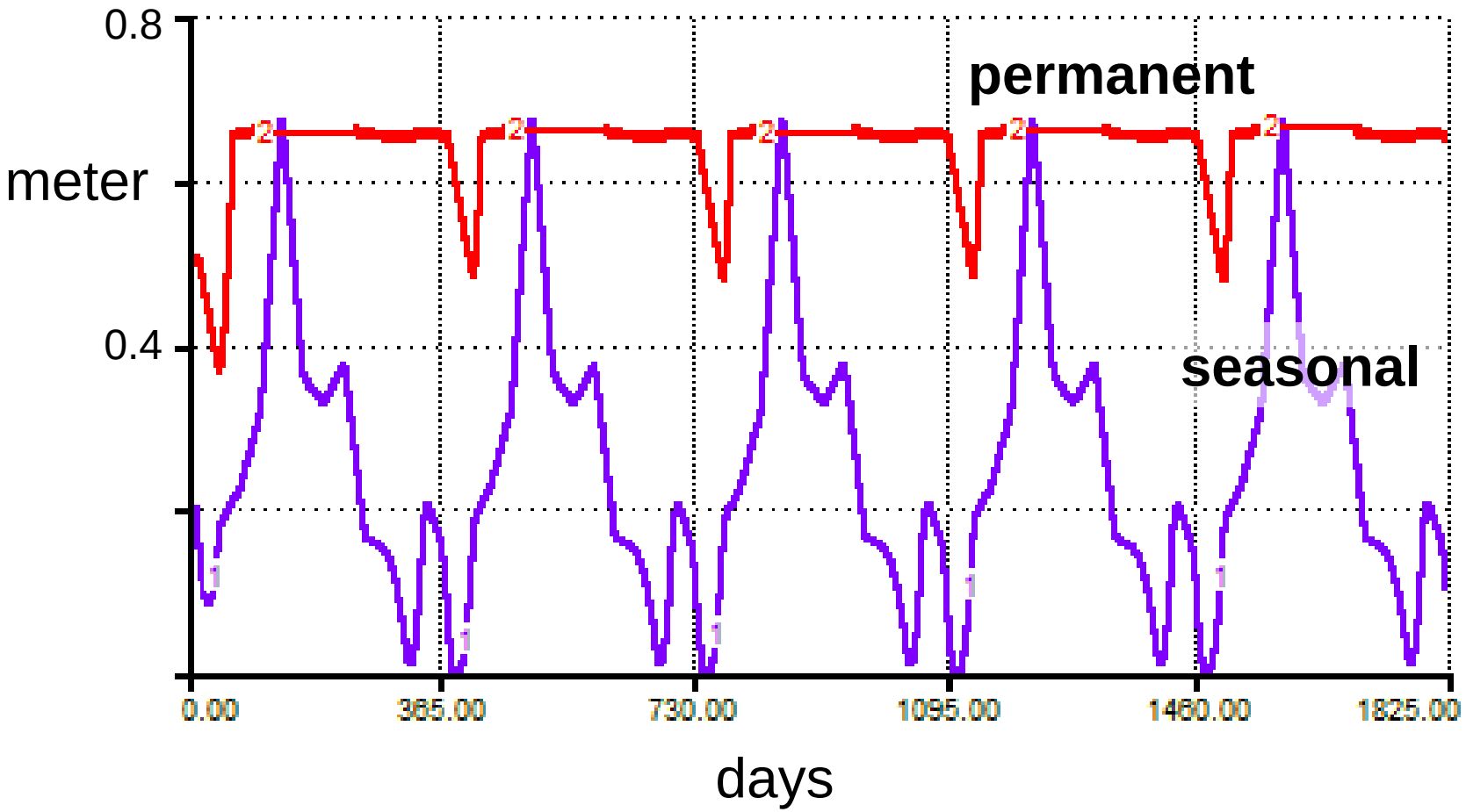
54 state variables and 158 flows

Characteristics of the model

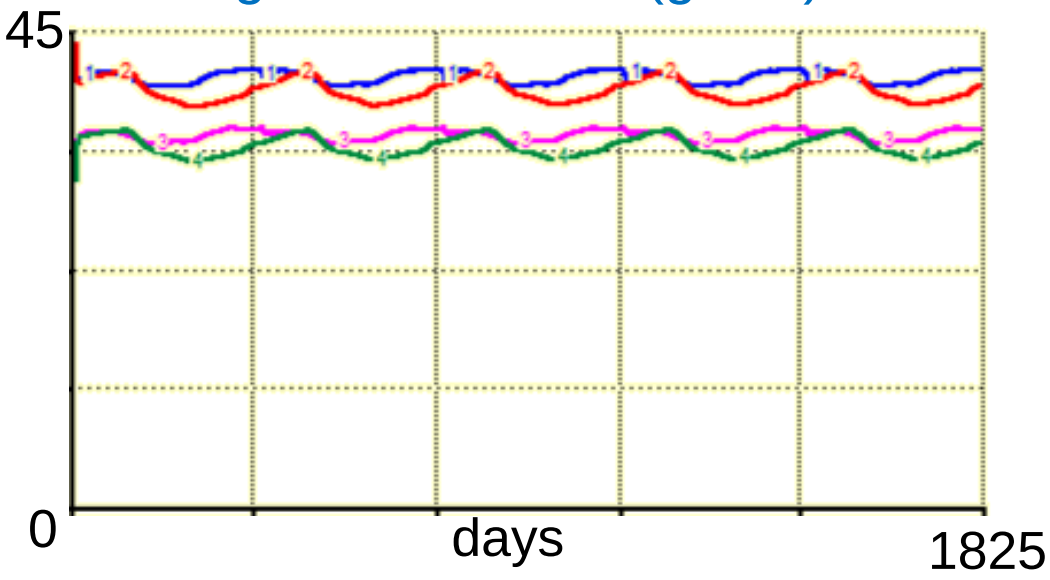
- Literature data on Lake Naivasha was used for parameterization
  - Precipitation and evaporation (Gaudet, 1979)
  - Irradiance (Muthuri *et al.,* 1989)
  - Biomass (Muthuri *et al.,* 1989; Jones and Muthuri, 1997; Boar *et al.,* 2006 and Saunders *et al.,* 2007)

- Model based on three existing models
  - Van der Peijl and Verhoeven, 1999
  - Jorgensen *et al.,* 2002
  - van Dam *et al.,* 2007

Water levels



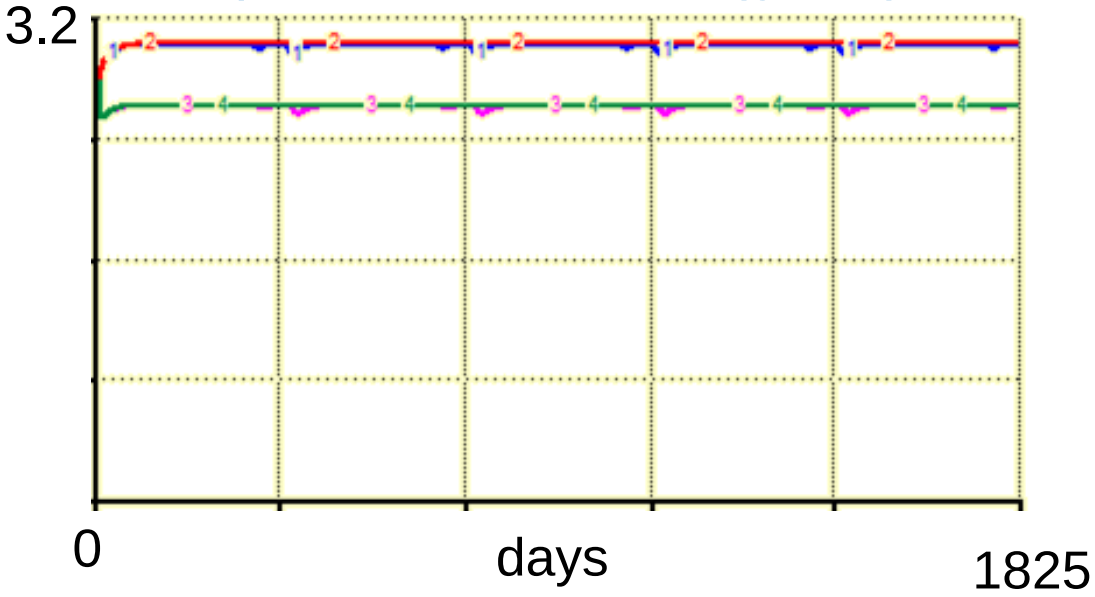
Nitrogen in biomass (g*m^{-2})



Literature values

ABG 44 g*m^{-2}
BGB 31 g*m^{-2}

Phosphorus in biomass (g*m^{-2})



ABG 2.6 g*m^{-2}
BGB 2.8 g*m^{-2}

Boar *et al*., 1999
Boar, 2006

Harvesting scenarios of above ground papyrus

Daily harvesting (e.g. 50%)

Biomass*0.5/365
(every day)

Batch harvesting (e.g. 50%)

Biomass*0.5
(once per year)

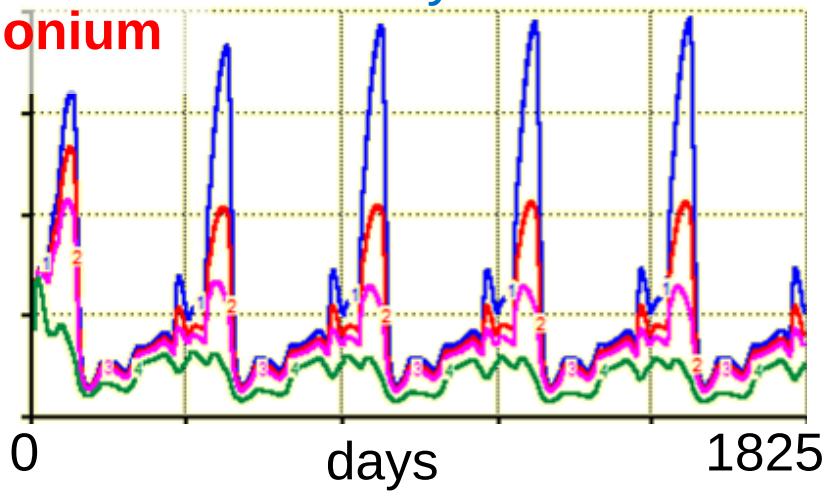
Ammonium and available phosphorus in outflow ($g*m^{-3}$)

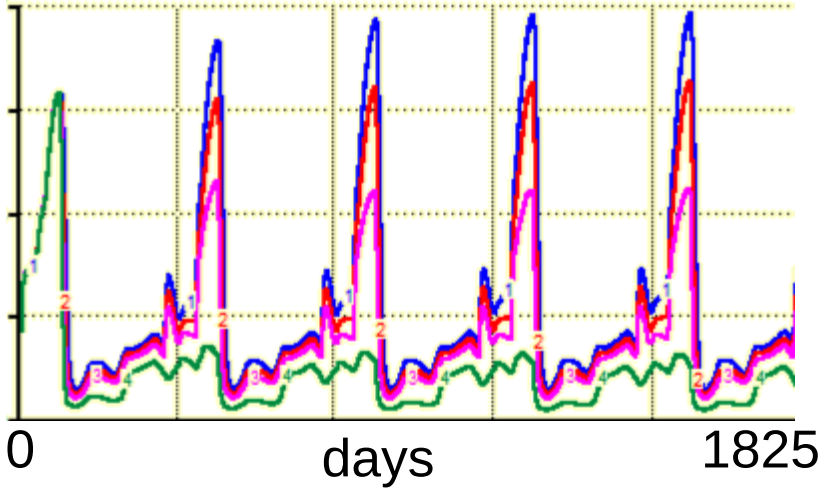
Harvesting 0%, 10%, 20% and 100%

Daily

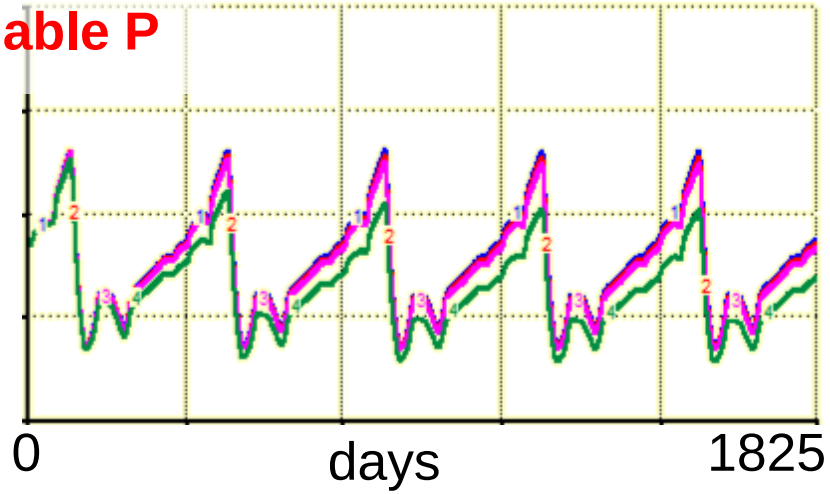
Batch

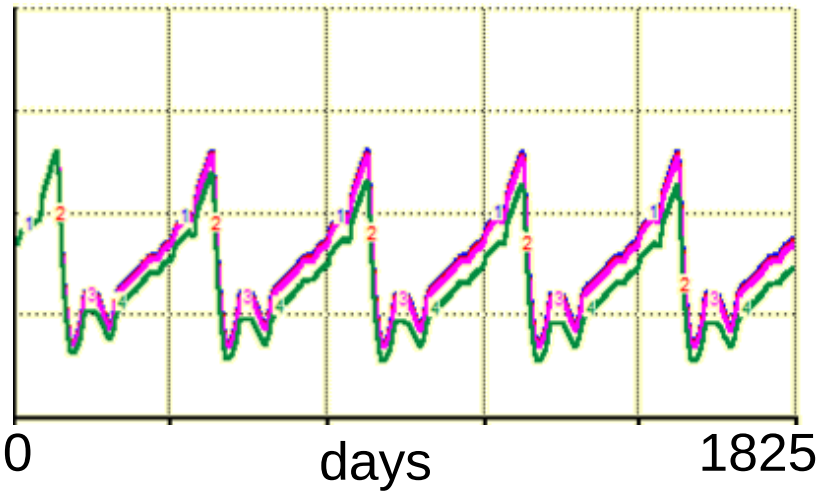
ammonium





available P



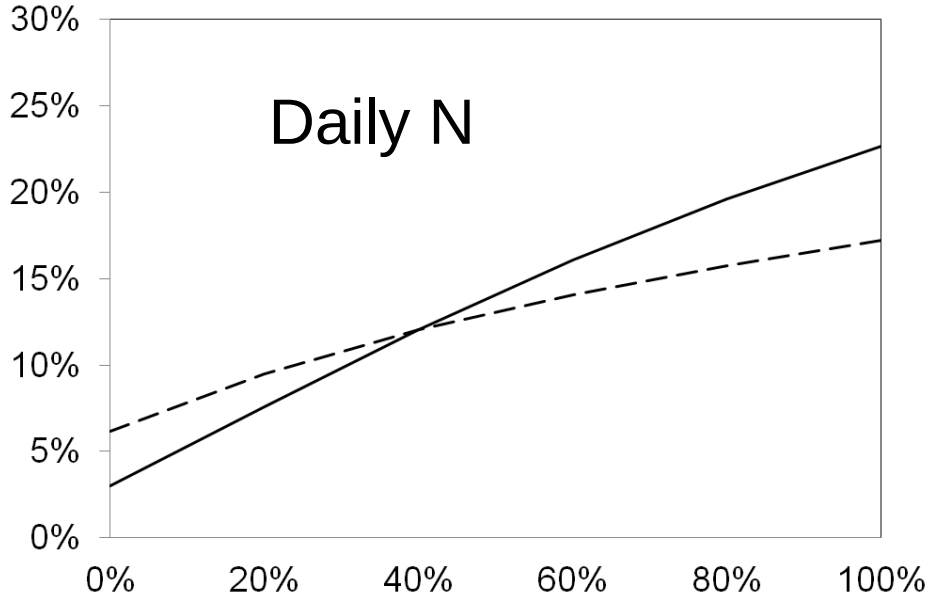


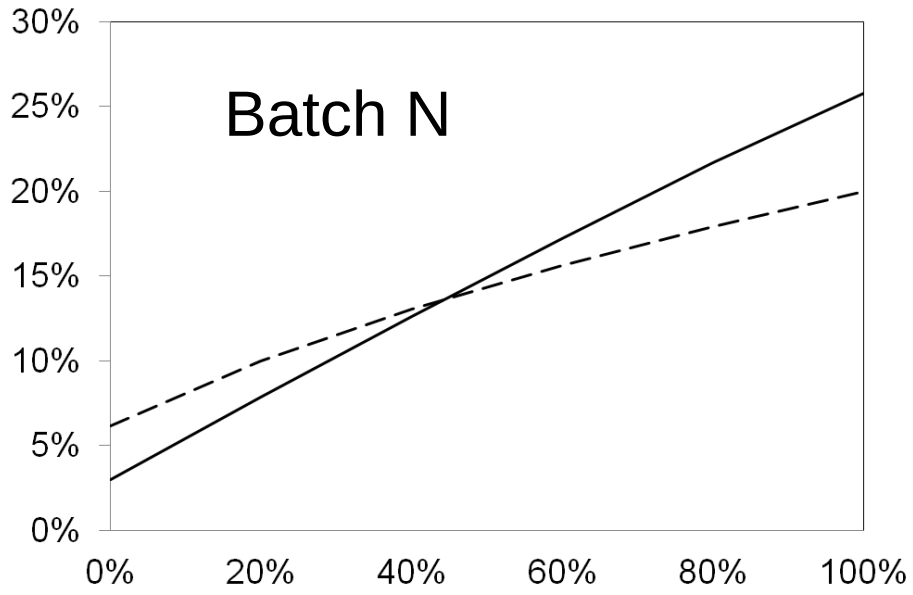
Results for effects of harvesting on N and P retention

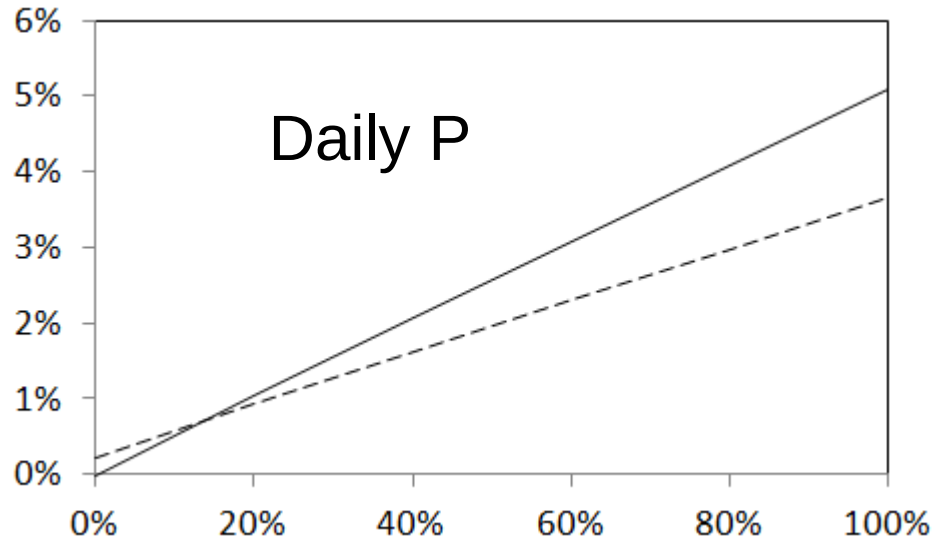
*Retention is defined as (IN – OUT)/IN * 100%*

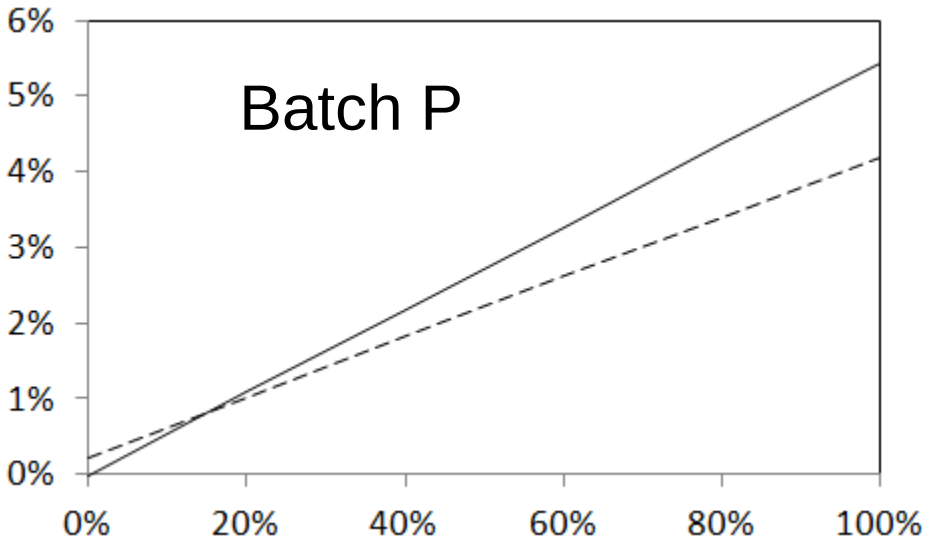
S wetland

P wetland









Discussion and conclusion nitrogen and phosphorus

- Papyrus wetlands play a role in buffering and removal of nitrogen and harvesting has a positive effect.
- Papyrus wetlands play a marginal role in buffering phosphorus.
- Converting papyrus to agricultural land in the dry season may have a positive effect of N retention
- Peat formation

Discussion and conclusion on differences between hydrology

- More N retention in seasonally flooded wetlands due to N limitation of uptake by papyrus in permanently flooded wetland with harvesting
- Without harvesting higher in permanently flooded wetland due to denitrification
- For other cases this may be different (nutrient loading)

Finally

Papyrus harvesting has a positive impact on nutrient retention as long as the papyrus is allowed to grow back and no fertilizer is applied

Papyrus wetlands do
retain nitrogen,
but phosphorus much less


Thank you!