PREDICTING THE IMPACTS OF AGRICULTURAL MANAGEMENT PRACTICES ON WATER, SEDIMENTS AND PHOSPHORUS LOAD

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MOTIVATION

Southern Brazil:

Shallow and stony soils
Steeper slopes

+

Vegetation removal
Intensive agriculture

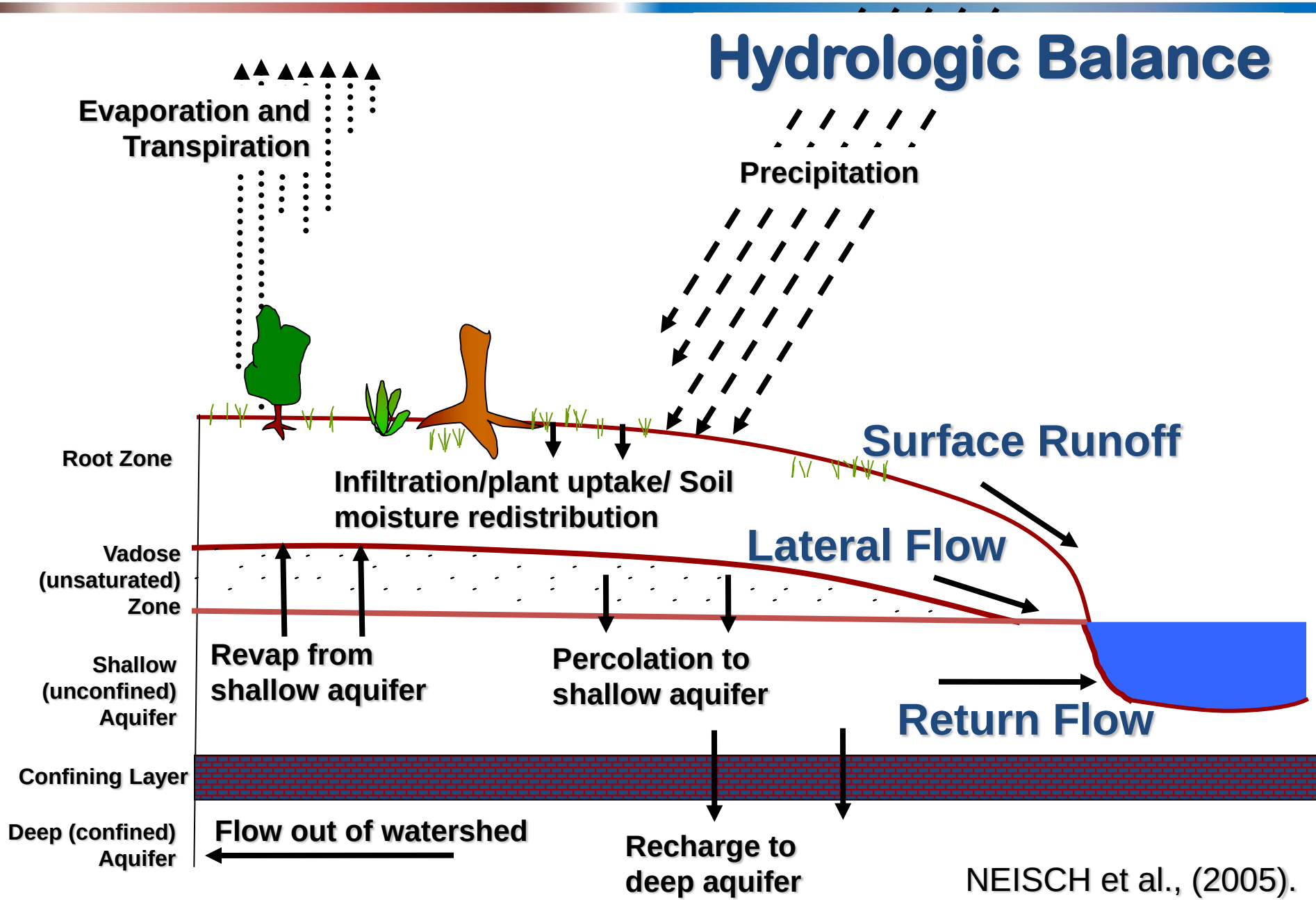
Soil Erosion

Transfer of pollutants
to surface waters

Source: Sequinatto (2007), pictures: Kaiser, D.R.; Pellegrini, A.

SWAT model

Hydrologic Balance



NEISCH et al., (2005).

Sediments:

MUSLE (Modified Universal Soil Loss Equation)

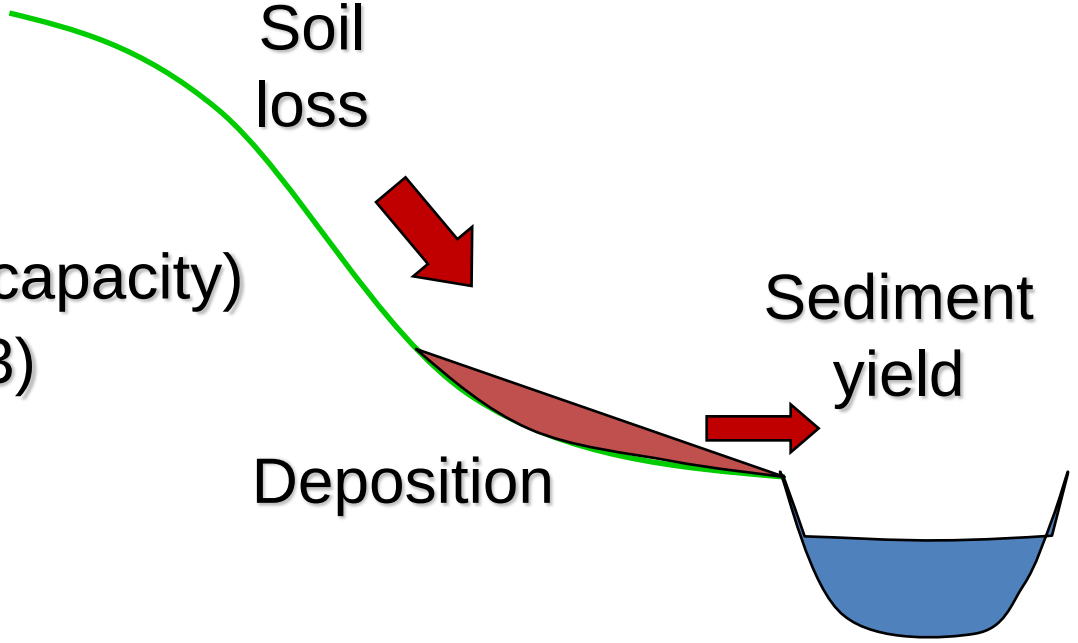
(Williams, 1975)

+

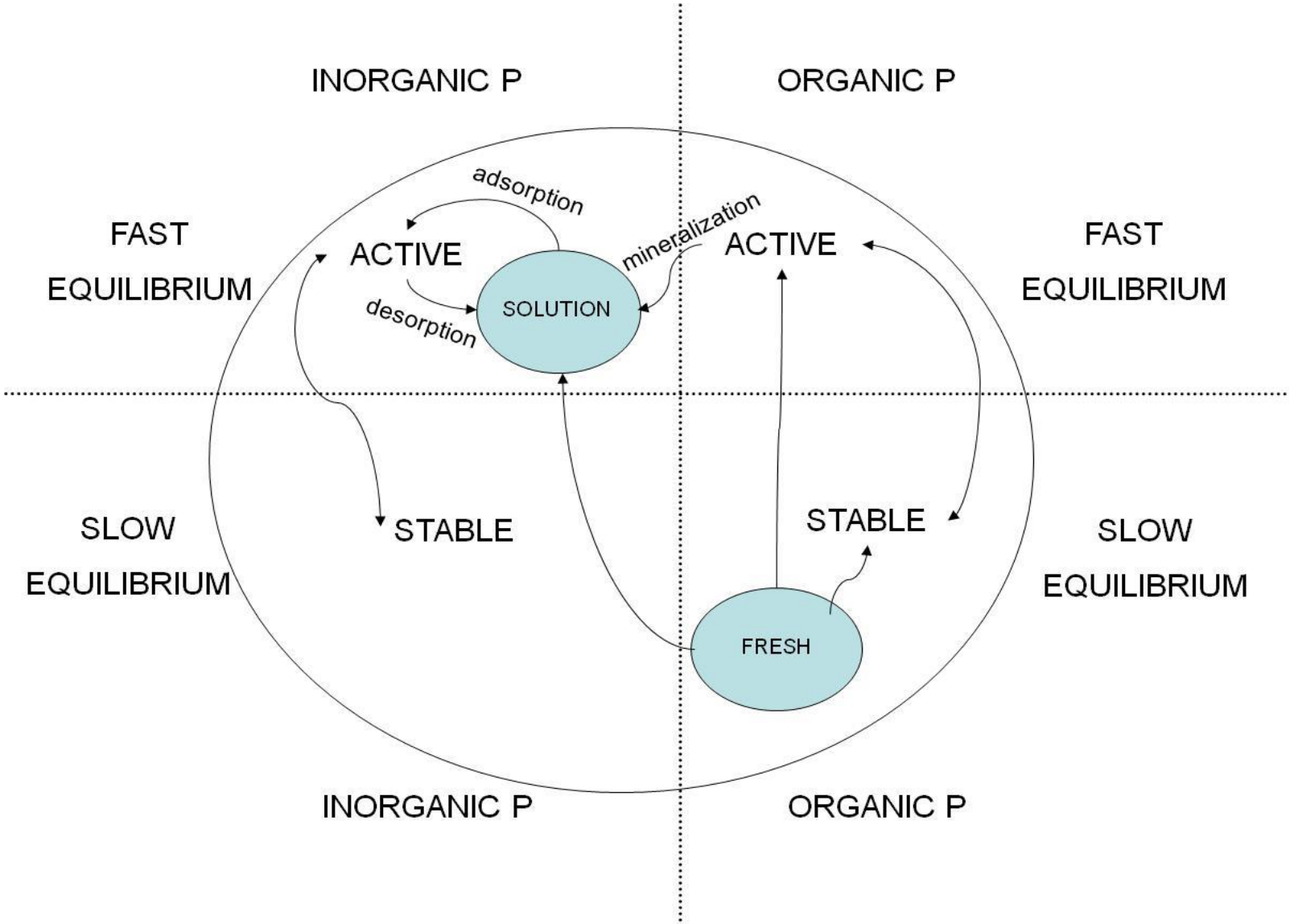
LTC (Landscape transport capacity)
(Bonuma et al., 2013)

=

Sediment Yield



Phosphorus cycle



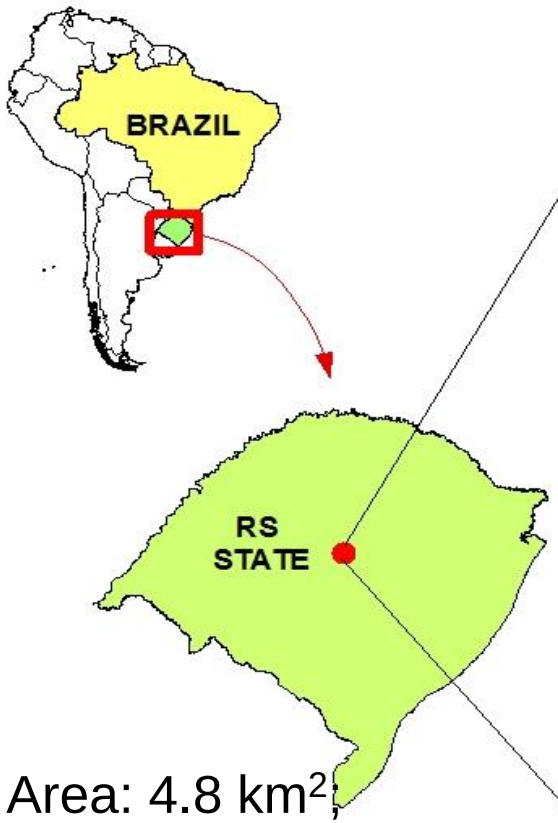
OBJECTIVES

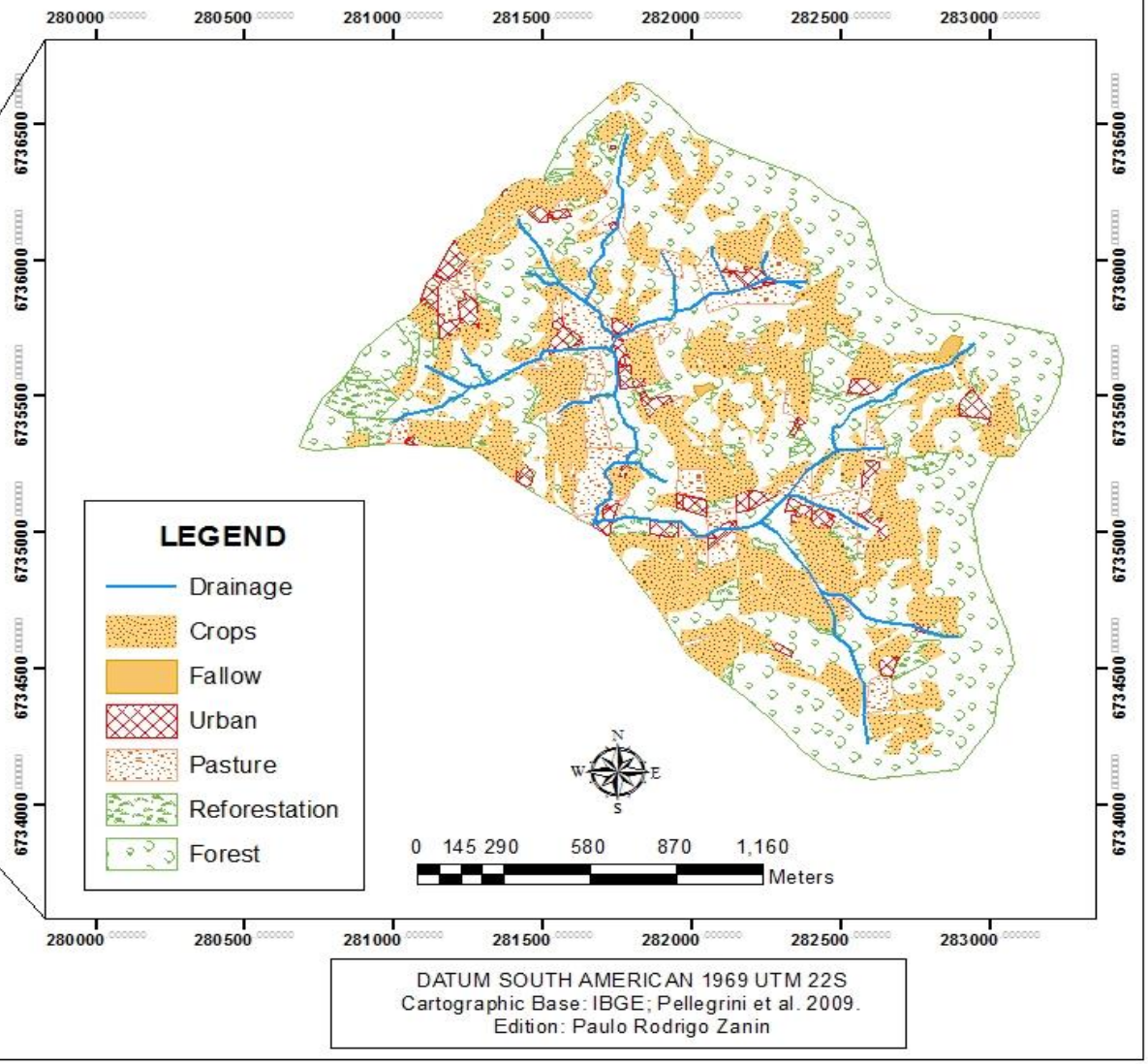
To **evaluate** the land use and **management alternatives** on the **water balance**, **sediment yield** and **phosphorus transfer** with the **SWAT model** for the **Arroio Lino watershed** located in Southern Brazil.

i. To assess hydrological processes, sediment and phosphorus transfer simulations with SWAT model

ii. To make realistic predictions of the impacts of agricultural management changes on the water, sediments and phosphorus loads.

Arroio Lino watershed:





- Area: 4.8 km^2;
- Topography: hilly.
- Annual rainfall: 1500 mm

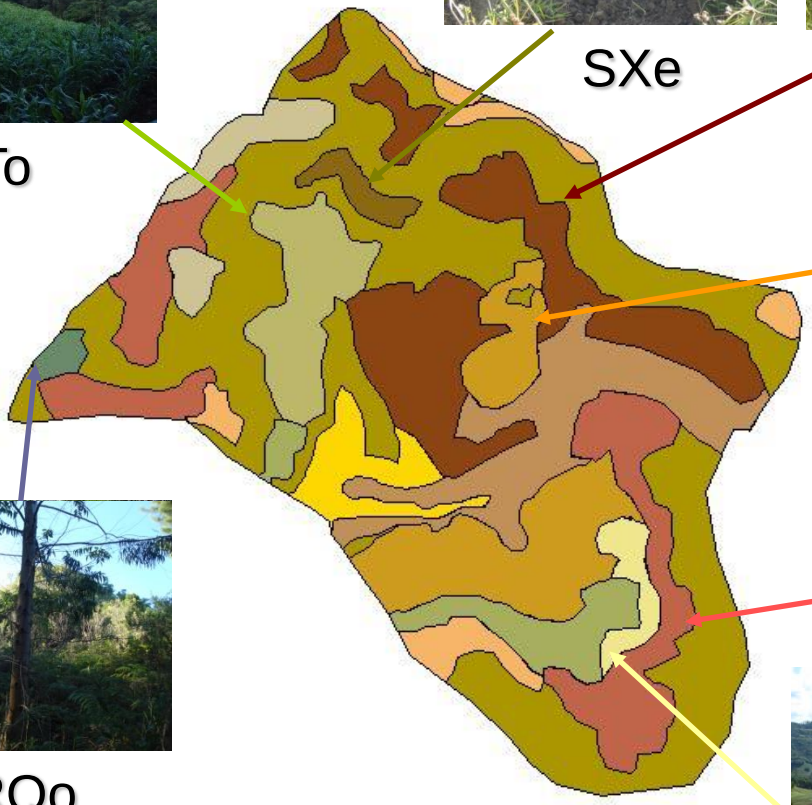
INPUT DATA

SOILS:

MTo

SXe

RLe



MXo

RQo

CXVd

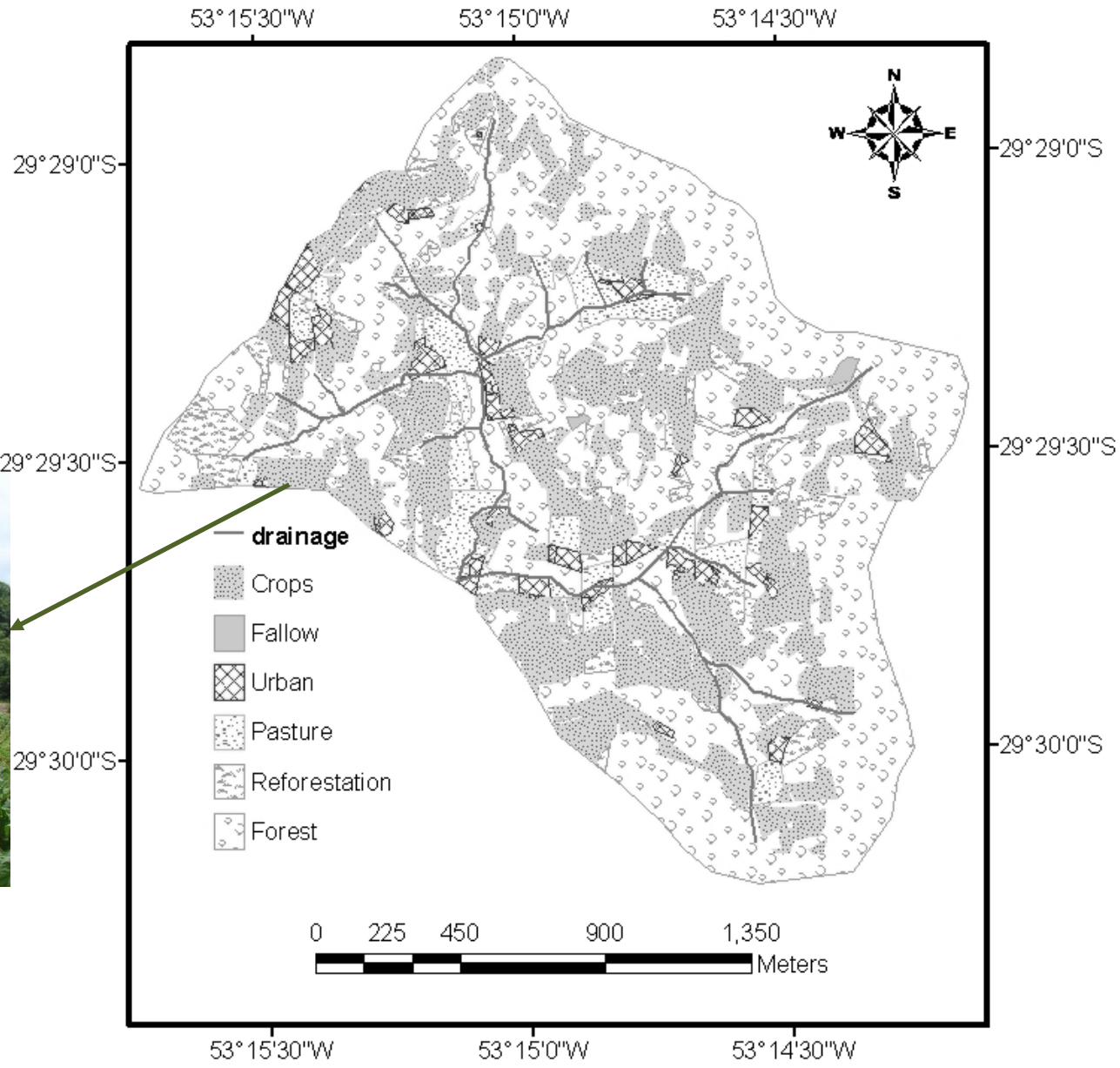
PAe

Source: Adapted from Dalmolin et al., (2004)

INPUT DATA

LAND USE:

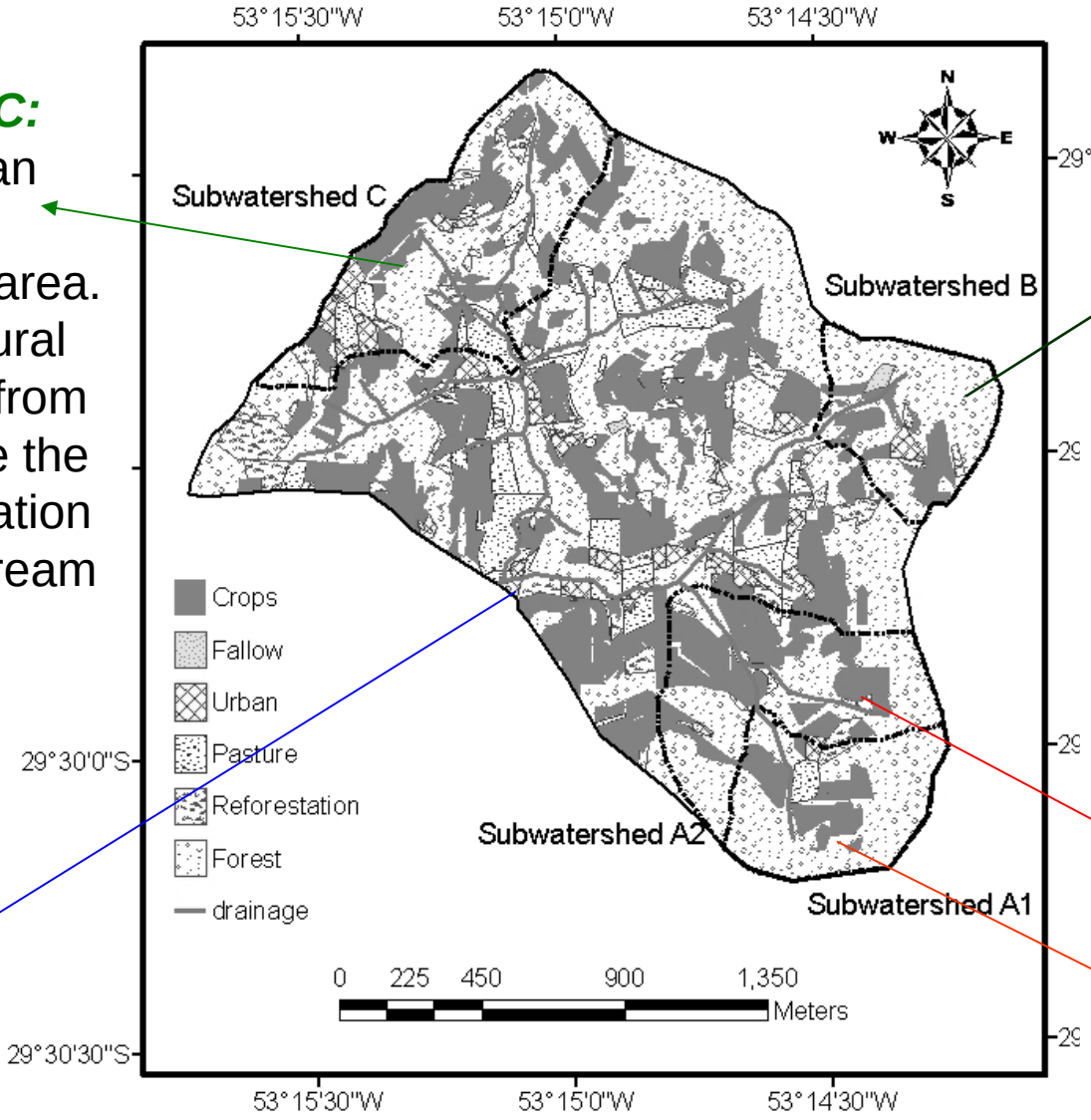
Tobacco crops
(~25%)



INPUT DATA

Water quality sample points:

Subbasin C:
High human activities.
Crops = 25% area.
The agricultural fields are far from streams since the natural vegetation are around stream areas.



Outlet

Subbasin B:
Low human activities.
Crops = 16% area

Subbasin A:
High human activities. Agricultural fields are closed to streams, no protection by vegetation.

Subbasin A1:
Crops = 12% of drainage area

Subbasin A2:
Crops=25% of drainage area

Source: Adapted from Pellegrini et al., (2009)

METHODS

Input data

Simulation

Baseflow filter (Arnold and Allen, 1999)

Water balance analysis

Statistical analysis

Measured data

Flow, Sediments, P: (NSE, PBIAS, RSR*, r^2)

NO

Manual calibration + auto-calibration SCE-UA (Green and van Griensven, 2008)

Sensitivity analysis LH-OAT *(Van Griensven et al., 2005)*

YES

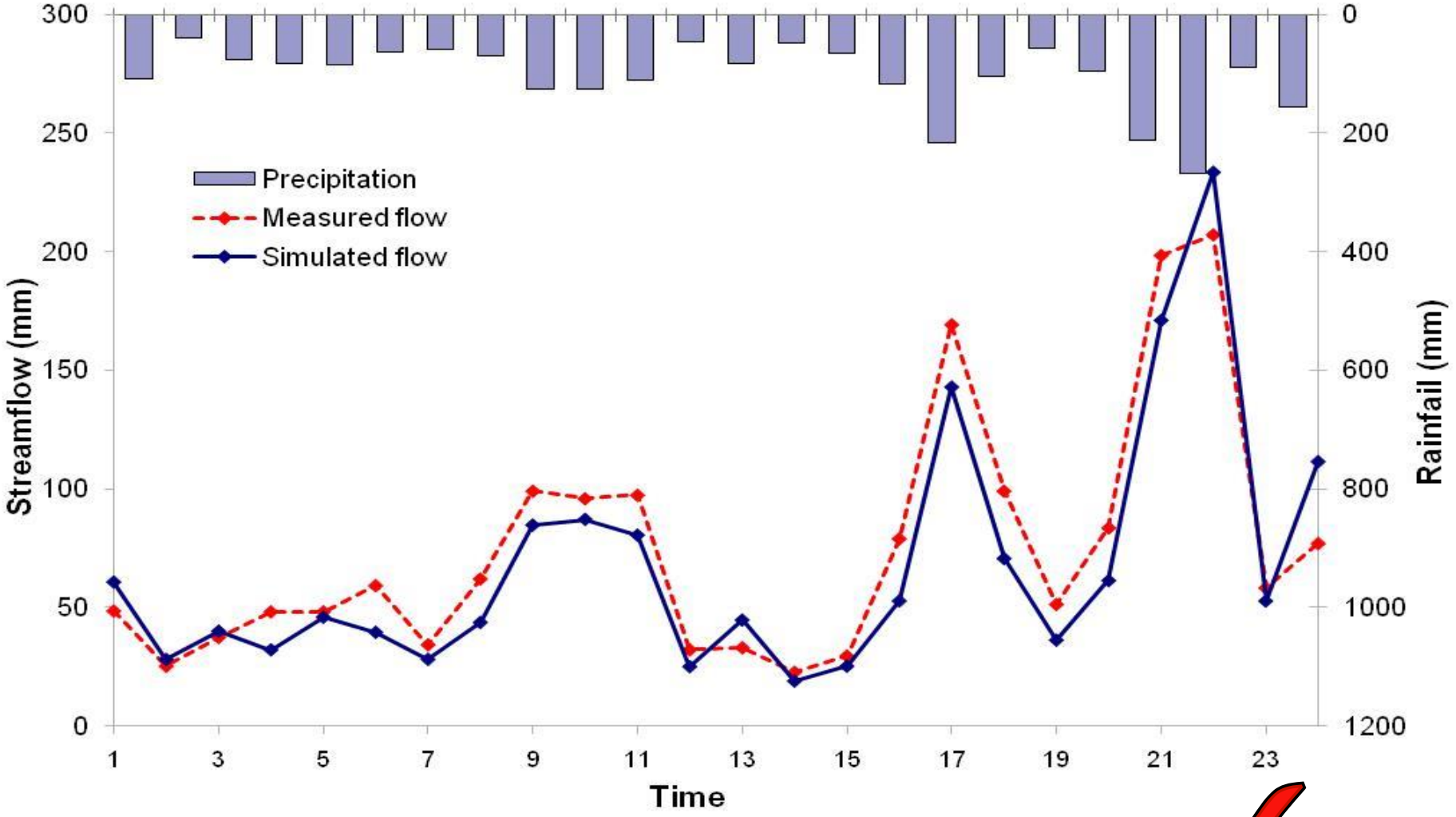
Validation

Management Scenarios

*Moriasi *et al*. (2007)

RESULTS AND DISCUSSION

Calibration/Validation: Hydrology

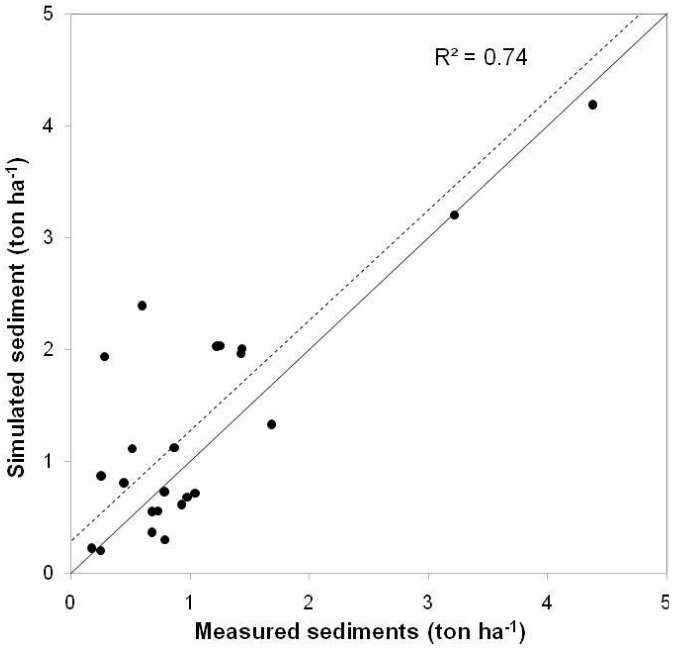


Flow Calibration:

r^2 = 0.9, NSE = 0.87, RSR= 0.35, PBIAS = -8%

RESULTS AND DISCUSSION

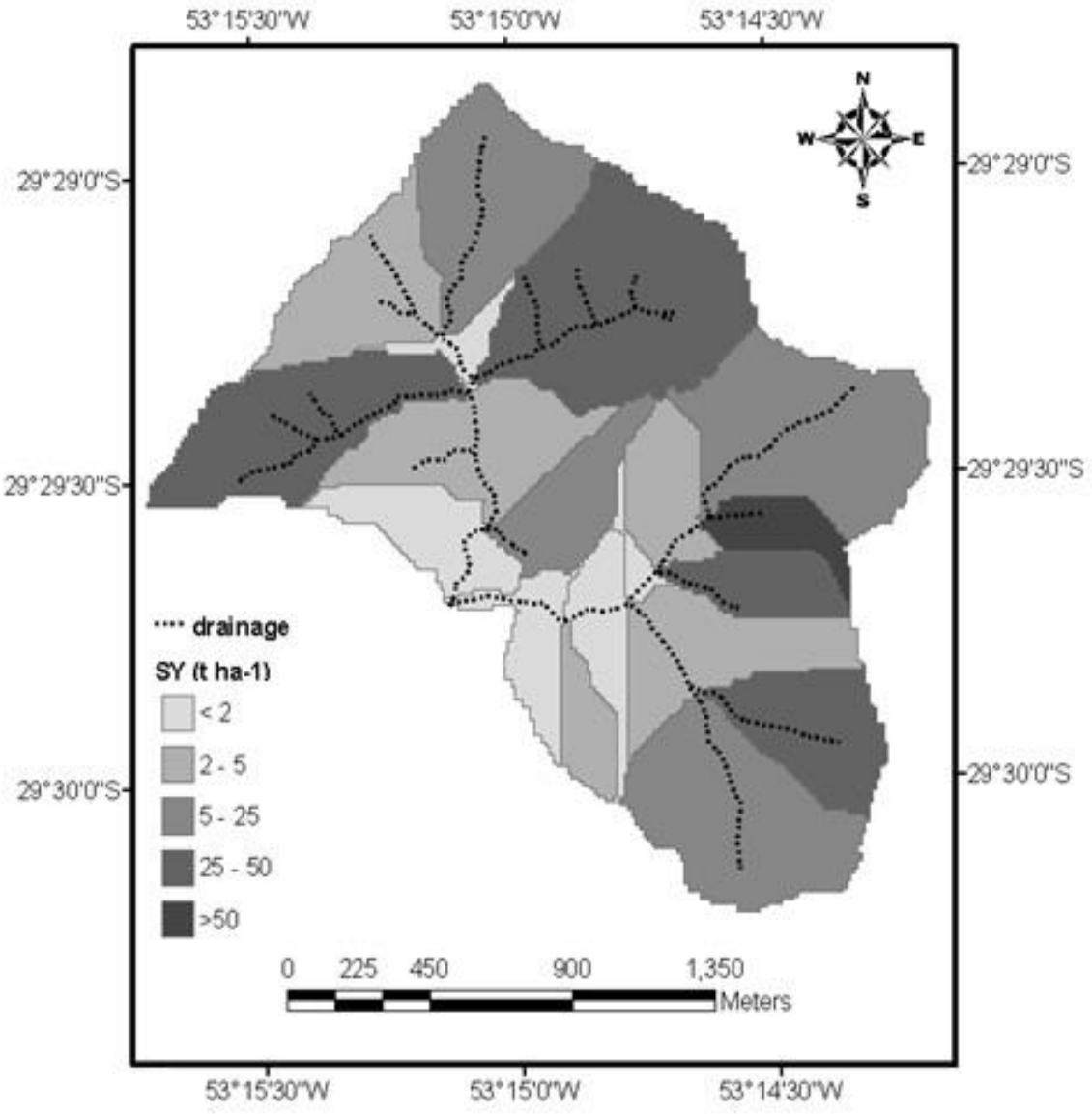
Calibration/Validation: Sediments



SY calibration:

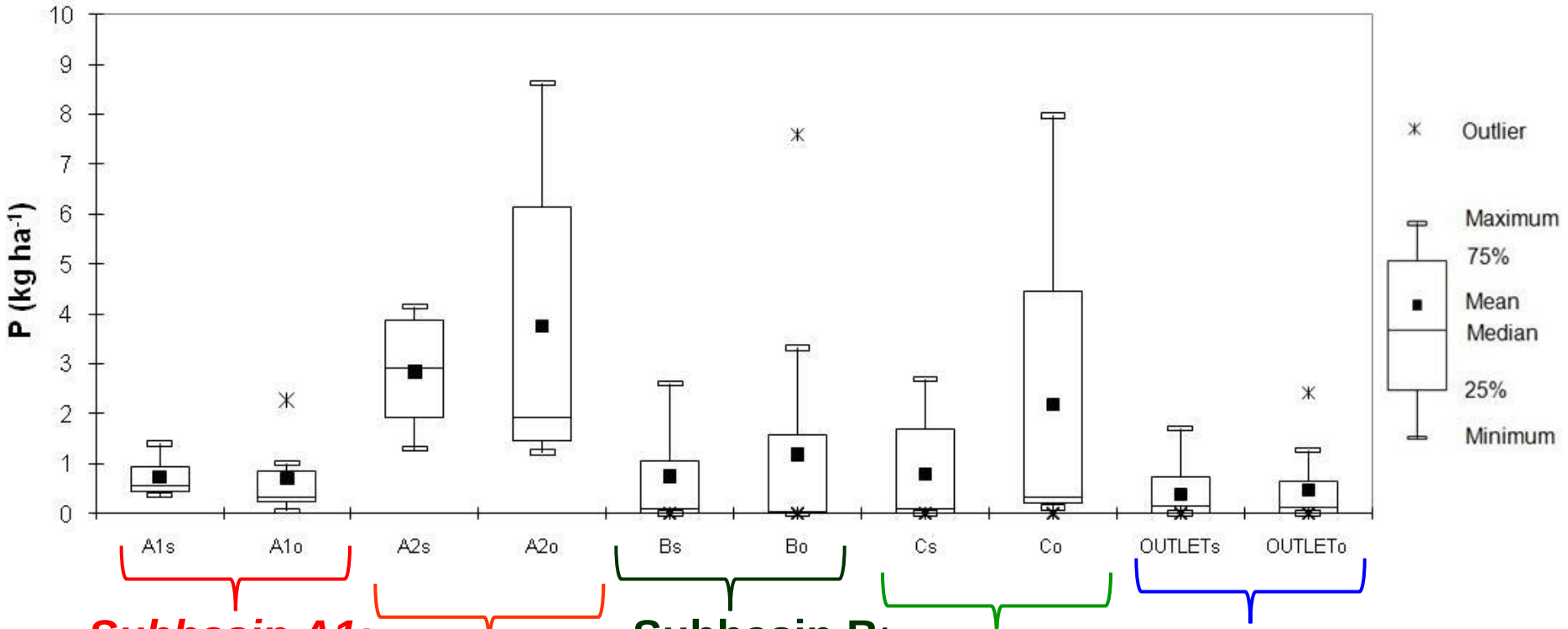
r^2 = 0.74, NSE = 0.70

RSR= 0.57, PBIAS = 14%



RESULTS AND DISCUSSION

Calibration/Validation: Phosphorus



Subbasin A1:
Crops (12%)

Subbasin A2:
Crops (25%) are closed to streams, no protection by vegetation.

Subbasin B:
Crops (16%)

Subbasin C:
Crops (25%): are far from streams, natural vegetation around stream areas.

Outlet

RESULTS AND DISCUSSION

Calibration/Validation: Phosphorus

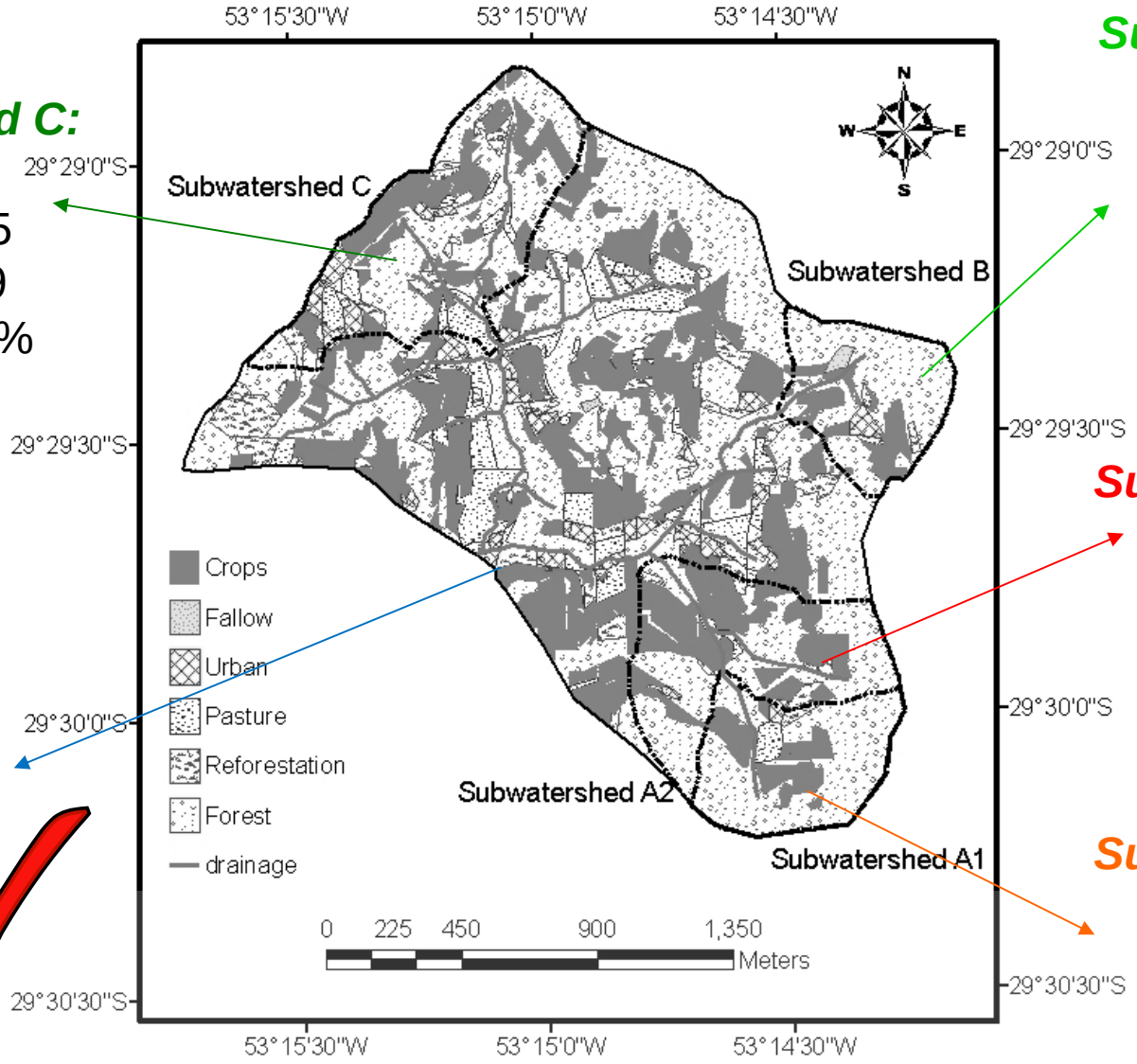
Subwatershed C:
r^2 = 0.71
NSE = 0.65
RSR= 0.59
PBIAS = 22%

Subwatershed B:
r^2 = 0.62
NSE = 0.48
RSR= 0.72
PBIAS = 37%

Subwatershed A2:
r^2 = 0.70
NSE = 0.38
RSR= 0.79
PBIAS = 25%

Outlet:
r^2 = 0.77
NSE = 0.73
RSR= 0.52
PBIAS = 19%

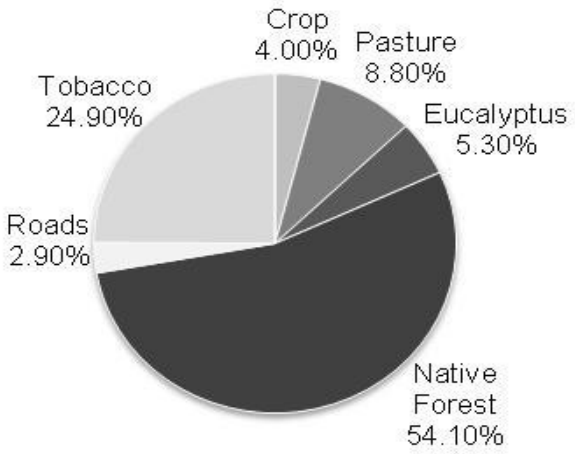
Subwatershed A1:
r^2 = 0.51
NSE = 0.46
RSR= 0.73
PBIAS = -4%



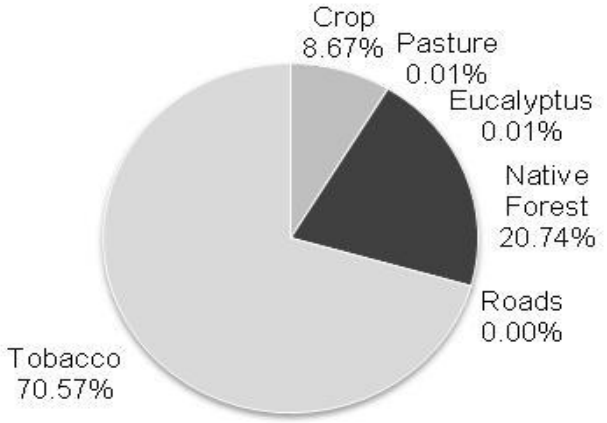
RESULTS AND DISCUSSION

P load distribution:

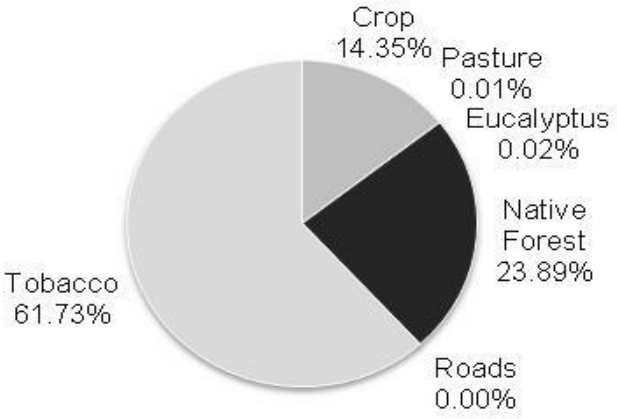
LAND USE AREA



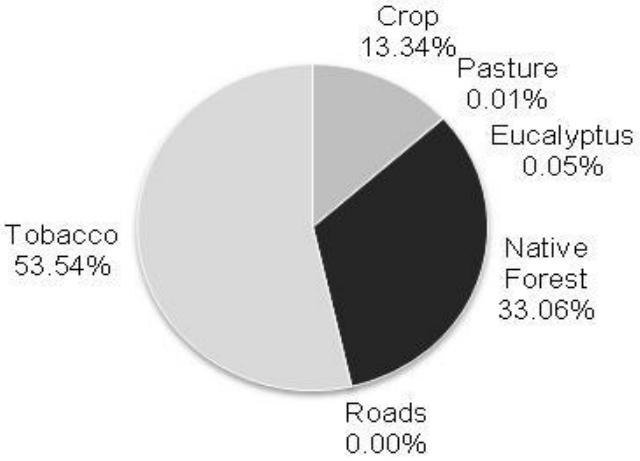
SOLUBLE P YIELD



SEDIMENT P YIELD



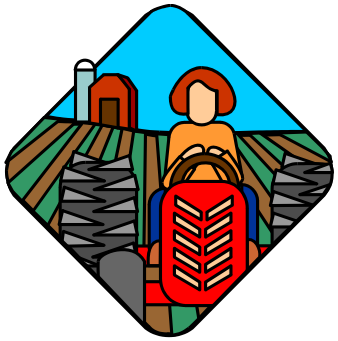
ORGANIC P YIELD

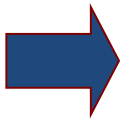


SCENARIOS ANALYSIS

How agricultural management alternatives affect future water, sediment yields and phosphorus transfers?

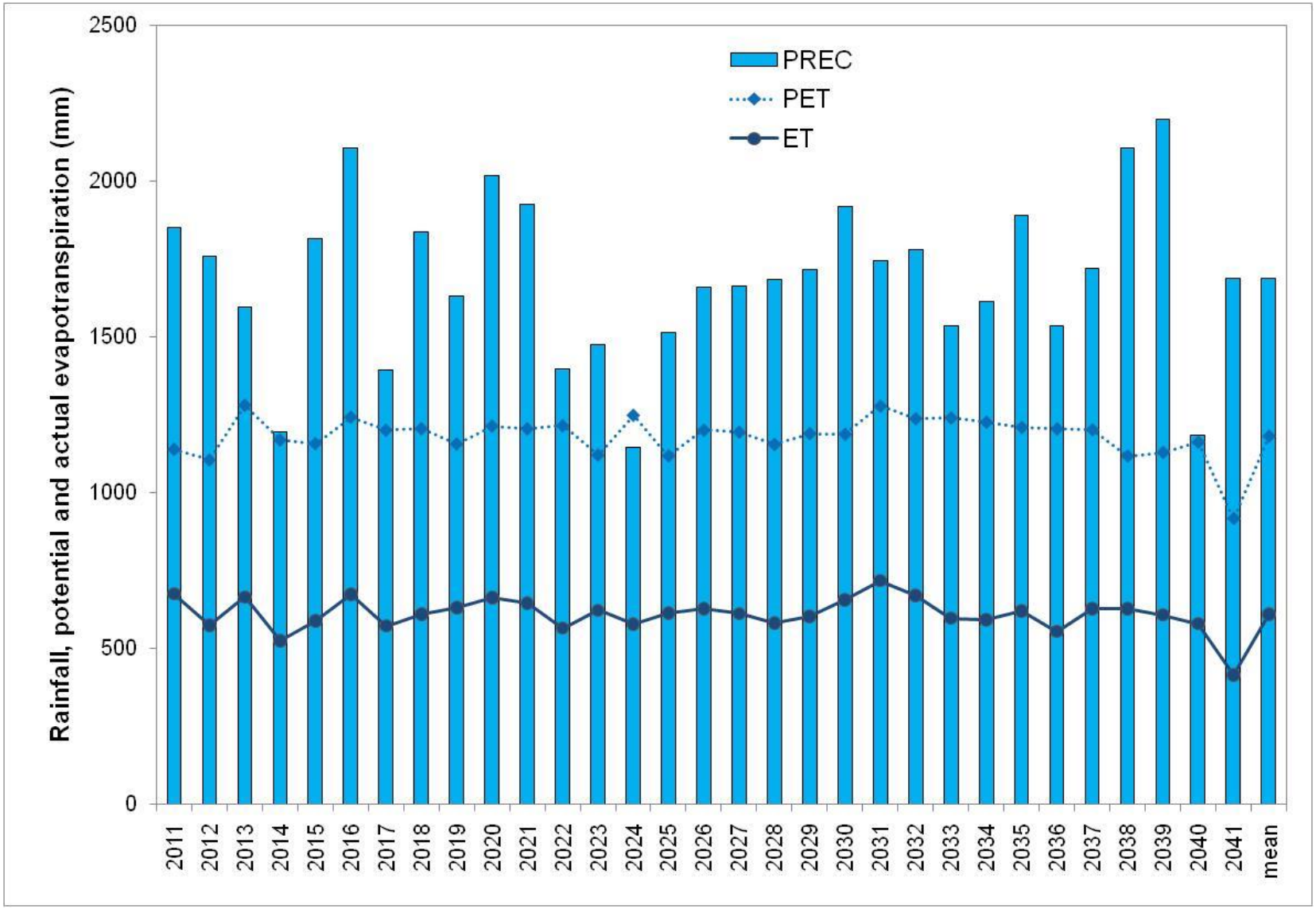
+





SCENARIOS ANALYSIS

30-year period of simulation:



SCENARIOS ANALYSIS

3 Management Scenarios:

CT: Conventional tillage

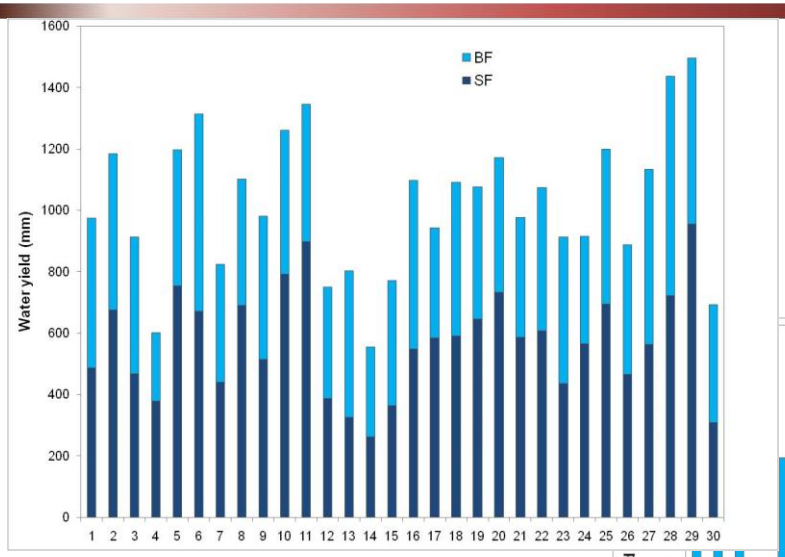
MT: Minimum tillage

NT: No-tillage
↓ 50% of fertilizer application rate.

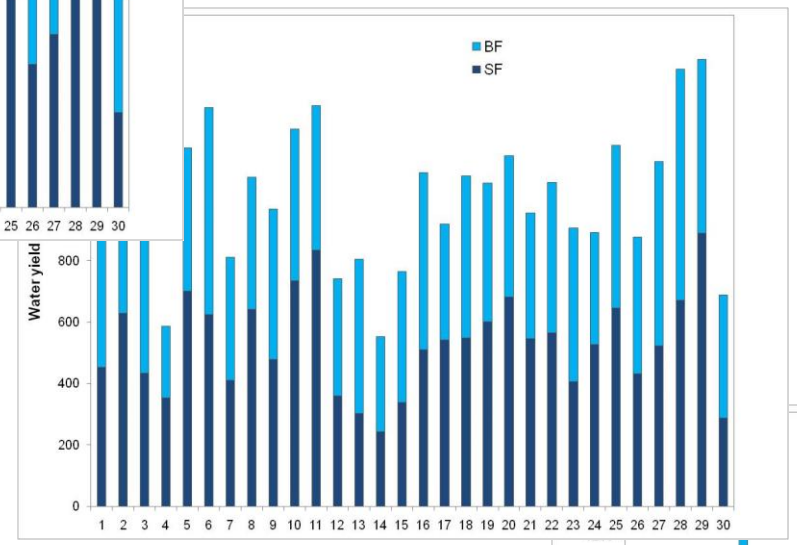
Pictures: Pellegrini, A.

SCENARIOS - RESULTS

Effect of tillage on runoff:



CT: Conventional tillage



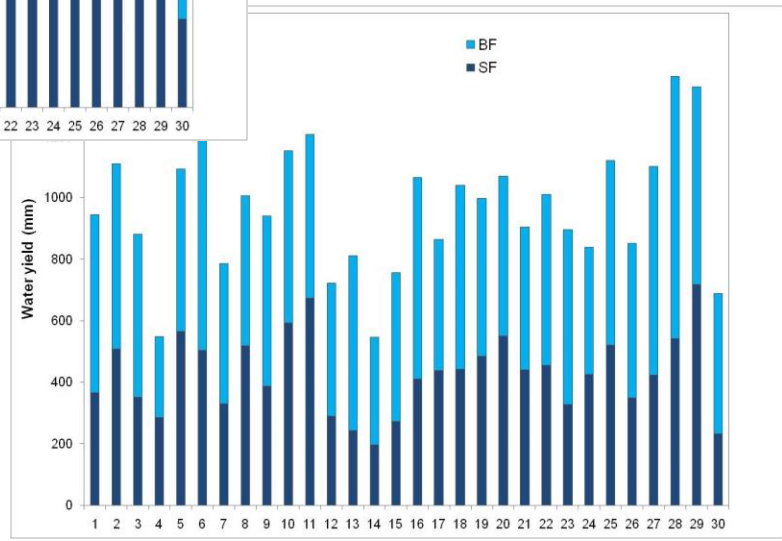
MT: Minimum tillage

↓SR

↑ BF

↓ WY

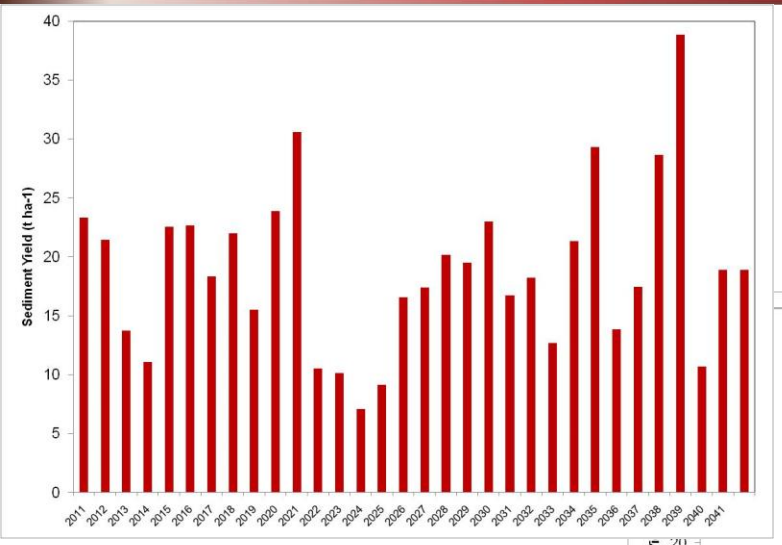
CT-NT: -6%



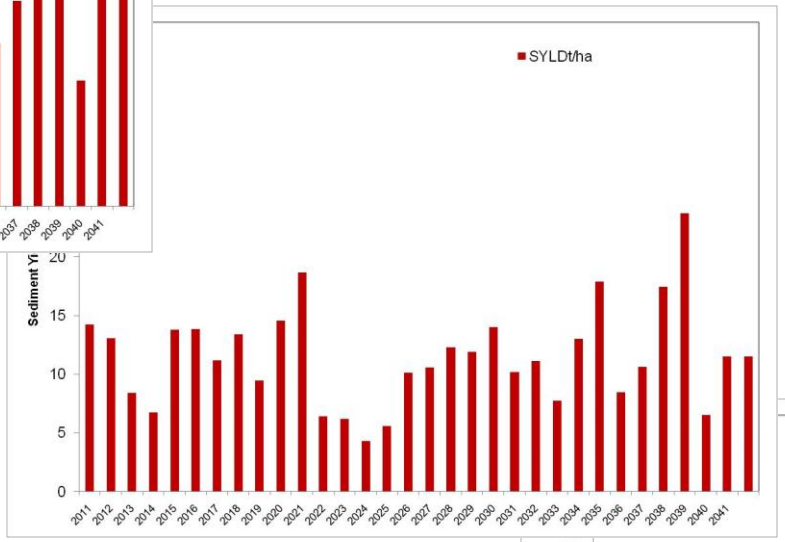
NT: No-tillage

SCENARIOS - RESULTS

Effect of tillage on sediments:



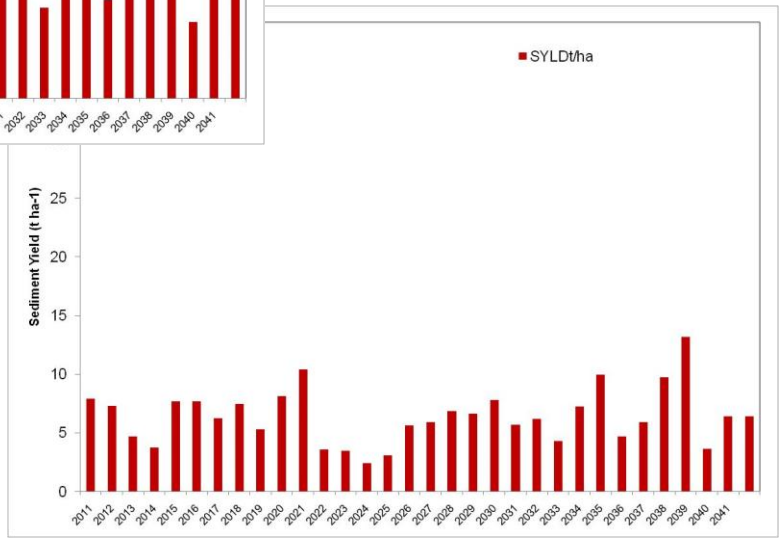
CT: Conventional tillage



MT: Minimum tillage

↓SY

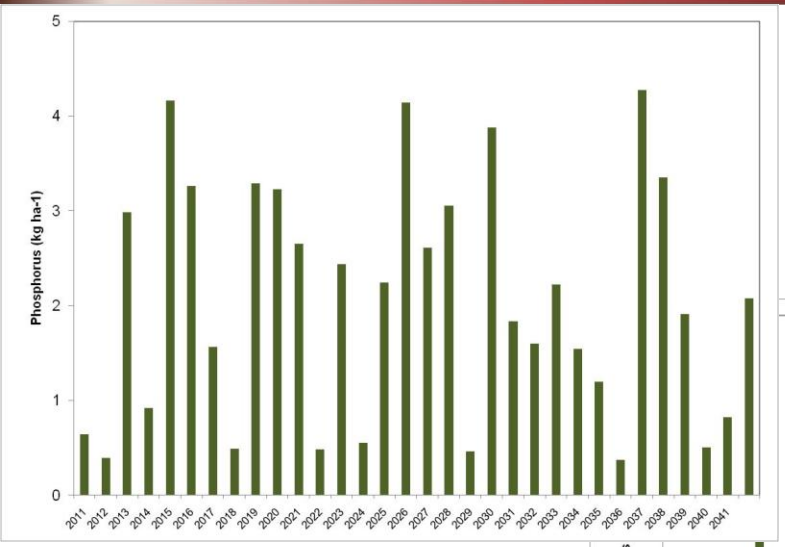
CT-NT: -66%



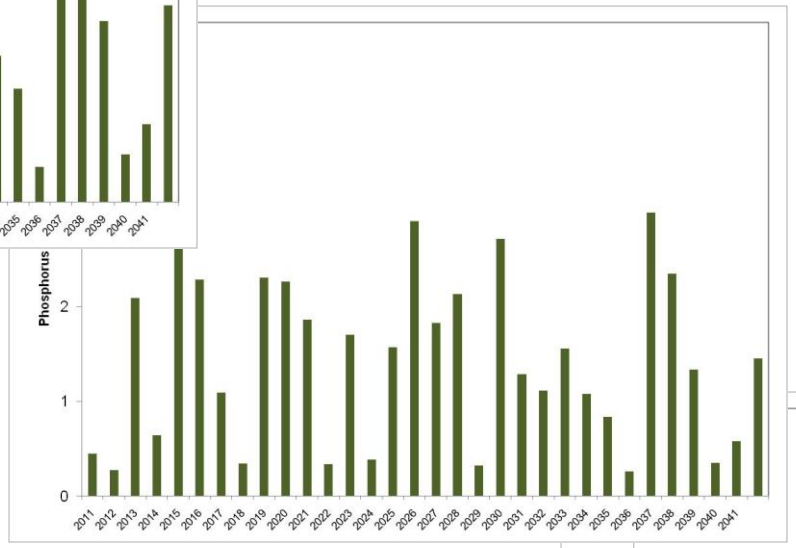
NT: No-tillage

SCENARIOS - RESULTS

Effect of tillage on P:



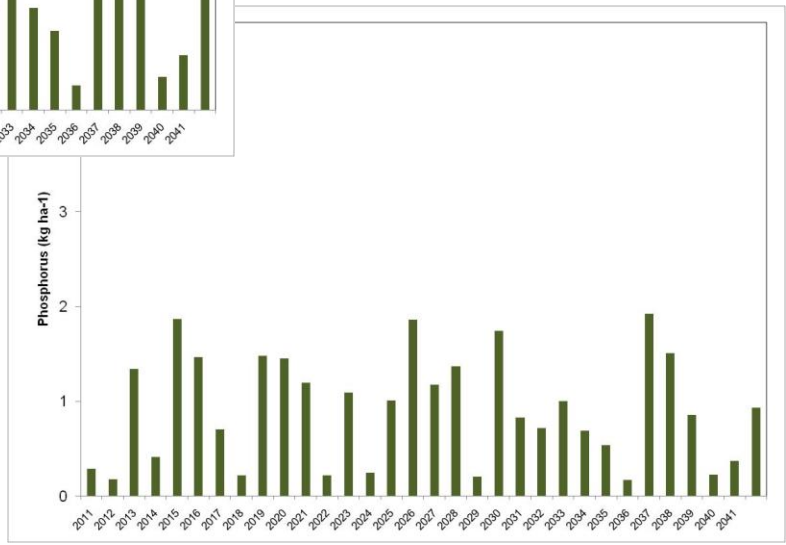
CT: Conventional tillage



MT: Minimum tillage

↓P

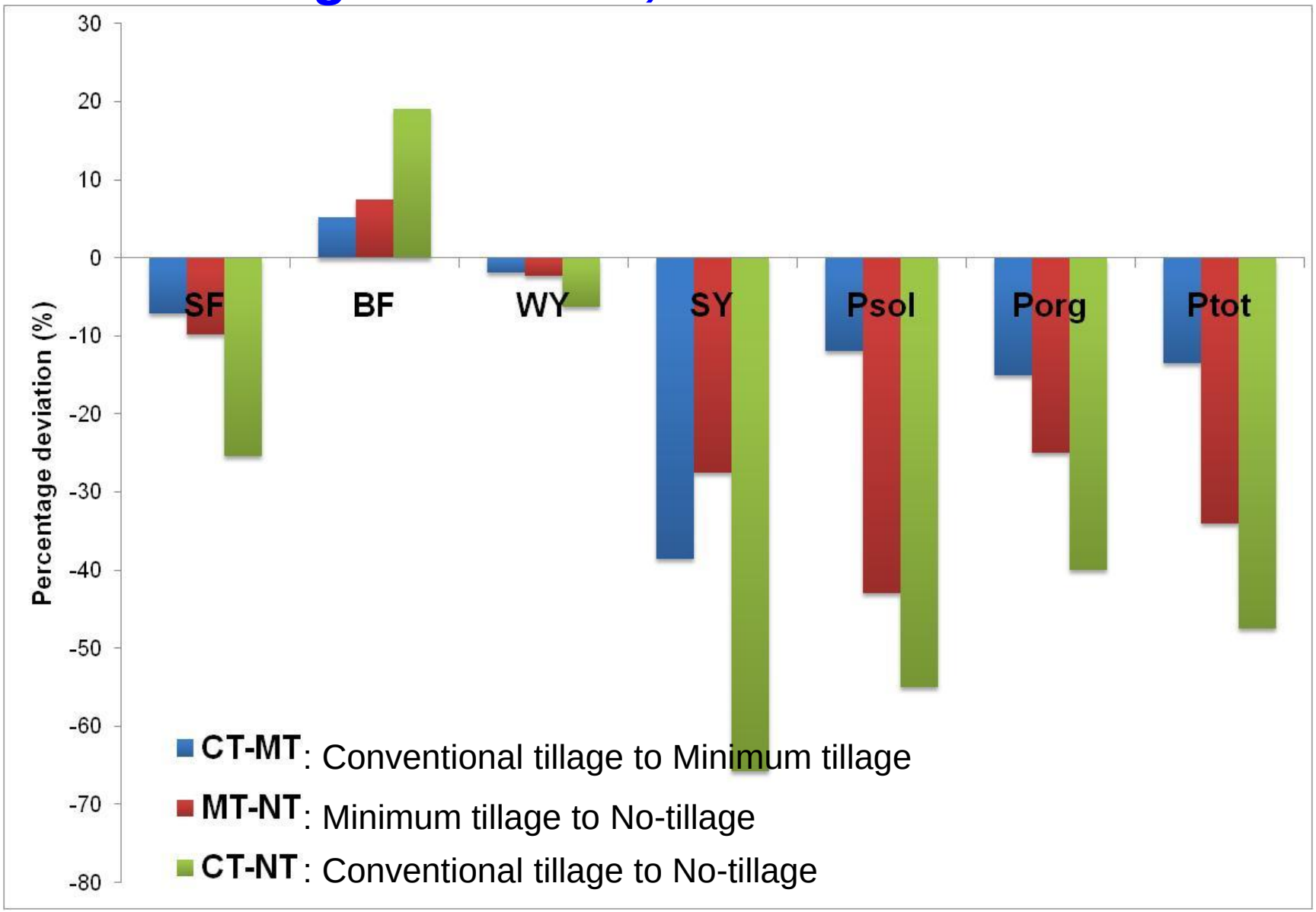
CT-NT: -60%



NT: No-tillage

SCENARIOS - RESULTS

Effect of tillage on runoff, sediment and P:



CONCLUSIONS

Performance of the model:

- Calibration and validation – ok.

Management scenarios:

- **Water balance**: decreasing tillage intensity resulted in an increase of baseflow while surface runoff and total water yield decreased.
- **Sediment yield**: decreased regarding to the decrease of overland flow and soil erosion.
- **P loads**: the major change was due to the decrease (-50%) in the fertilizer application rate (CT-NT) than due to the change in management practices.

RECOMMENDATIONS

- **Data:** model simulation + measurements → clues for the **identification of the** origin and nature of **pollution** and for the quantification of its loads.

- Results generated with **model simulations** - can assist in environmental management and in the choice of **economic alternatives** that **minimize environmental impacts** caused by a particular **land use**.

- Based on the results - SWAT is assessed to be a feasible tool for **diffuse pollution evaluation** and have the potential to provide a **strong base for environmental management** in Brazilians watersheds.

ACKNOWLEDGEMENTS

Thank you for your attention!

Merci beaucoup!

Obrigada pela atenção!

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