SWAT APPLICATION TO ASSESS EFFECTS OF DIFFERENT FERTILIZATIONS ON WATER QUALITY IN AN AGRICULTURAL WATERSHED

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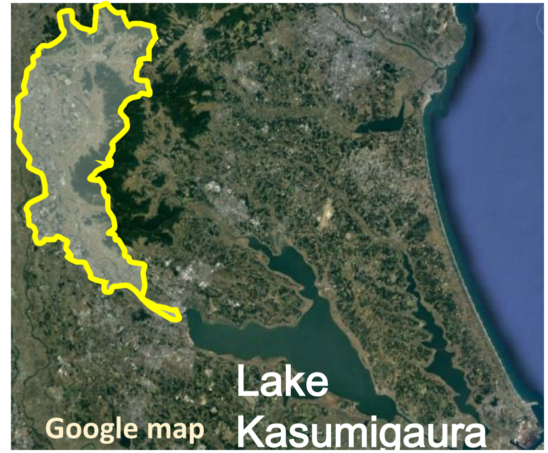
STUDY OUTLINE

Background

Human activity
- Agriculture
- Industry
- Domestic

Environment
- Water
- Soil
- Air



http://blogs.yahoo.co.jp/stockfan21/13842604.html

Objective : To study the desirable balance of agriculture and water conservation

Methods

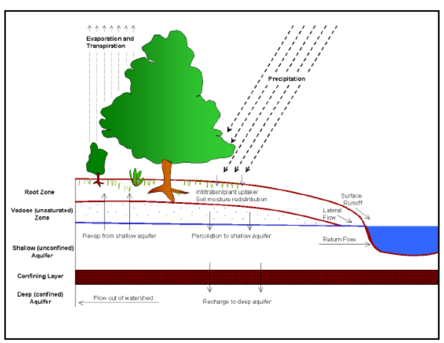
SWAT (Soil and Water Assessment Tool) by USDA

Many physical models and empirical parameters are included in the tool.

★**Estimation** of water, sediment(SED) and nutrient movement

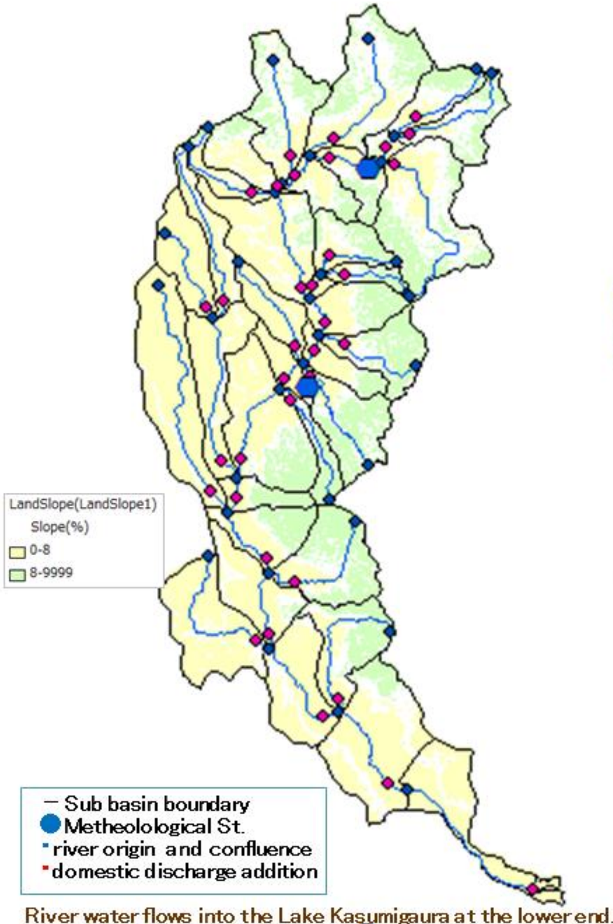
★**Scenario analysis**

・・・Assessing effects of different fertilizations on water quality in an agricultural watershed

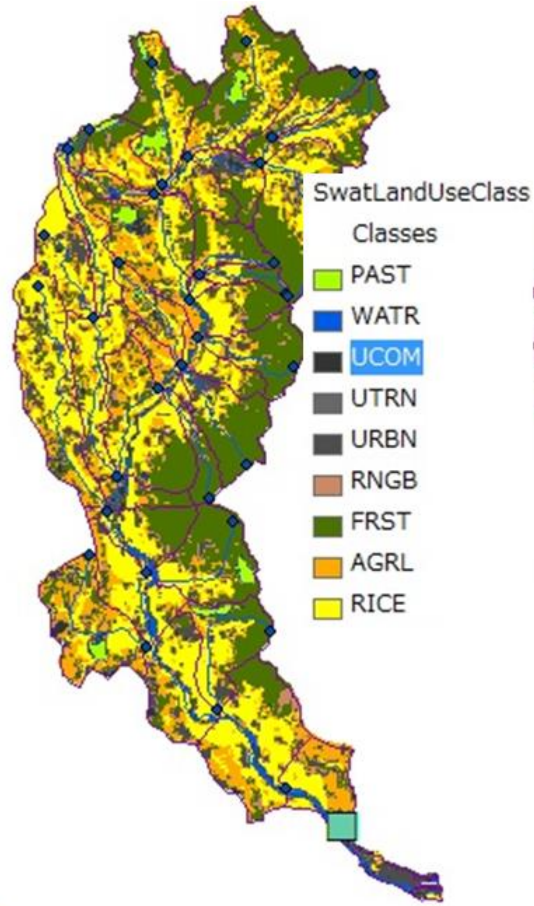


Schematic representation of the hydrologic cycle.

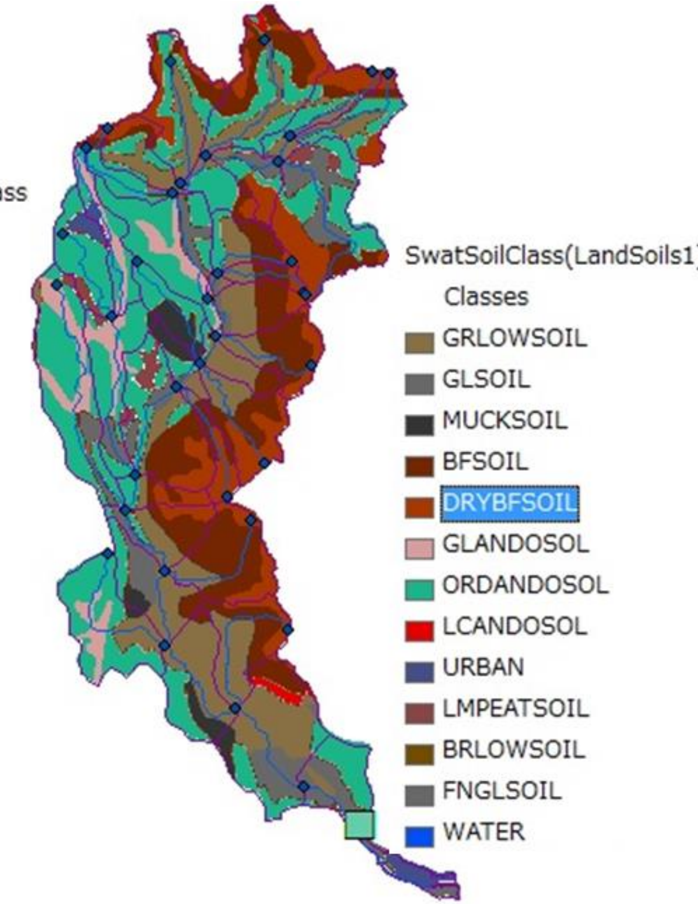
Study area: Sakura River Watershed



DEM



Land Use Map



Soil Map

Outline for Sakura River Watershed

Area 335km^2, ⊿H 853m, subbasin 35, HRU 424 (Threshold: LandUse/Soil/Slope=5% /10% /20%)

LundUse: Forest 34%, Paddy (RICE) 29%, Upland fileds (AGRL) 20%, Urban (residence, road etc.) 14%, Water 2%, Pasture 1%, others 1%

Soil: Andisol 32%, Glay lowland soil 20%, Brown forest soil 29%, Gley soil 9%, Andic gley soil 5%, Black soil 2%, others 3%

Other Input data for model configuration

Weather data ･･･precipitation, temperature, radiation etc. at 3 meteorological stations
Soil-profile physical properties data (Solphy-J, NARO)
Irrigation water supplying data
General crop management (fertilization, tillage etc.)
Domestic discharge (cf. Ibaraki Pref. data)
Constant flow out from each sub basin in proportion to its urban area.
water 0.2m^3, SED 1g, TN 2g, TP 0.2g /capita/day

SWAT Run

Analytical methods
"Daily Rain/CN (curve number) /Daily Route" method for surface runoff
"Penman/Monteith " method for evapotranspiration

Calibration

Comparing modeled flow, sediment, Org-N, NO_3-N, Org-P, Min-P
with observed data from Ministry of the Environment and Ibaraki pref.

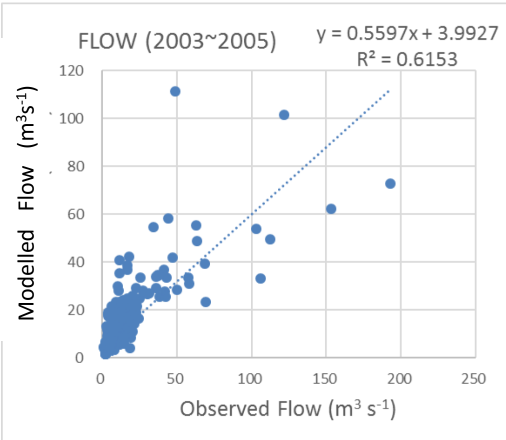
Parameterization

Fine adjustment of parameters using SWAT-CUP
(calibration/uncertainty or sensitivity program interface for SWAT)

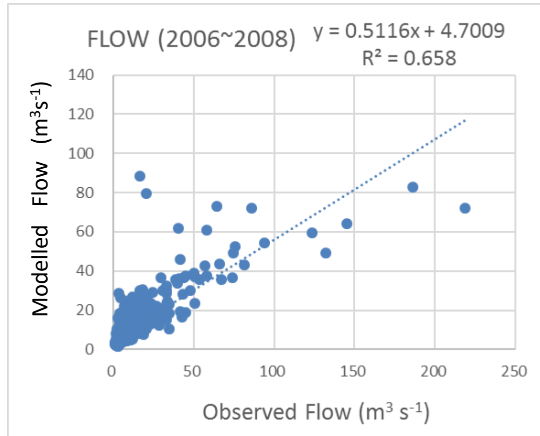
Validation

Comparing modeled values with observed data
Evaluation by R^2 and NS (Nash-Sutcliffe model efficiency coefficient)
Warm-up (2000~2002), Calibration (2003~2005), Validation (2006~2008)

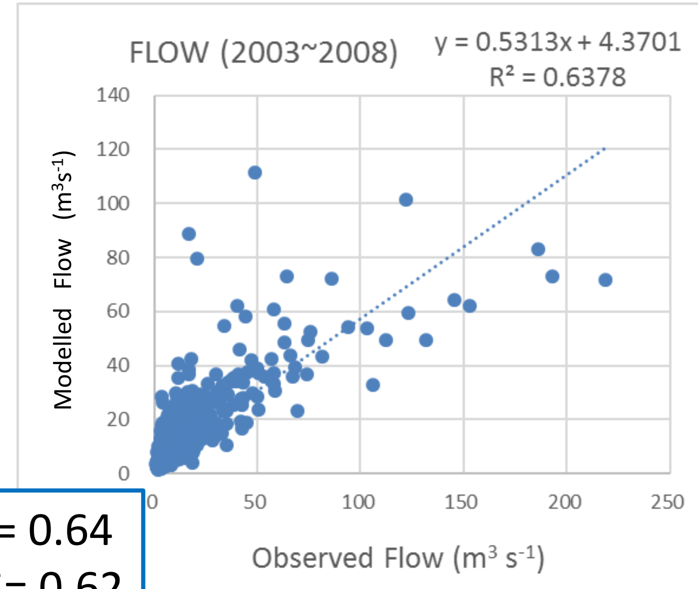
RESULTS Flow



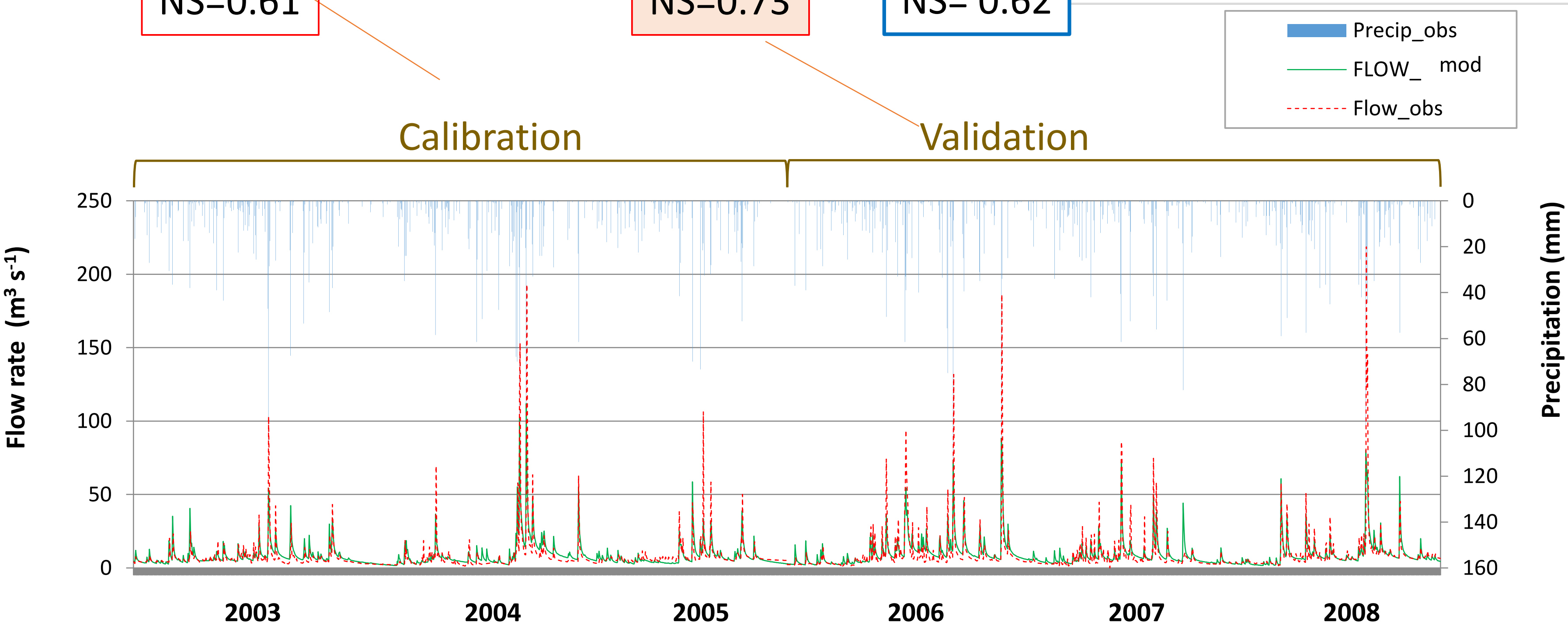
R^2=0.62
NS=0.61



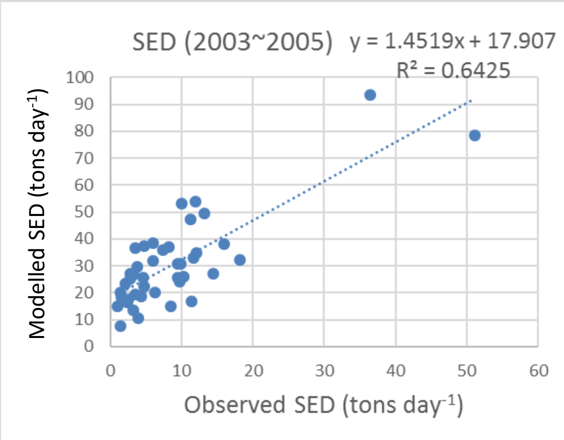
R^2=0.66
NS=0.73

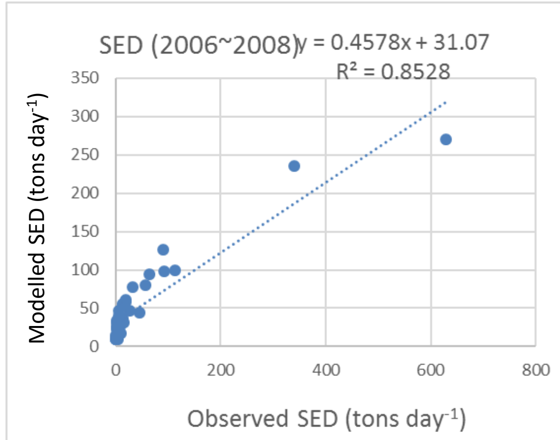


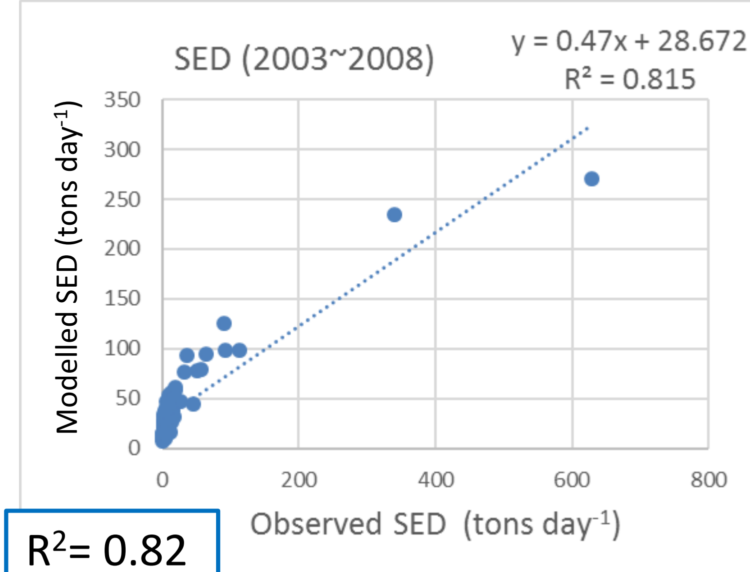
R^2= 0.64
NS= 0.62



Sediment



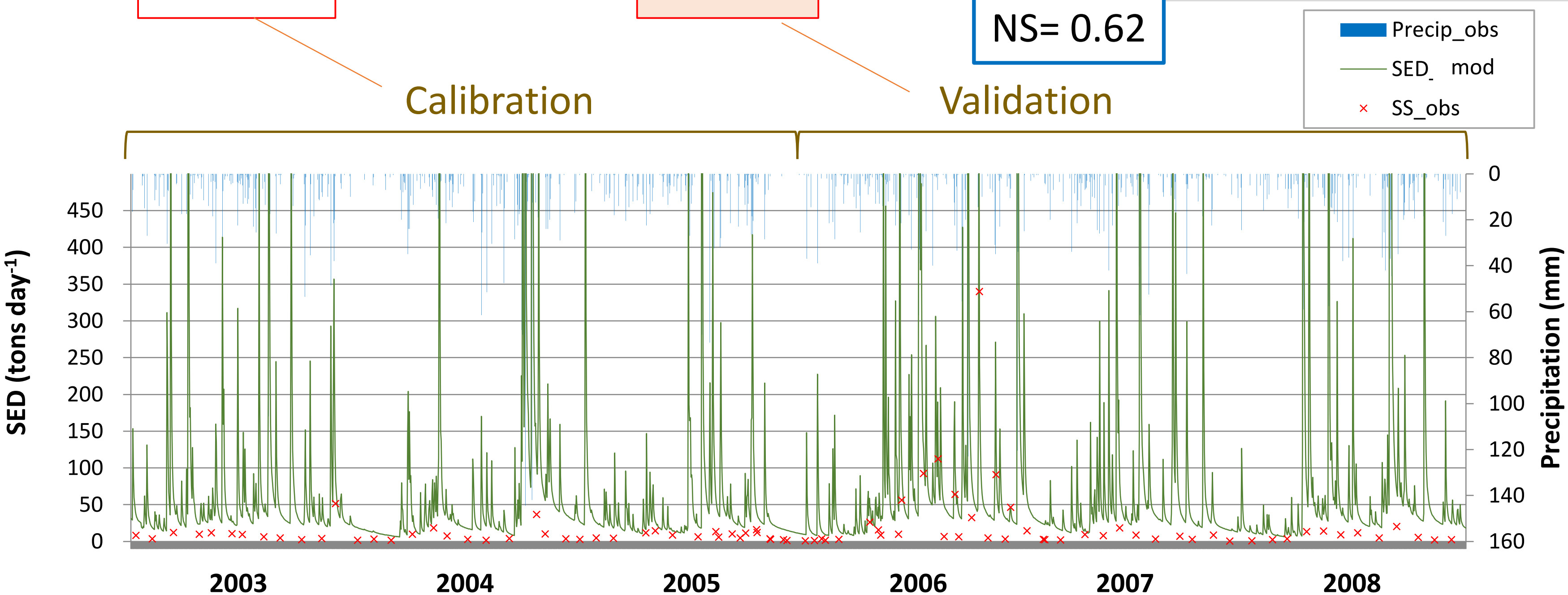




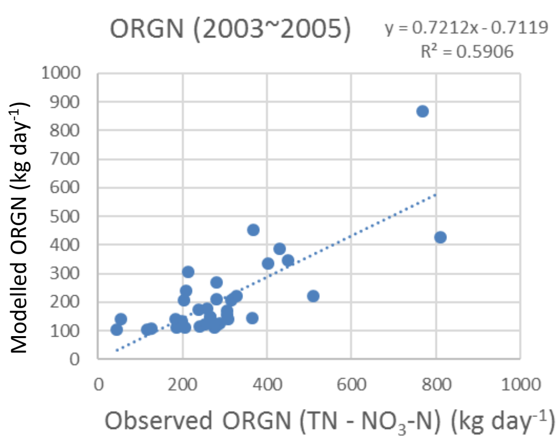
R^2=0.64
NS=-6.15

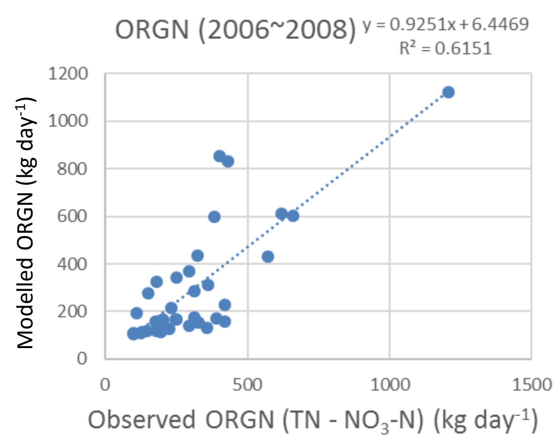
R^2=0.85
NS=0.66

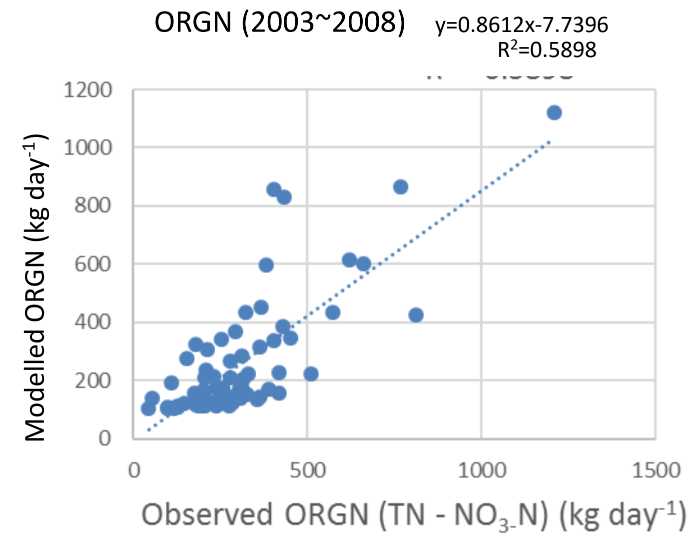
R^2= 0.82
NS= 0.62



Org-N



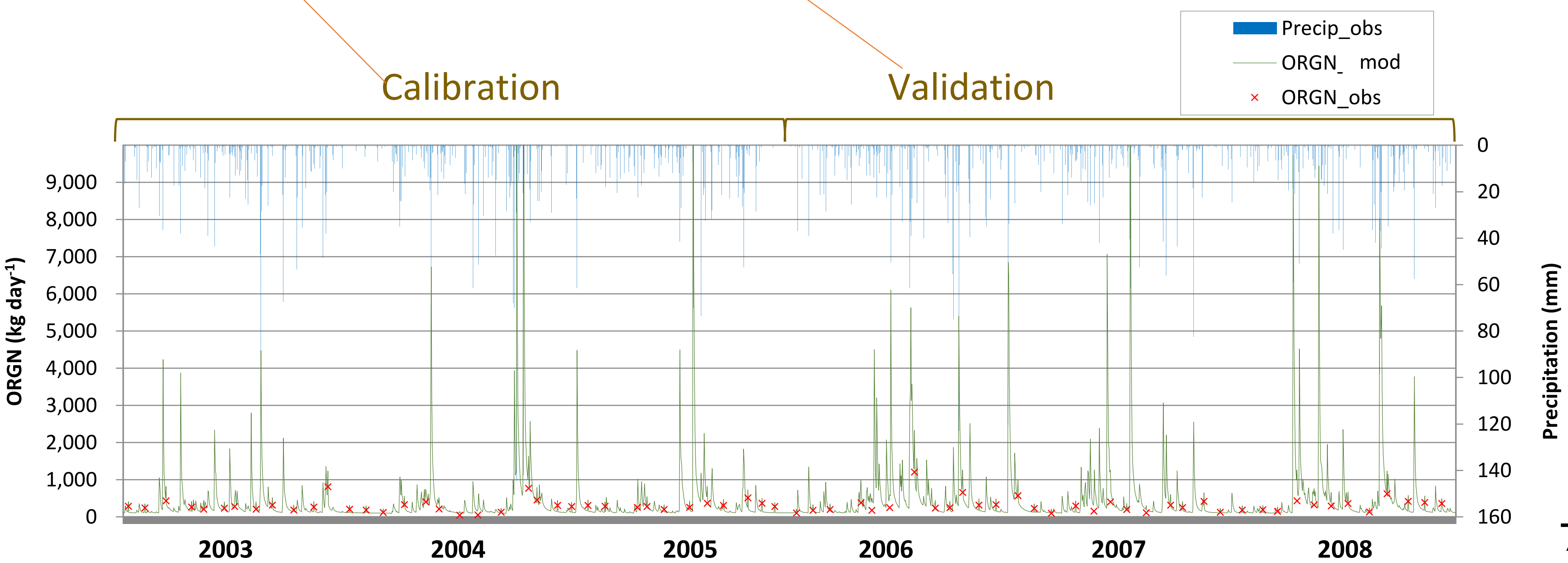




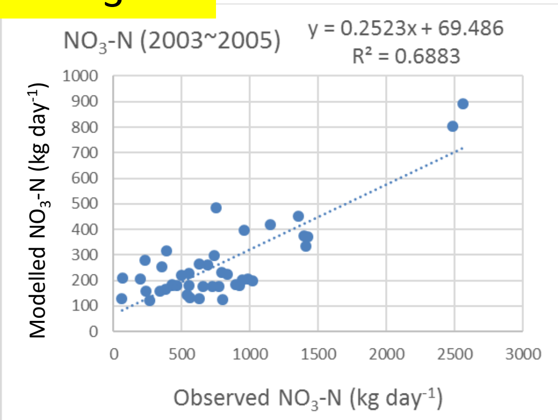
R^2=0.59
NS=0.27

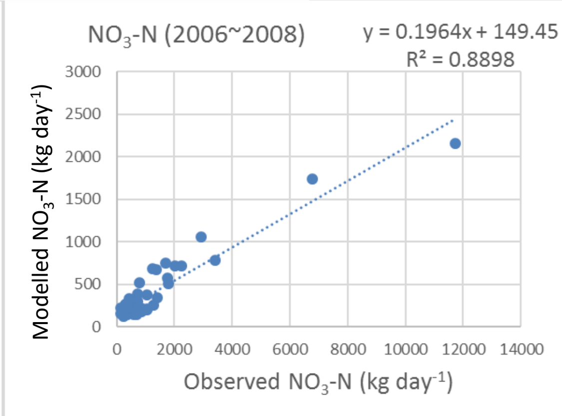
R^2=0.62
NS=0.45

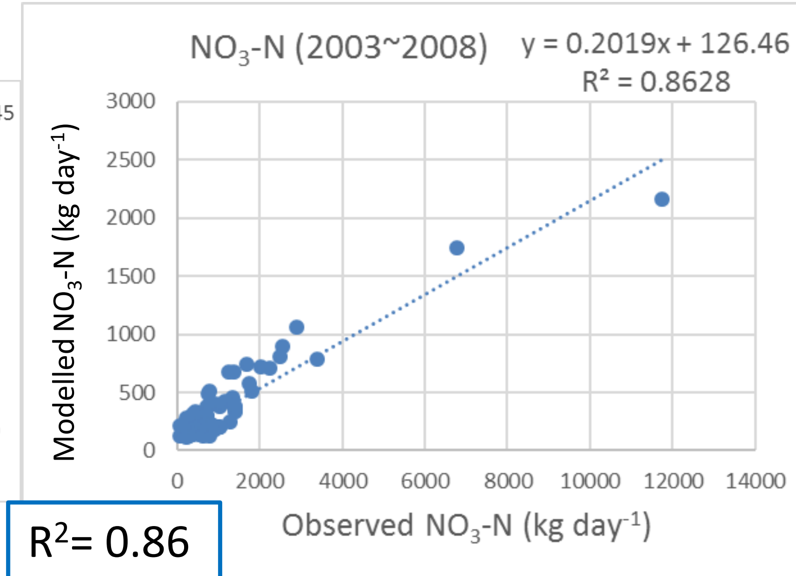
R^2= 0.59
NS= 0.39



NO_3-N



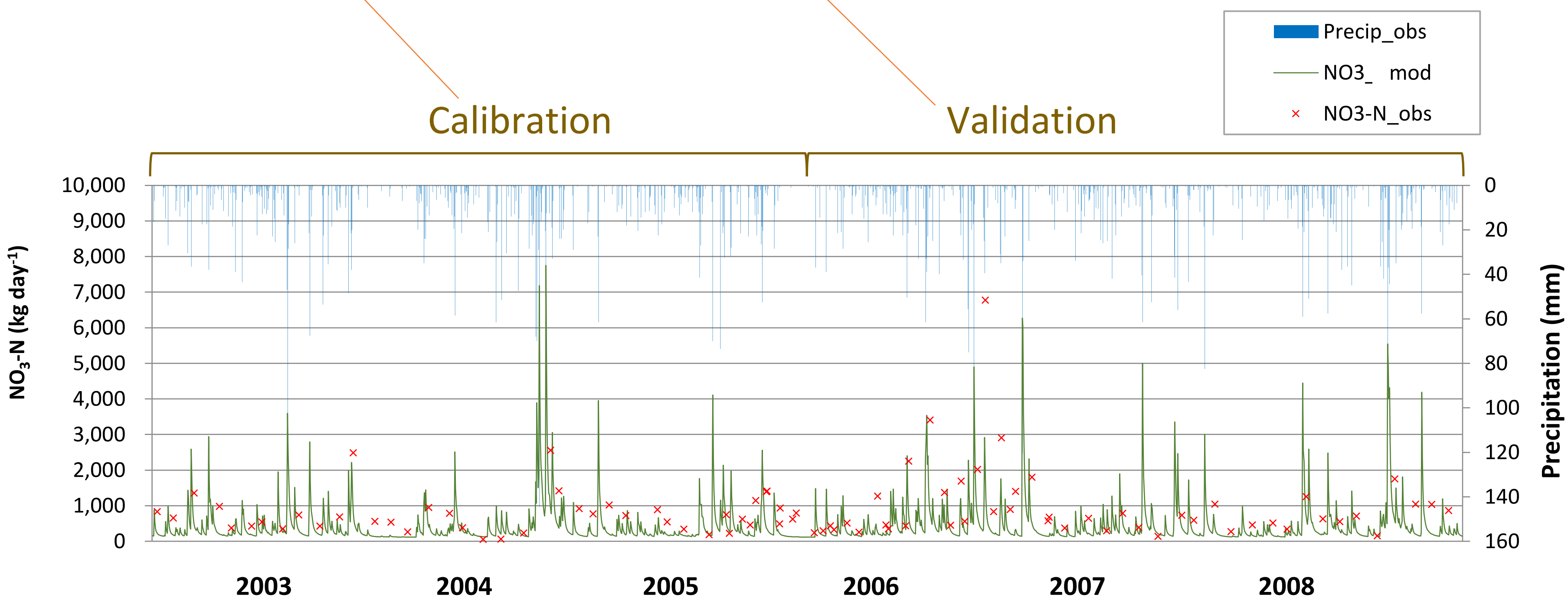




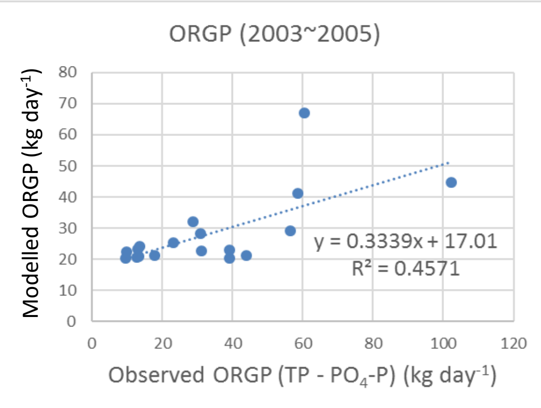
R^2=0.69
NS=-0.50

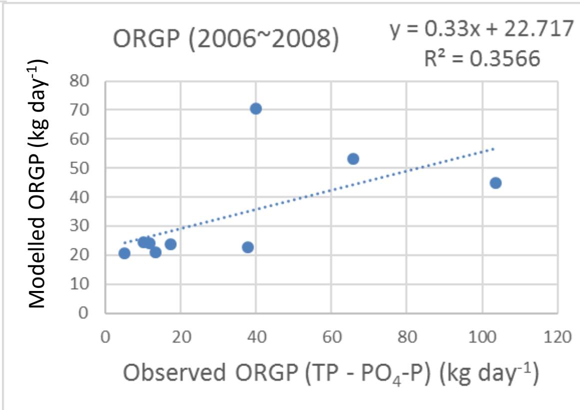
R^2=0.89
NS=0.15

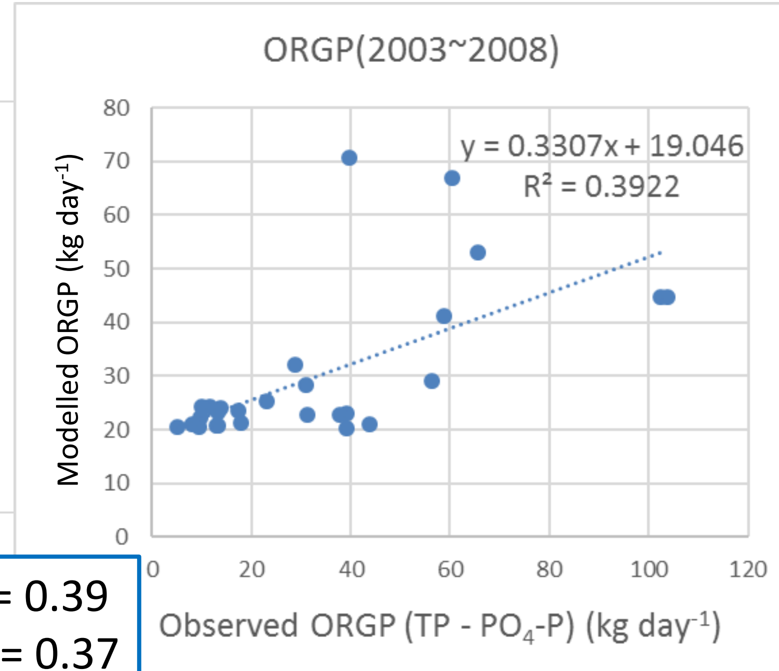
R^2= 0.86
NS= 0.13



Org-P



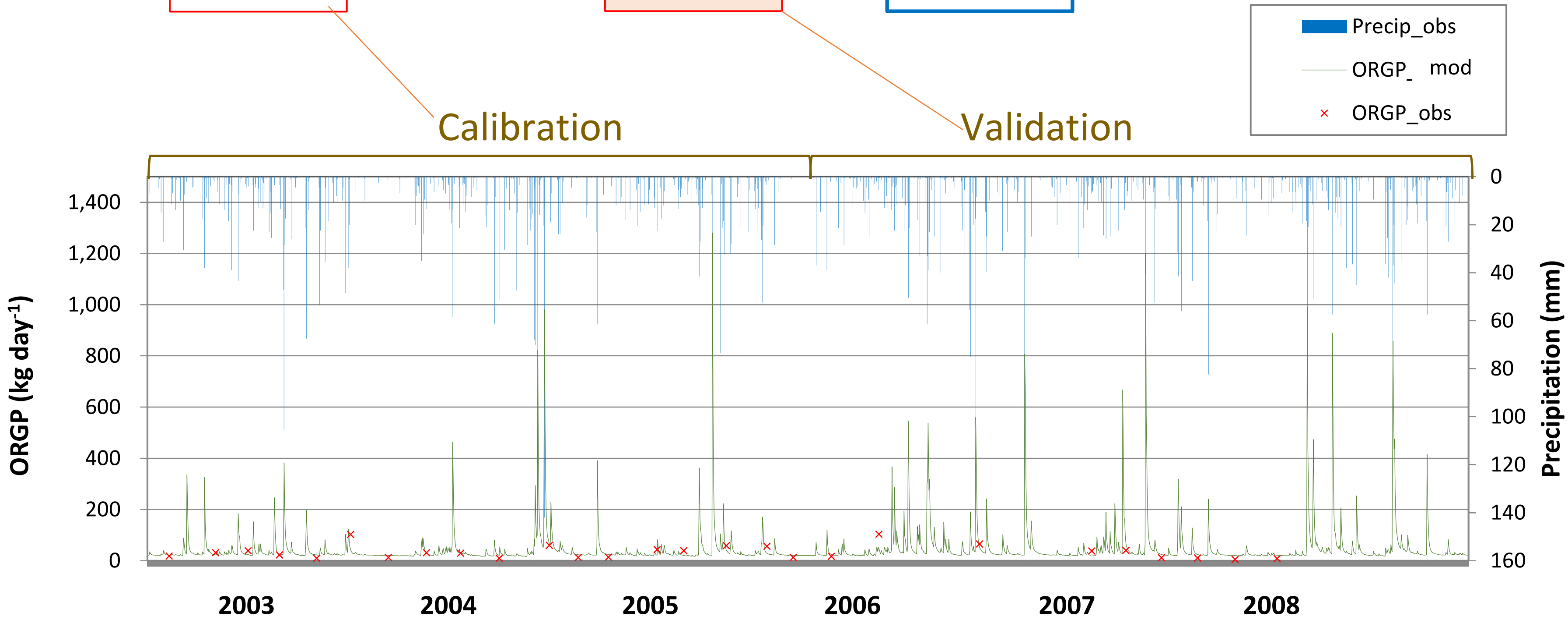




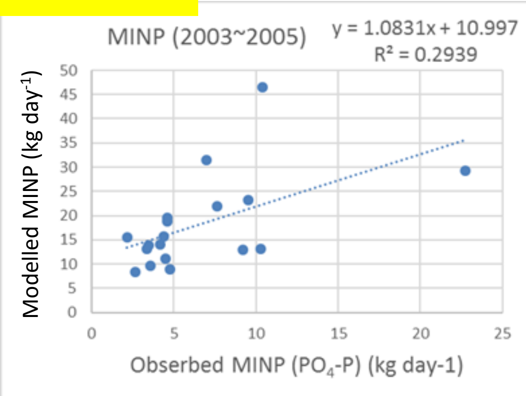
R^2=0.46
NS=0.37

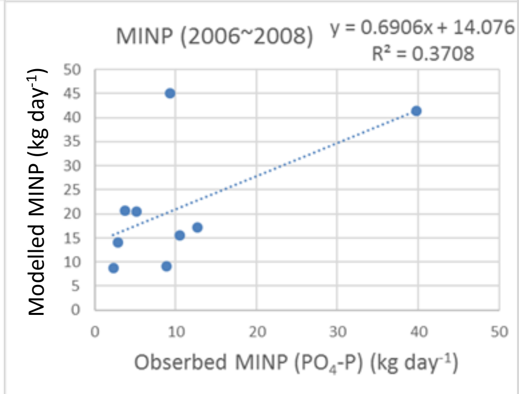
R^2=0.36
NS=0.36

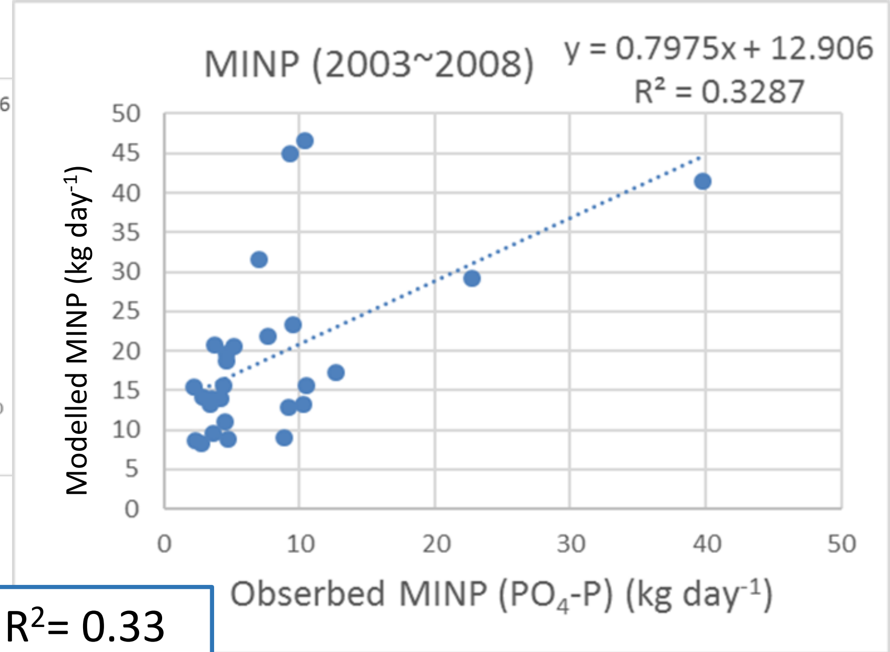
R^2= 0.39
NS= 0.37



Min-P



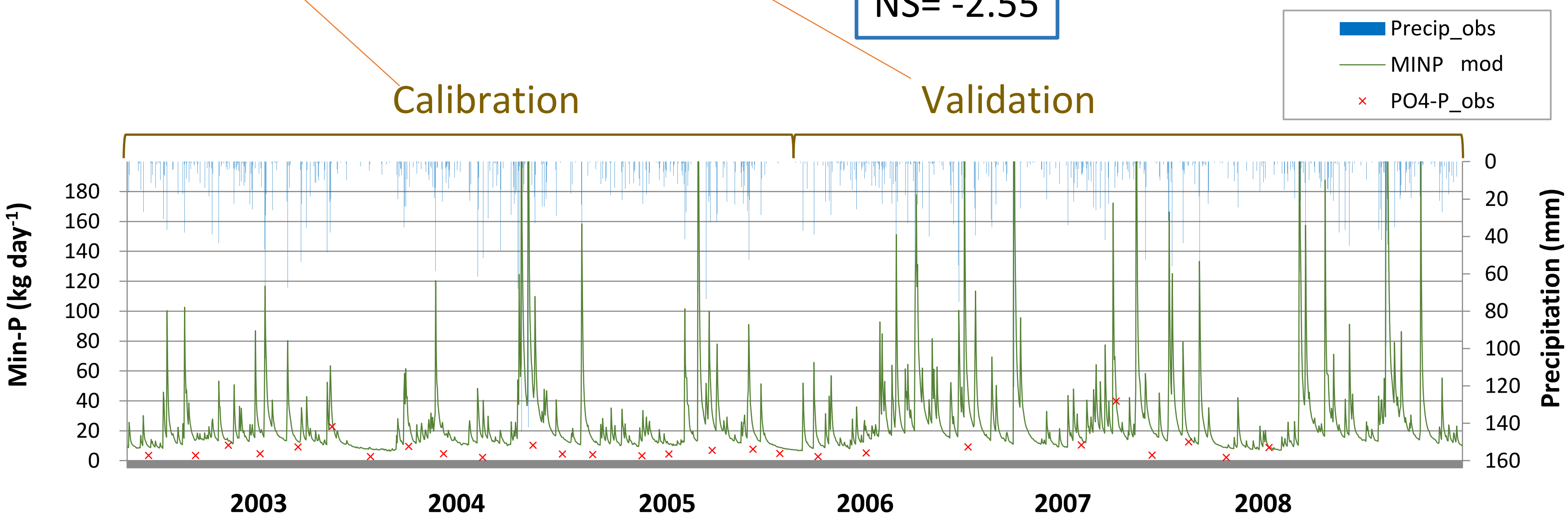




R^2=0.29
NS=-7.89

R^2=0.37
NS=-0.89

R^2= 0.33
NS= -2.55

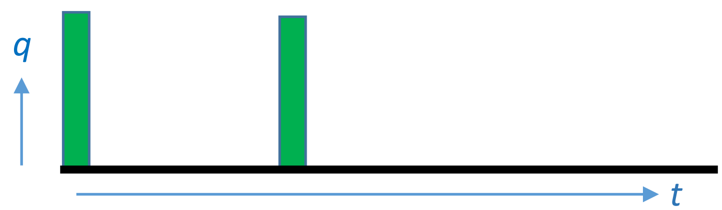


Simulated Min-P (mainly Ortho-P) overestimated measured Ortho-P. It might be caused from high phosphoric acid absorptivity of Andisols which spread widely in the watershed.

Acceptable estimation for flow, SED, N → **Scenario analysis**

CURRENT MANAGEMENT SETTING

Basal and additional fertilization

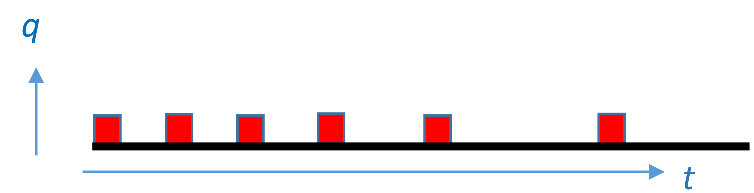


Fertilization pattern image

- Paddy ; basal fertilization at transplanting as chemical fertilizer (25-05-00)
  N80kg/ha, P16kg/ha
- Upland ; basal fertilization as chemical fertilizer
  N100kg/ha, P45kg/ha
  additional fertilization as chemical fertilizer
  N100kg/ha
- Pasture ; leaping 4 times/year
  auto fertilization as chemical fertilizer (25-05-00)
  （each N 10kg/ha, max N 20kg/ha × 4）

REVISED MANAGEMENT SETTING

Small and frequent fertilization



Fertilization pattern image

- Paddy ; auto fertilization as chemical fertilizer(25-05-00)
  (each N 10kg/ha &P2kg/ha, max N80kg/ha & P16kg/ha)
- Upland ; auto fertilization as chemical fertilizer(25-05-00)
  (each N 10kg/ha & P 2kg/ha, max N100kg/ha & P 20kg/ha)
- Pasture ; leaping 4 times/year
  auto fertilization as chemical fertilizer(25-05-00)
  （each N 2kg/ha, max N18kg/ha × 4）

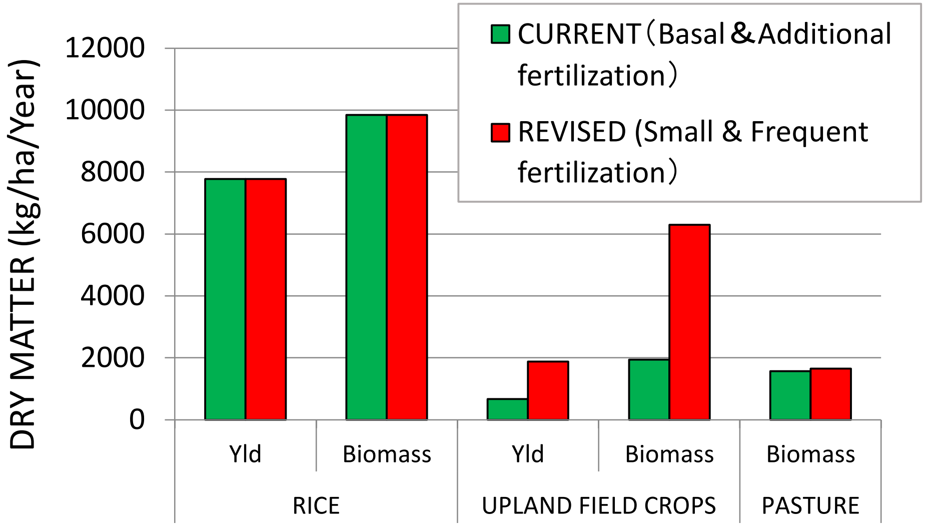
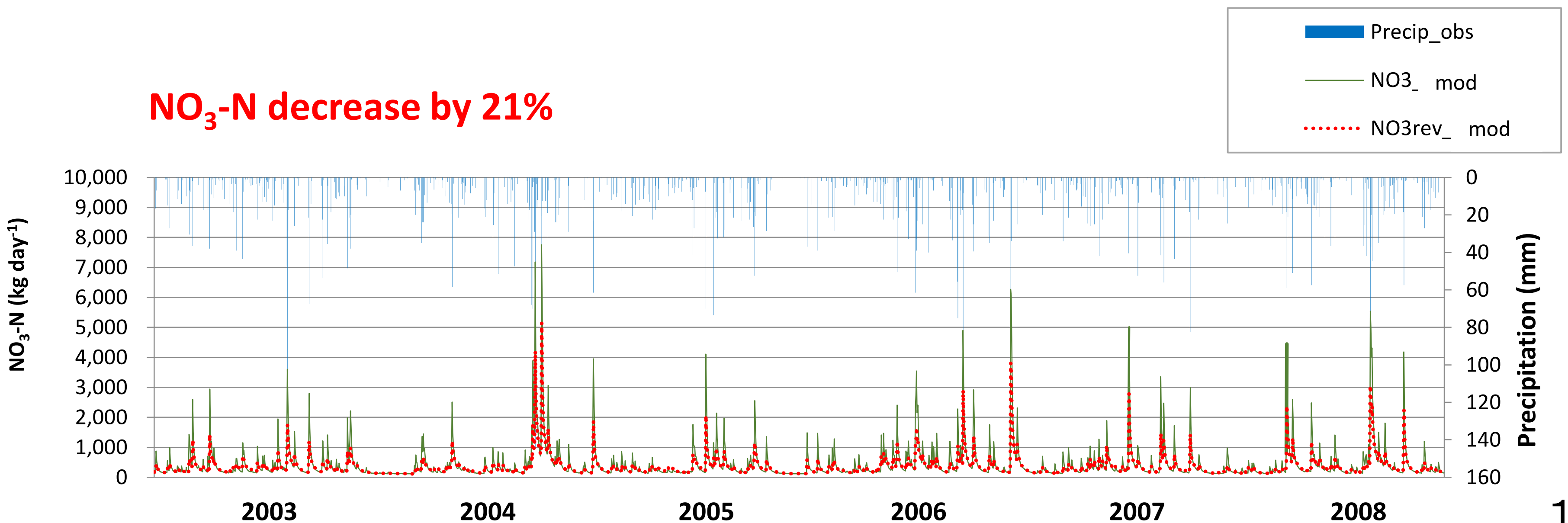


Fig.　Comparison of Crop Yields

By introducing revised fertilization (smaller and more frequent fertilization) to paddy, upland and pasture fields, equal or greater crop yields were estimated with smaller amount of N application and mitigated NO_3-N discharge.

NO_3-N decrease by 21%



CONCLUSION

SWAT was applied to assess effects of different fertilizations on water quality in an agricultural watershed. The results of scenario analysis for agricultural management changes showed that smaller and more frequent fertilization was effective for crop production and decrease in fertilizer application and water pollution.

Thank you very much for your attention.

We thank Ibaraki Prefecture for providing useful data and help to attend WLC16 conference.