# *Assessing the Impact of Tea Cultivation on Hydrology and Nutrient Export Using SWAT: A Case Study of the Feitsui Reservoir Watershed*

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# Introduction

- Under the influence of extreme climate events and land use disturbances, watersheds face potential risks of water quality degradation.
- Non-point source pollution is characterized by high spatiotemporal variability and is difficult to monitor effectively.
- The SWAT model integrates spatial data and hydrological processes to simulate pollutant transport mechanisms and quantify nutrient export.

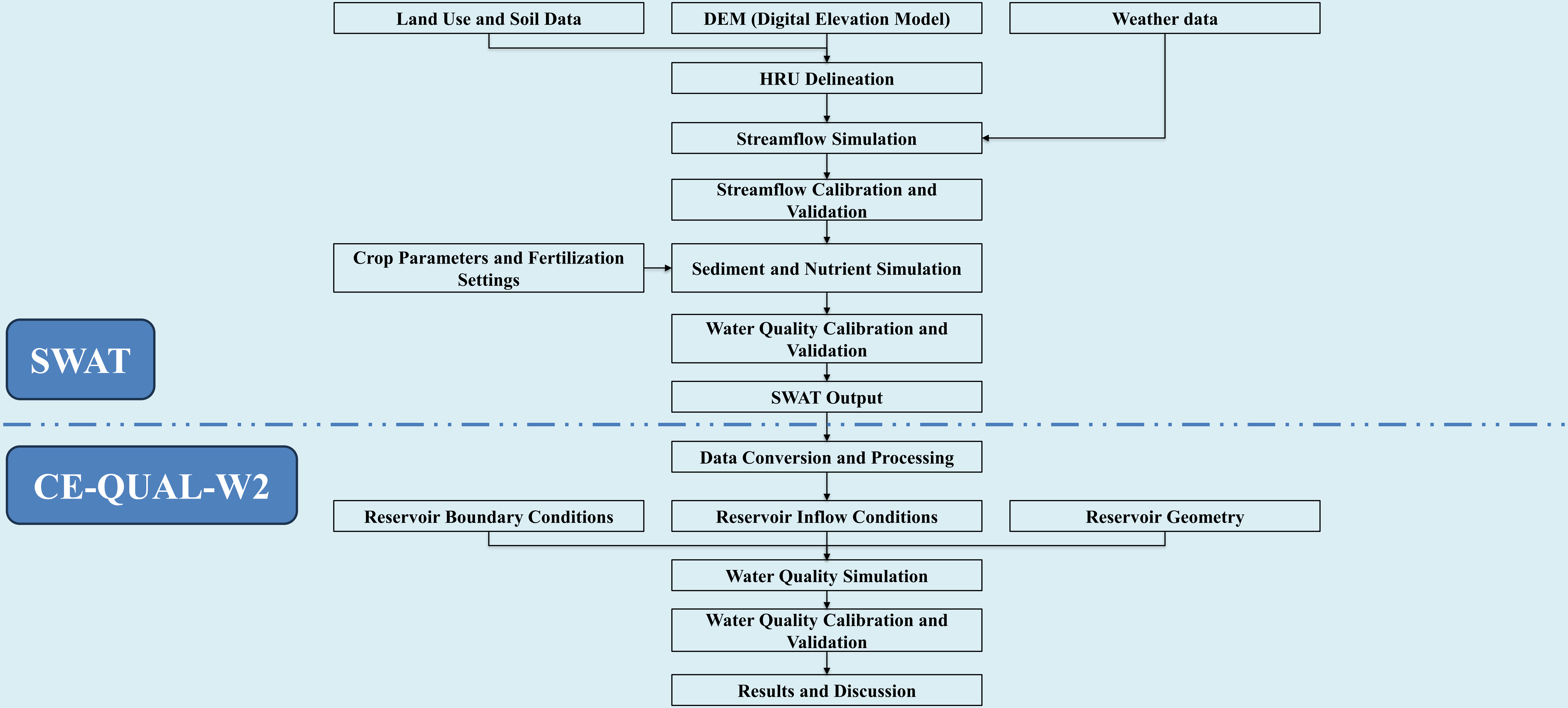
# Introduction

- **Soil erosion** is widely recognized as a major contributor to non-point source (NPS) pollution (Sun et al., 2020), with **hillslope runoff** being the key factor driving this erosion process (Lowe et al., 2021).

- In non-point source pollution, nitrogen is generally considered to come mainly from fertilizers applied in the current year, livestock waste, and domestic sewage. Zhang et al.,(2022) indicated that large amount of nitrogen also accumulates in the soil, with a portion of the applied **fertilizer remaining** and serving as a source for subsequent nitrogen losses. Meanwhile, **atmospheric nitrogen deposition** contributes substantially to the nitrogen load in water bodies.

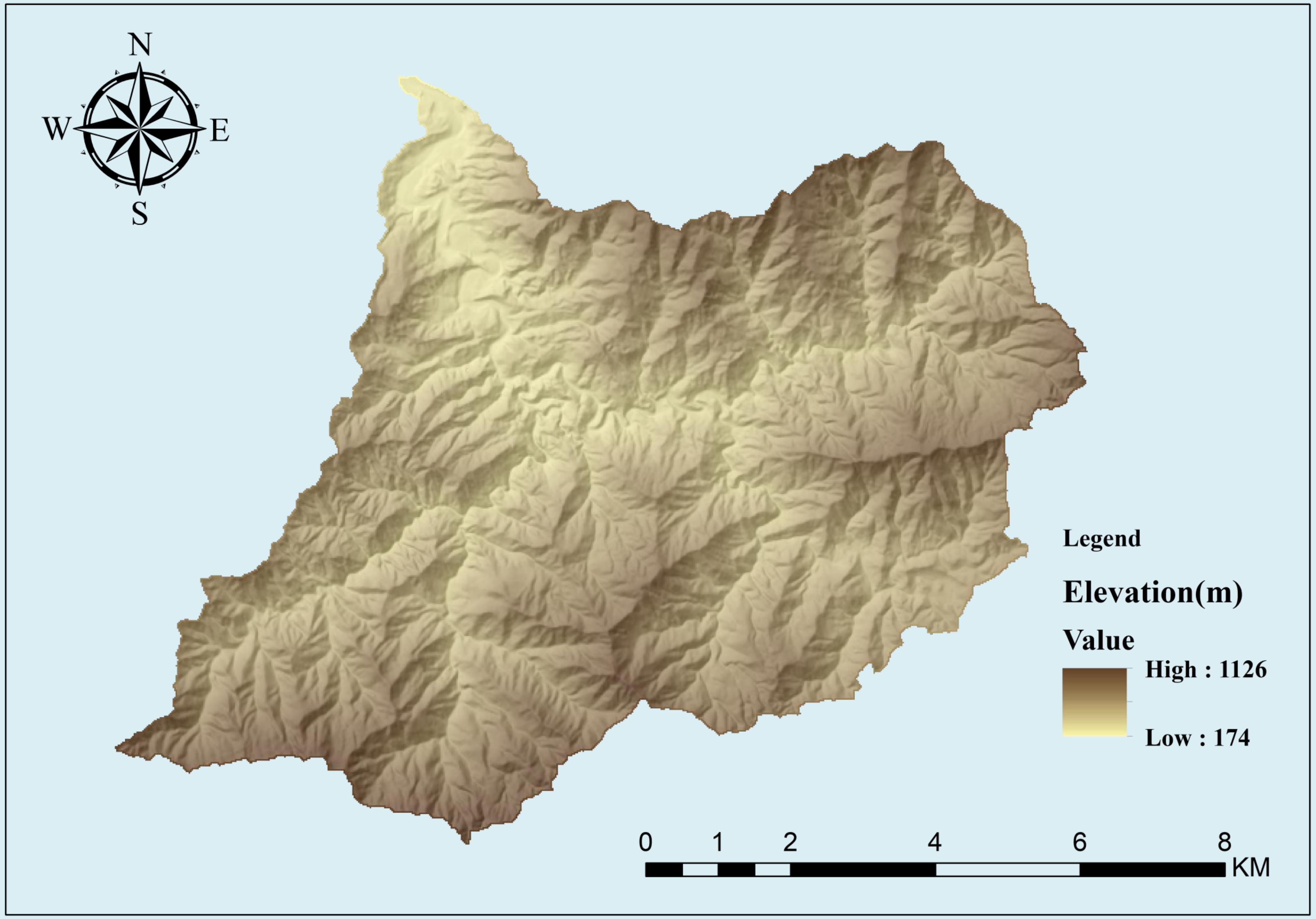
- According to Wang et al. (2021), **phosphorus loss** is primarily linked to **sediment transport**, and **climate change** also plays a significant role in influencing phosphorus dynamics.

# Method

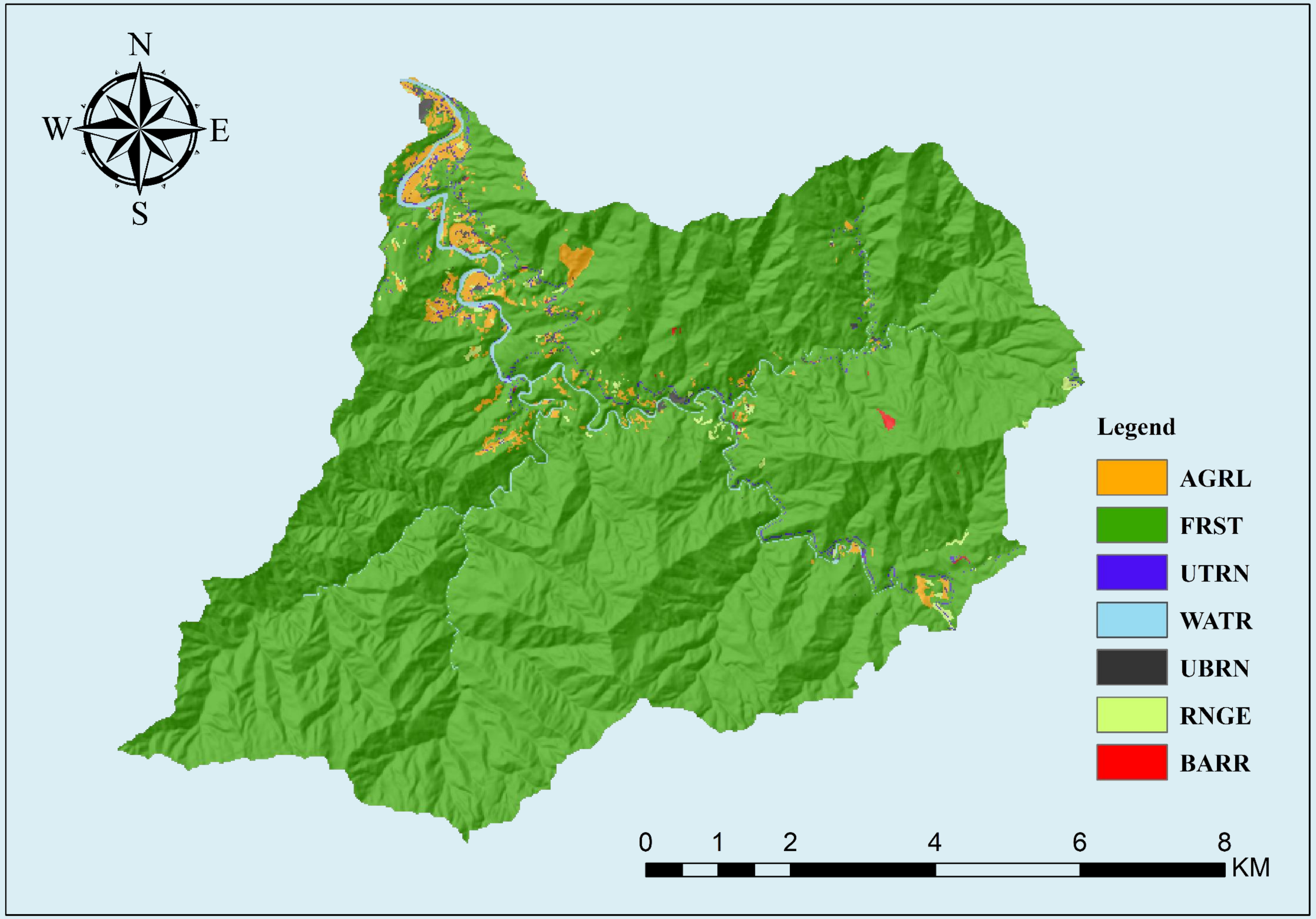

Land Use and Soil Data
DEM (Digital Elevation Model)
Weather data
HRU Delineation
Streamflow Simulation
Streamflow Calibration and Validation
Crop Parameters and Fertilization Settings
Sediment and Nutrient Simulation
SWAT
Water Quality Calibration and Validation
SWAT Output
CE-QUAL-W2
Data Conversion and Processing
Reservoir Boundary Conditions
Reservoir Inflow Conditions
Reservoir Geometry
Water Quality Simulation
Water Quality Calibration and Validation
Results and Discussion

# Background

- The Feitsui Reservoir serves as one of the primary water sources for Taipei.
- The Daiyujue river is an important upstream tributary of the reservoir, where agricultural activities are predominantly centered around tea cultivation.



# Study Area




- While forest areas constitute the majority of land cover in the Feitsui Reservoir watershed, agricultural activities are primarily concentrated along riparian zones.
- Such proximity to stream networks significantly enhances the potential for nutrient and sediment runoff to reach downstream sections, posing a greater risk to water quality.

| LANDUSE | Area(%) |
|---|---|
| AGRL | 2.17 |
| FRST | 95.43 |
| UTRN | 0.52 |
| WATR | 1.01 |
| UBRN | 0.32 |
| RNGE | 0.46 |
| BARR | 0.08 |

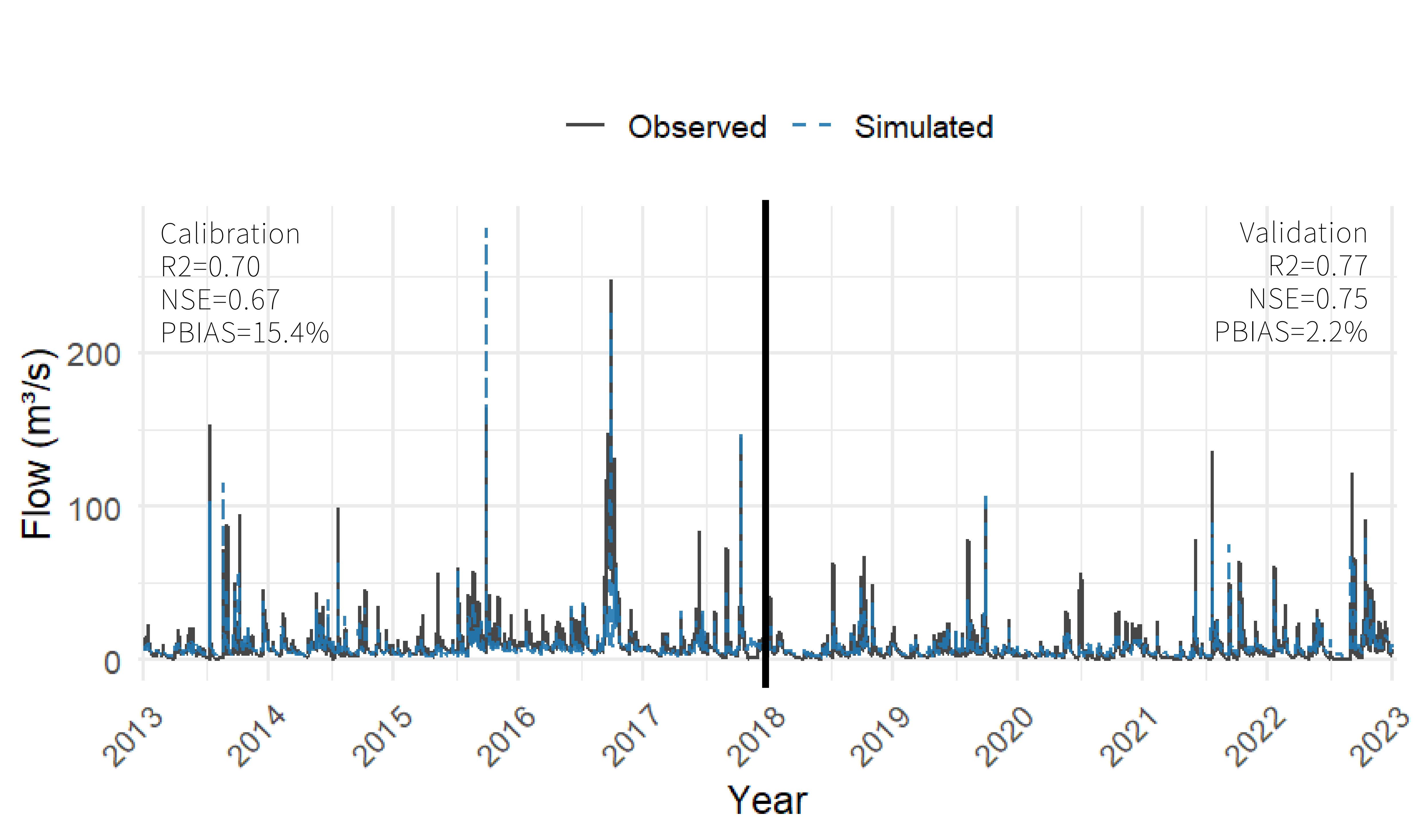
# Model Setup and Simulation Period

- Simulation Period: 2010–2022
  - Warm-up: 2010-2012
  - Calibration: 2013–2017
  - Validation: 2017–2022

- Time Scale:
  - Flow : Daily
  - Sediment, $NO_3^-$-N, TP : Monthly

| Fertilizer Schedule | N element | P element |
|---|---|---|
| 2/15 | 108 | 33 |
| 7/15 | 108 | 33 |
| 9/15 | 144 | 44 |

# Model Calibration and Validation



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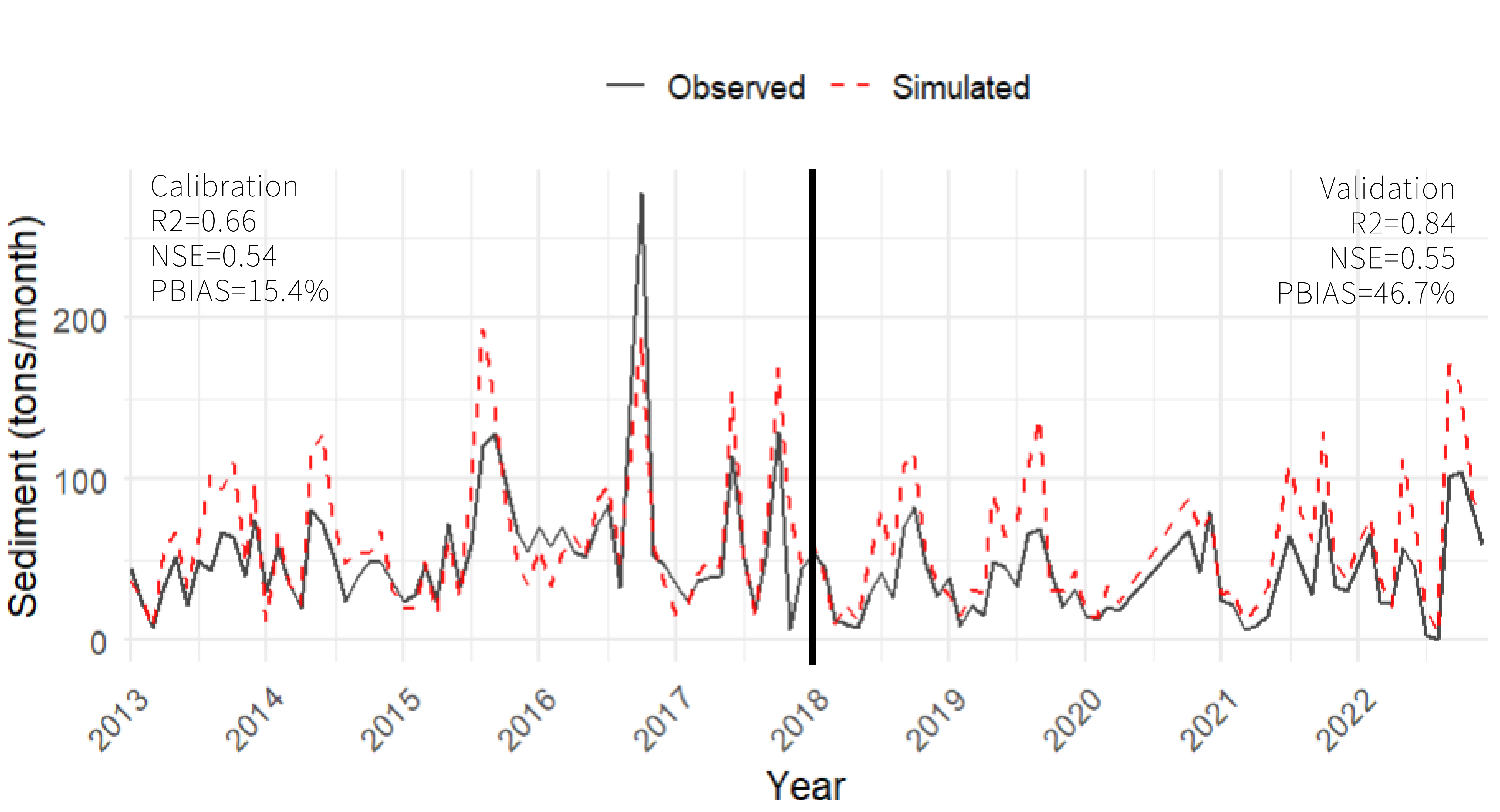

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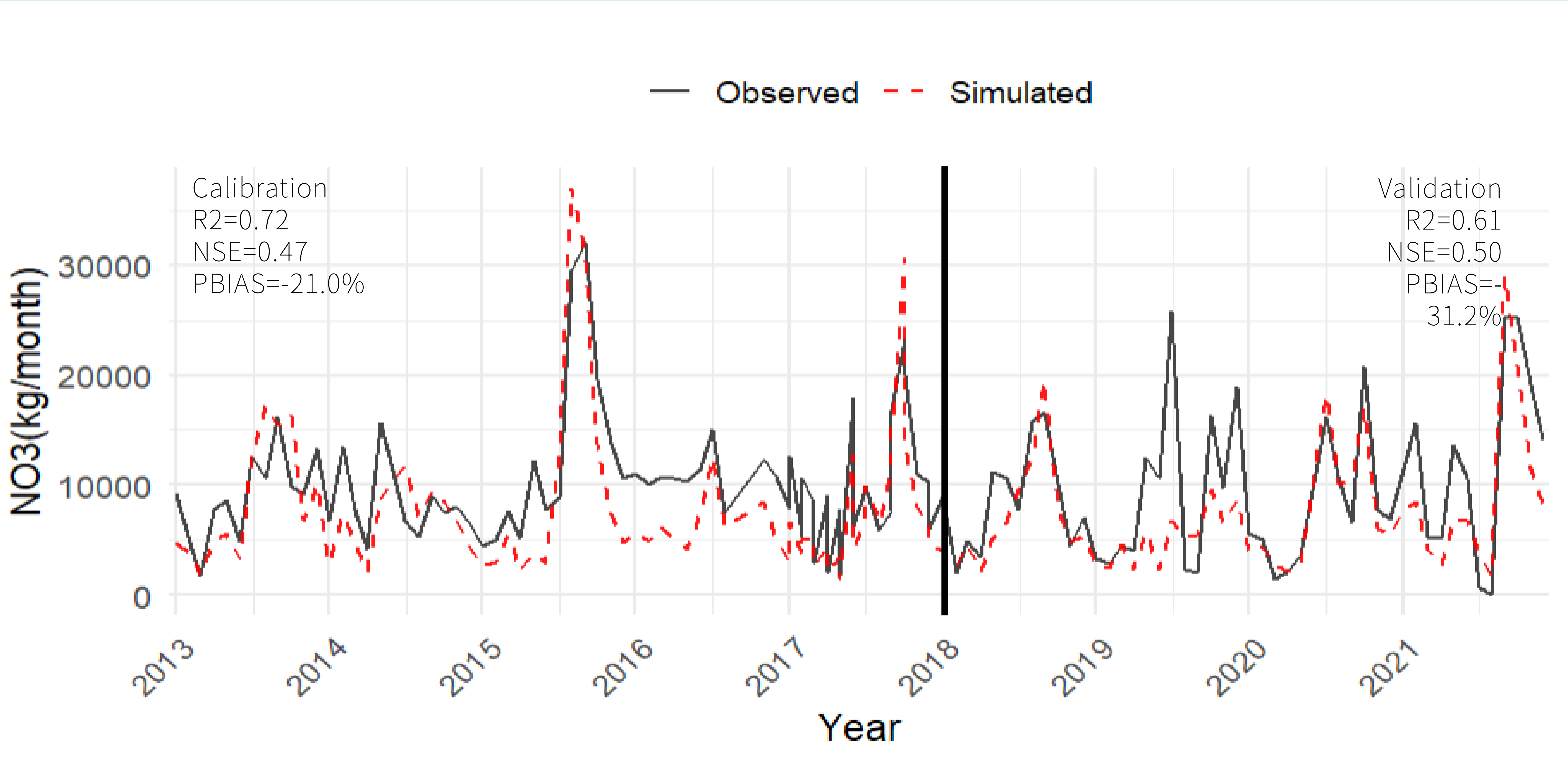

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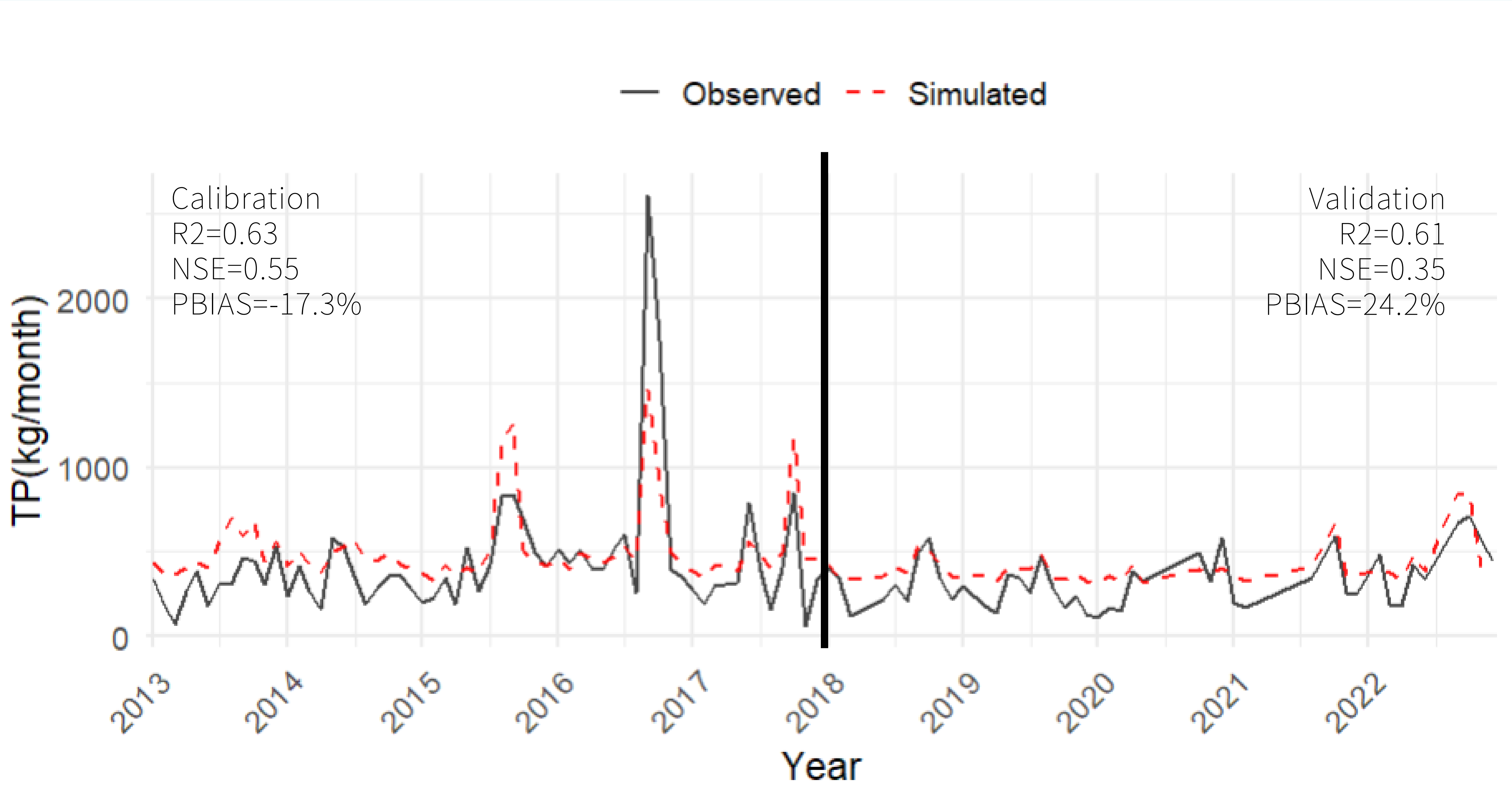
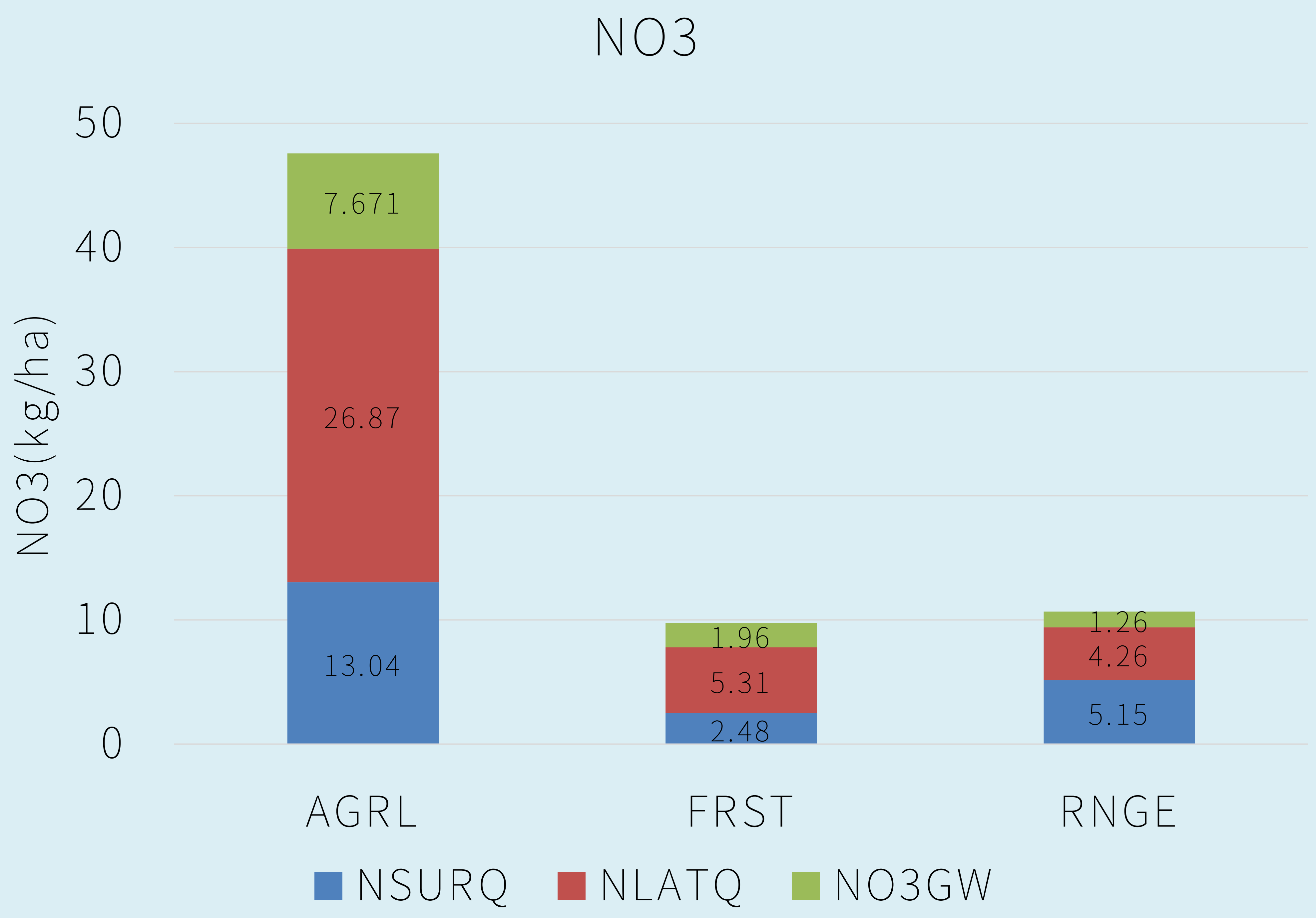
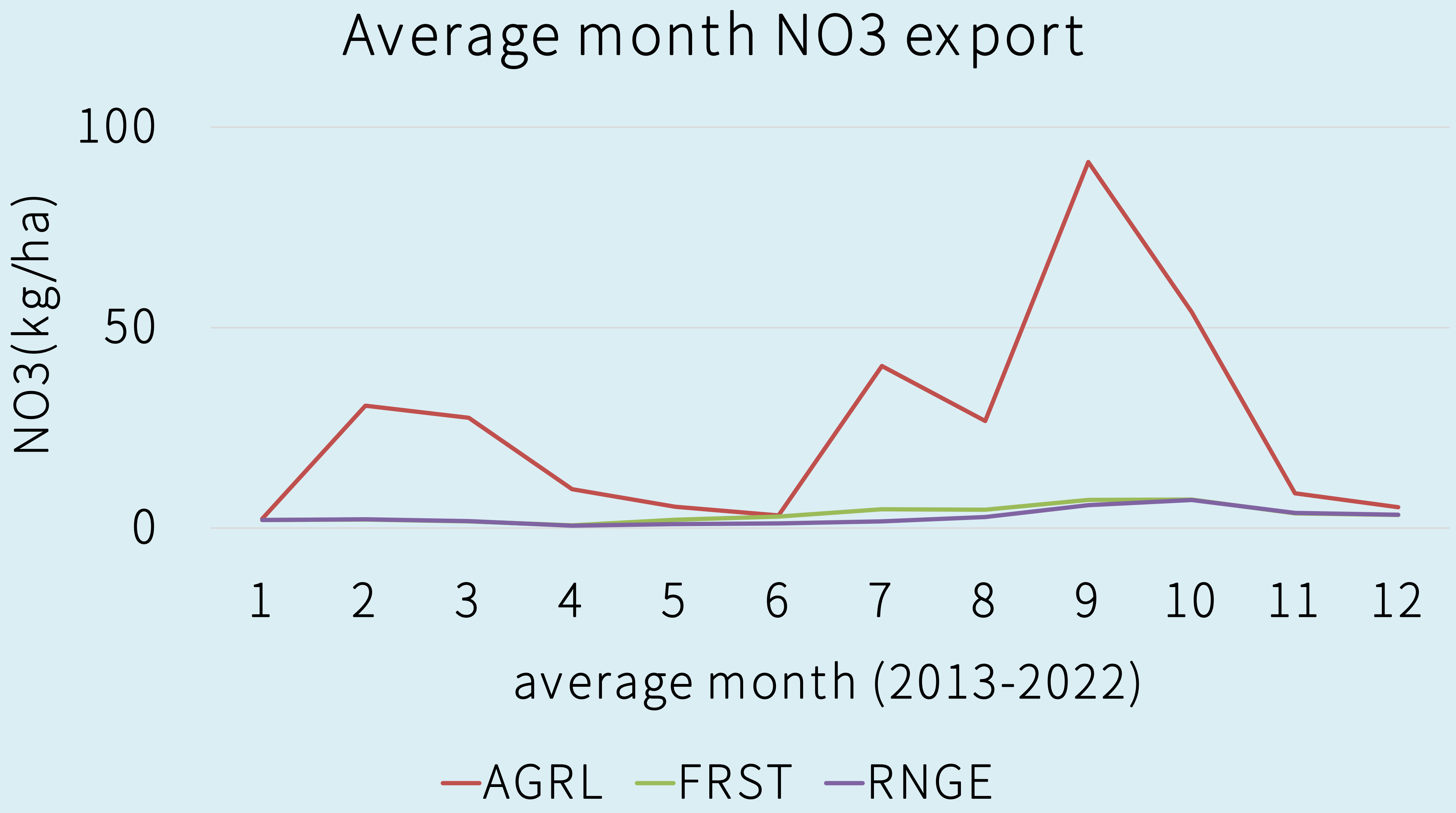


# NO3 Export by Land Use



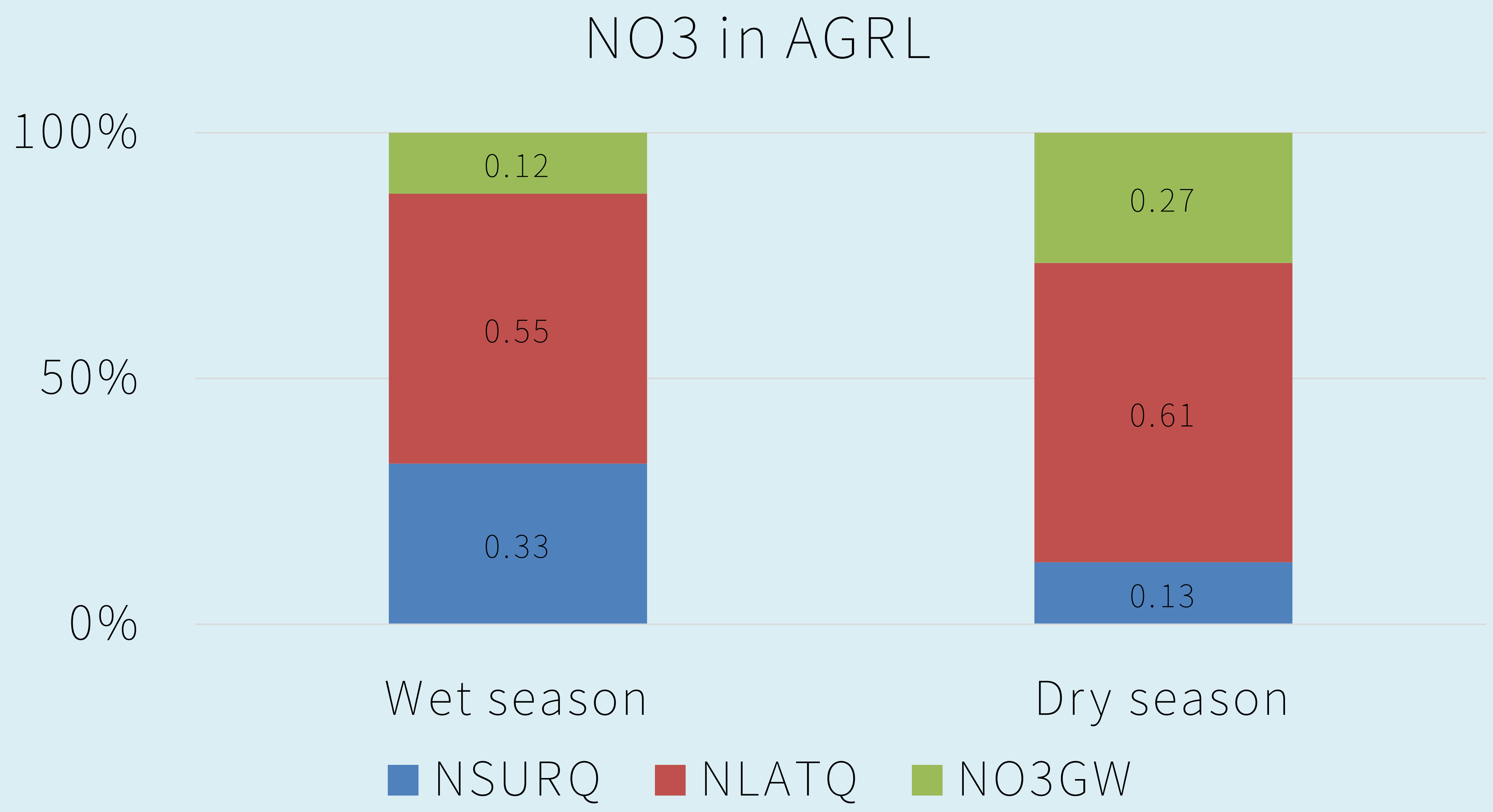

- Nitrogen export from agricultural land is mainly through **lateral flow** (NLATQ), followed by surface runoff (NSURQ), with minimal contribution from groundwater (NO3GW).This may result from **high fertilizer input and soil permeability**.
- In contrast, forest (FRST) and rangeland (RNGE) show more **balanced nitrogen pathways**, suggesting better nitrogen retention and reduced transport to water bodies in non-agricultural land uses.

# Average month NO3 Export




- As shown in the figure, nitrate ($NO_3^-$) export from agricultural land (AGRL) peaks in February, July, and September, aligning closely with the **fertilizer application schedule**.
- Notably, September exhibits the highest monthly average of 12.73 kg/ha, coinciding with **heavy rainfall.**
- This highlights the **strong interaction between fertilization timing and extreme precipitation in driving non-point source pollution**.

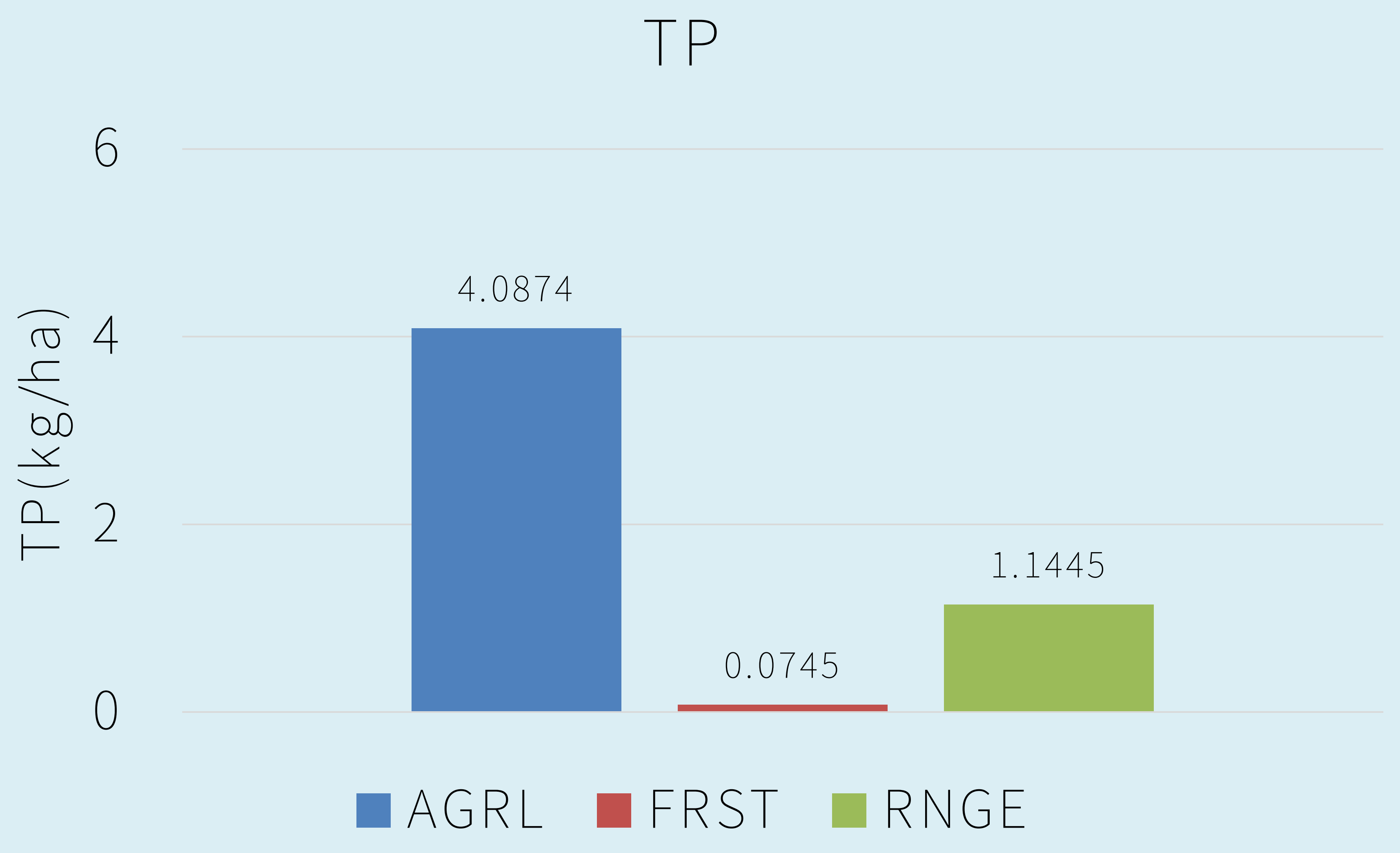
# Seasonal Comparison of NO3 Transport

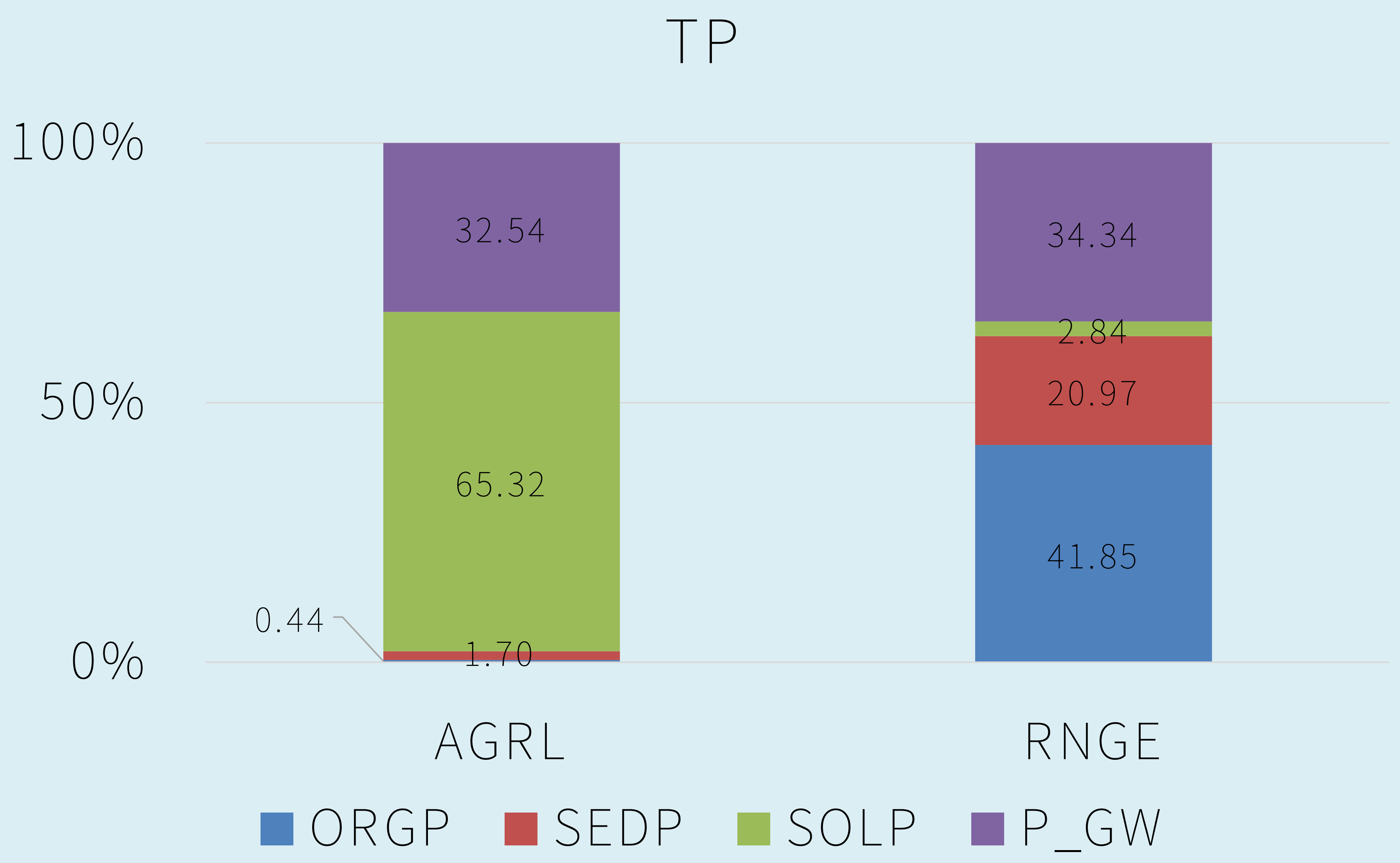



- In both wet and dry seasons, nitrate nitrogen transport is dominated by **lateral flow**.

  Wet Season : May - October
  Dry Season : September - April

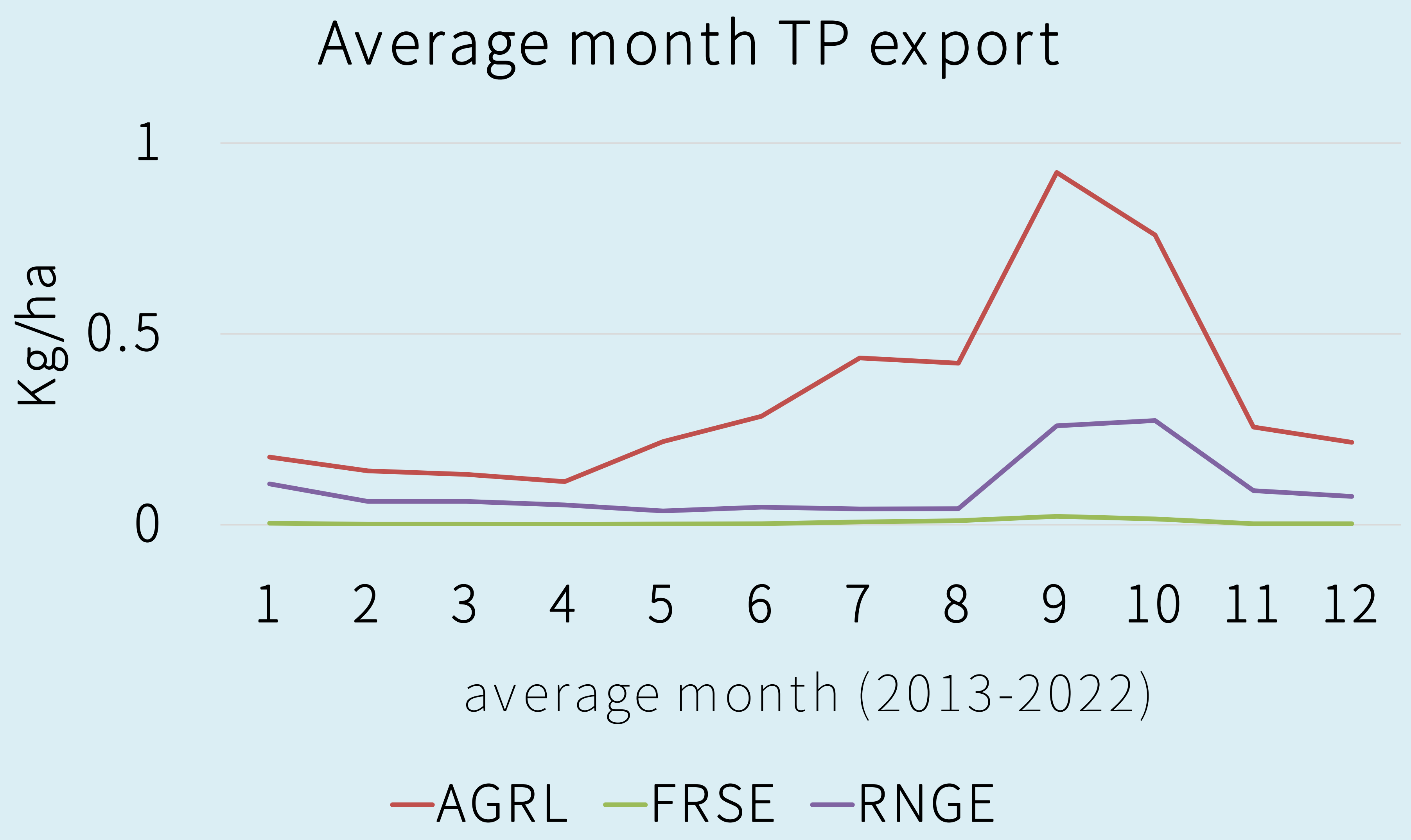
# TP Export by Land Use



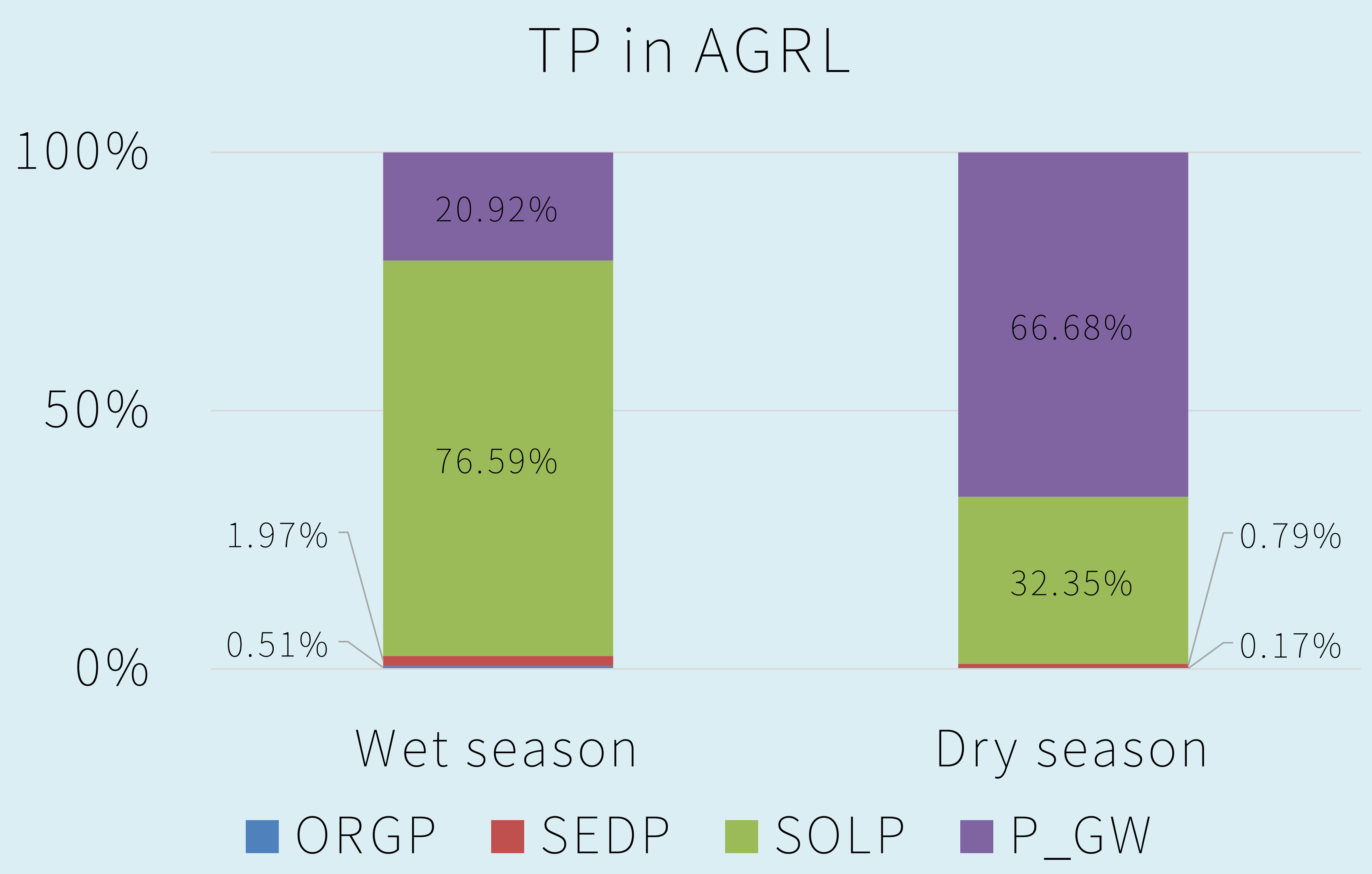

- Agricultural land is dominated by SOL_P, reflecting **the impact of fertilizer-related surface runoff** on phosphorus loading to water bodies.
- In contrast, grasslands are associated with organic and sediment-bound phosphorus, indicating that phosphorus export mainly originates from **natural background erosion and soil organic matter**.

# Average month TP Export




- Phosphorus export from agricultural land increased markedly during the rainy season (May to October). This seasonal trend reflects the **combined effect of fertilizer application and surface runoff.**
- Forest and grassland areas showed minimal seasonal variation in phosphorus export, indicating **stable background conditions with limited erosion**.

# Seasonal Comparison of TP Transport



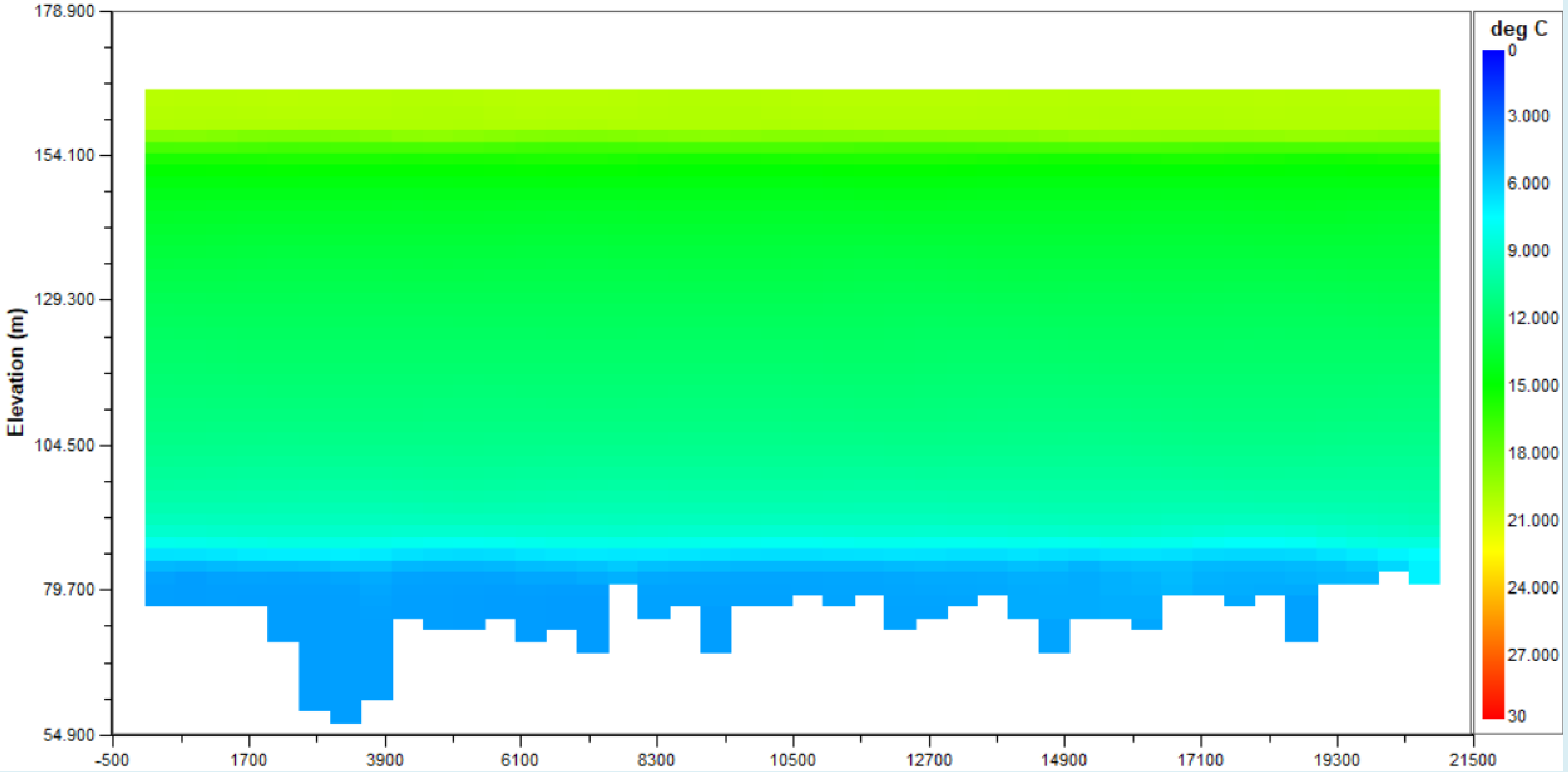

- Phosphorus transport **pathways differ between seasons.** During the wet season, soluble phosphorus (SOLP) dominates due to surface runoff, while in the dry season, groundwater-associated phosphorus (P_GW) becomes the primary contributor.

# Conclusion

- The export of both nitrate-nitrogen and total phosphorus is influenced **by fertilization and precipitation**, with rainfall playing a predominant role. It is thus advisable to avoid fertilizer application immediately before heavy rain events.
- Since **nitrate-nitrogen** is consistently transported via **lateral flow** across seasons, management efforts should focus on reducing surface leaching year-round. In contrast, seasonal differences in phosphorus transport pathways suggest that **wet-season control should target surface runoff** (e.g., buffer strips or cover crops), while dry-season strategies should address groundwater-related phosphorus, such as reducing soil phosphorus buildup.
- This study primarily focused on nutrient export per unit area. While forests would account for the highest total nutrient load when scaled to the entire watershed—given that they cover 95% of the study area—their contributions are considered background levels. Therefore, management efforts should still prioritize agricultural lands, which exhibit much higher export intensities and pose a greater risk to downstream water quality.

# Future Work

- To gain a better understanding of water quality dynamics, future work will involve coupling the SWAT model with CE-QUAL-W2 to simulate water quality transport within the reservoir area.



# *Thanks for listening !*