Enhancing the design of constructed wetlands along the Missouri River to improve nutrient removal

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NETWORK FOR ENGINEERING WITH NATURE

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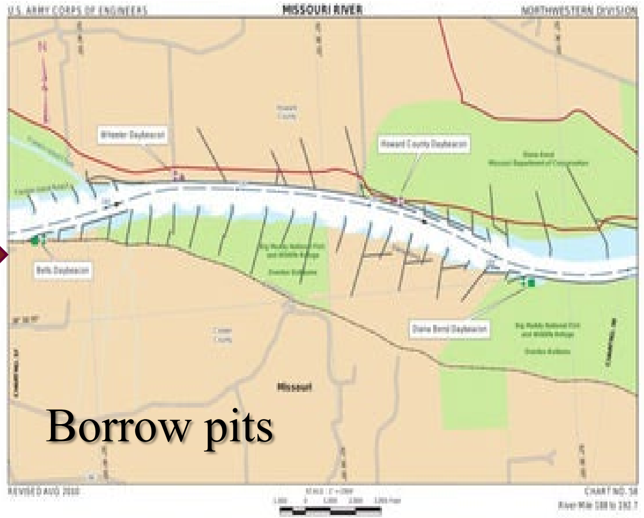
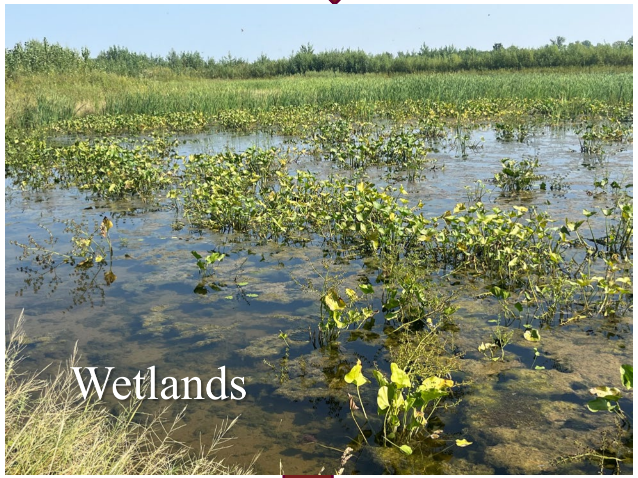


Work story



Free water surface constructed wetlands (FWS)

Borrow Pit Wetlands

- Soil collected from borrow pits for levee repair or setbacks
- Borrow pits can be converted to wetlands to provide ecological value

Photo: USACE

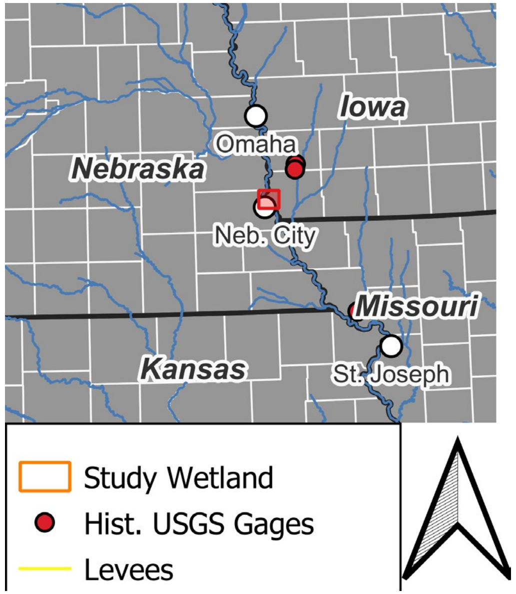
Borrow Pit Wetlands

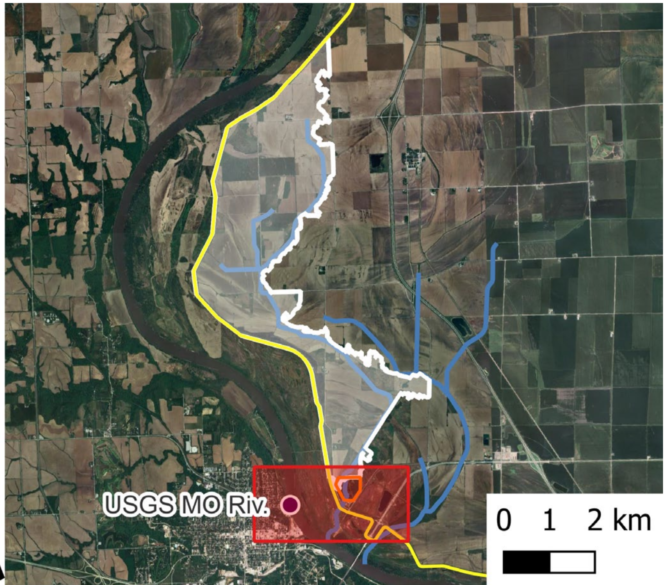
Borrow Pit Wetlands

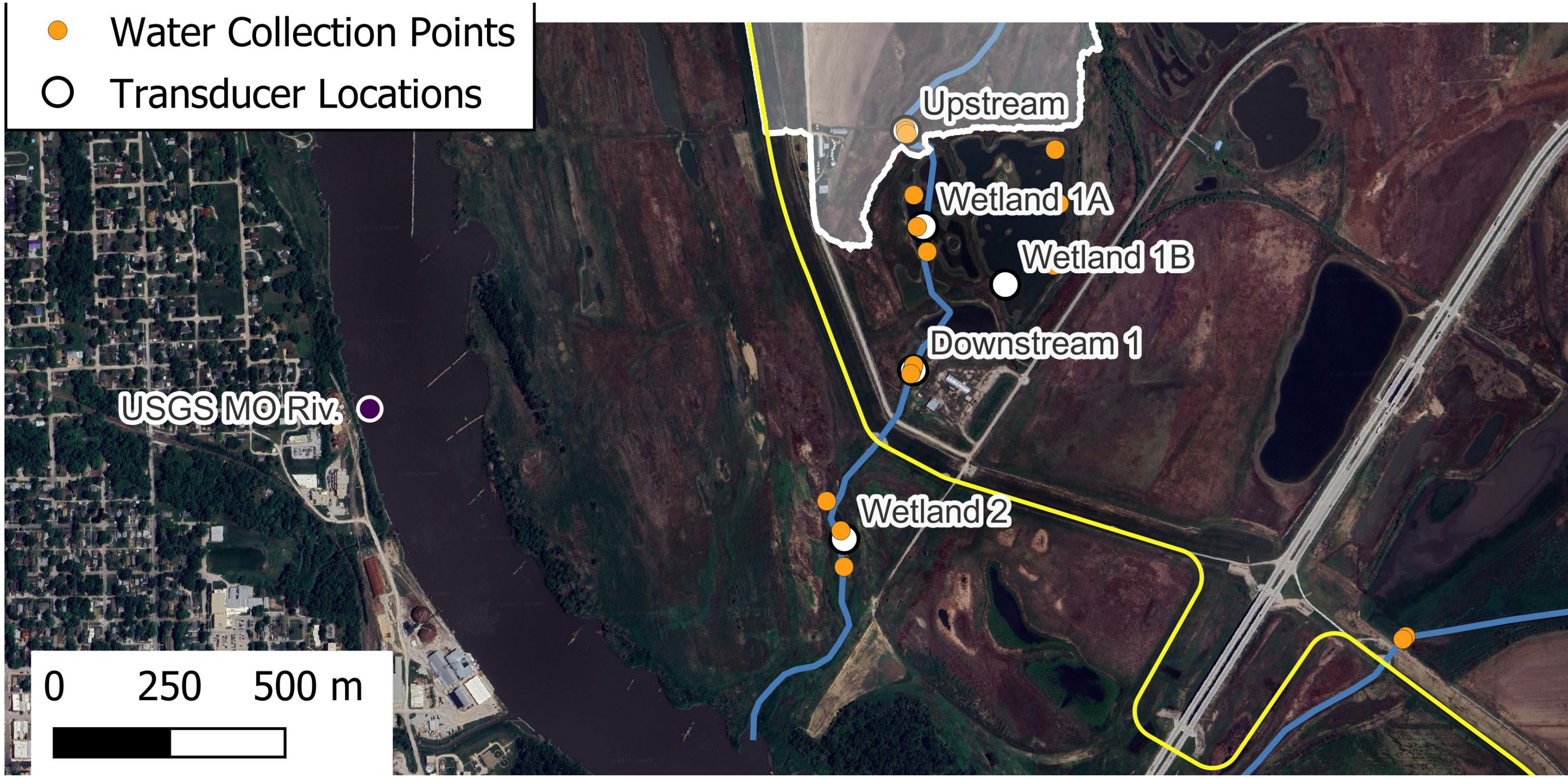
Borrow Pit Wetlands

Borrow Pit Wetlands

What are the water quality benefits of these constructed wetlands?

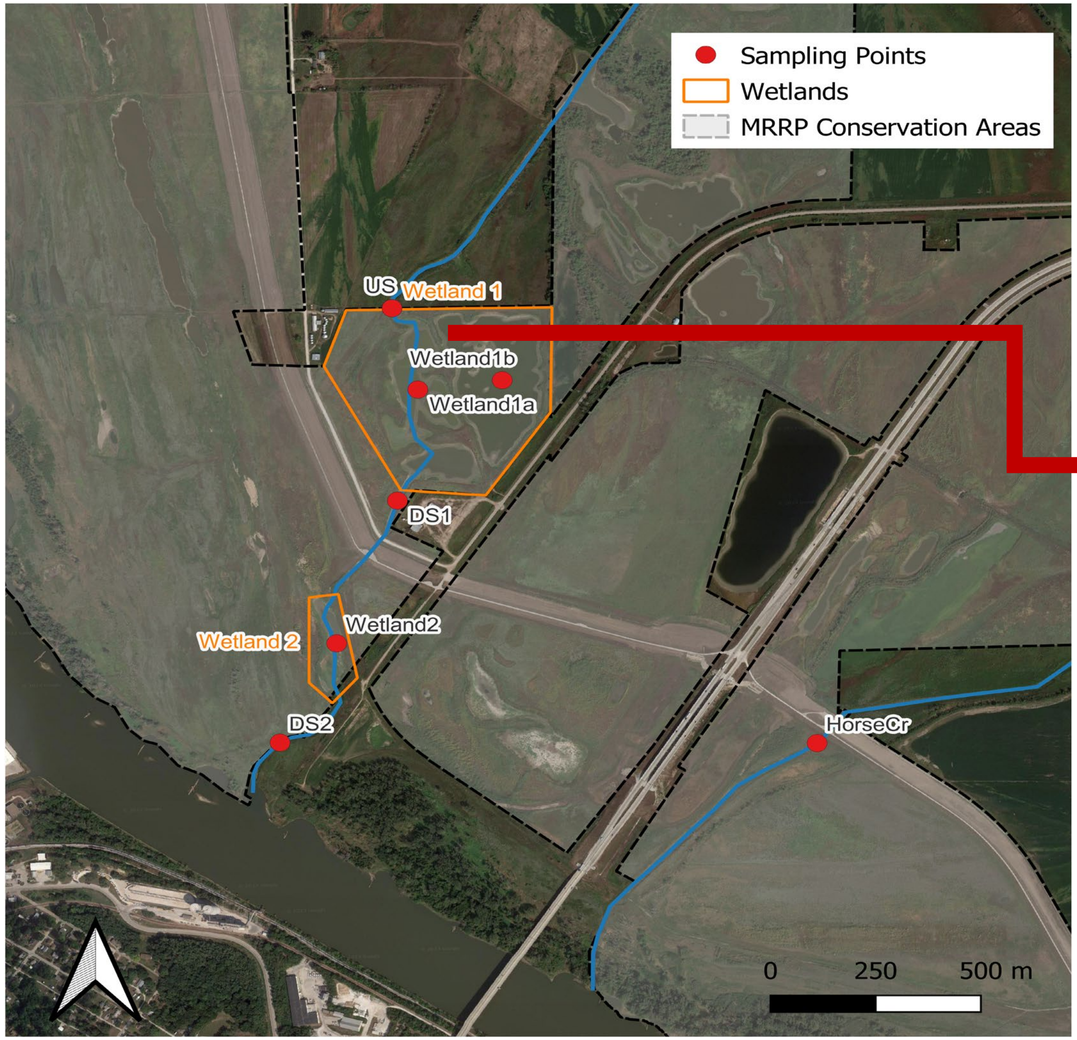


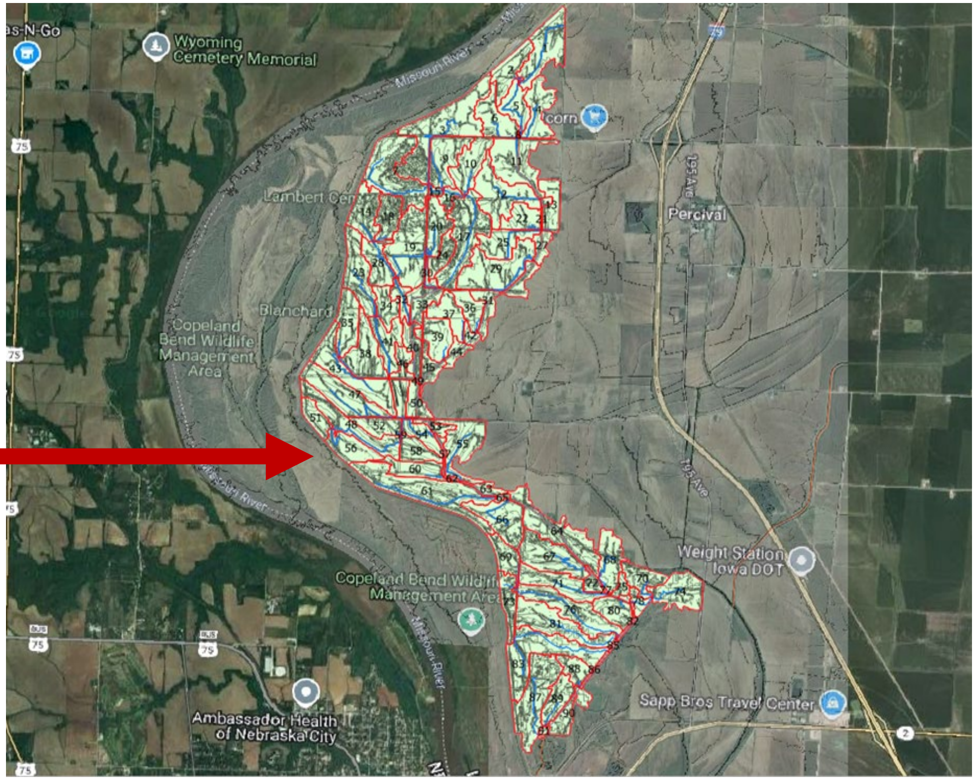




Work targets

- ❖ Evaluating Newly Established Constructed Wetlands along the Missouri River
- ❖ Enhancing the design of constructed wetlands to improve nutrient removal





Area: 15.6 km² (1,559 ha)

Area: 21.0 ha wetland was created by USACE in 2012 as part of a levee repair and realignment project

Land use in the watershed is dominated by:

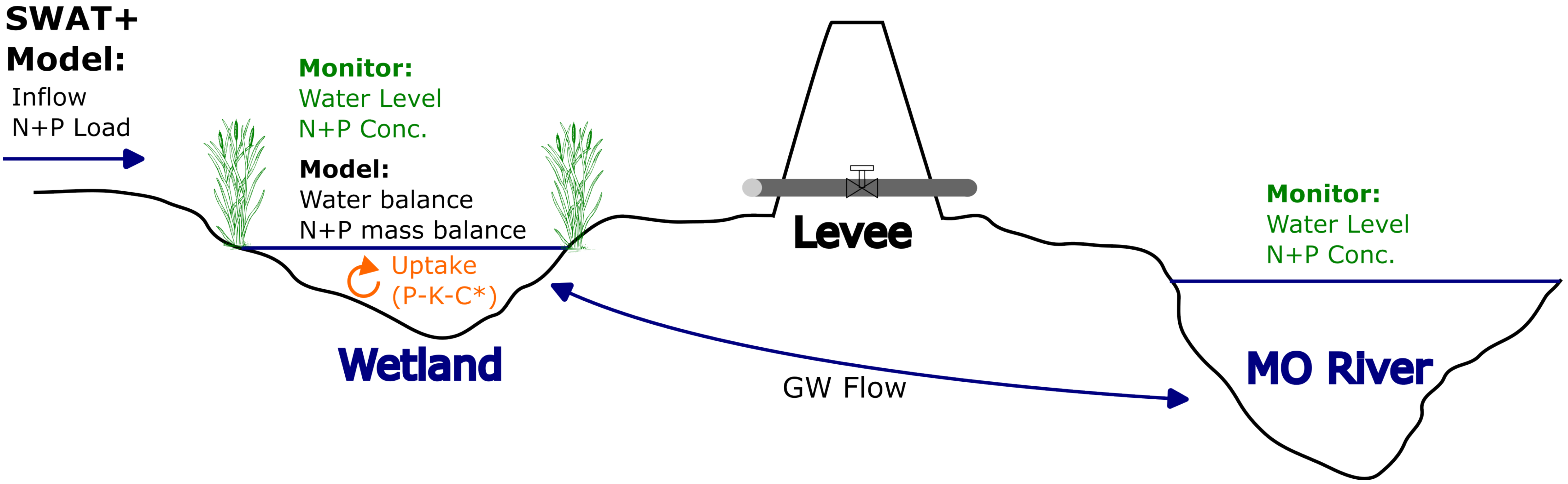
- row-crop agriculture (83.3%),
- hay/pasture (6.3%) and
- forested land (7.4%).

The wetland-to-watershed ratio is 1.3% (US range 2.5%)

The challenges are:
Surface runoff, groundwater (in/out), other water balance fluxes?
The wetland had no observed outflow during the monitoring period?

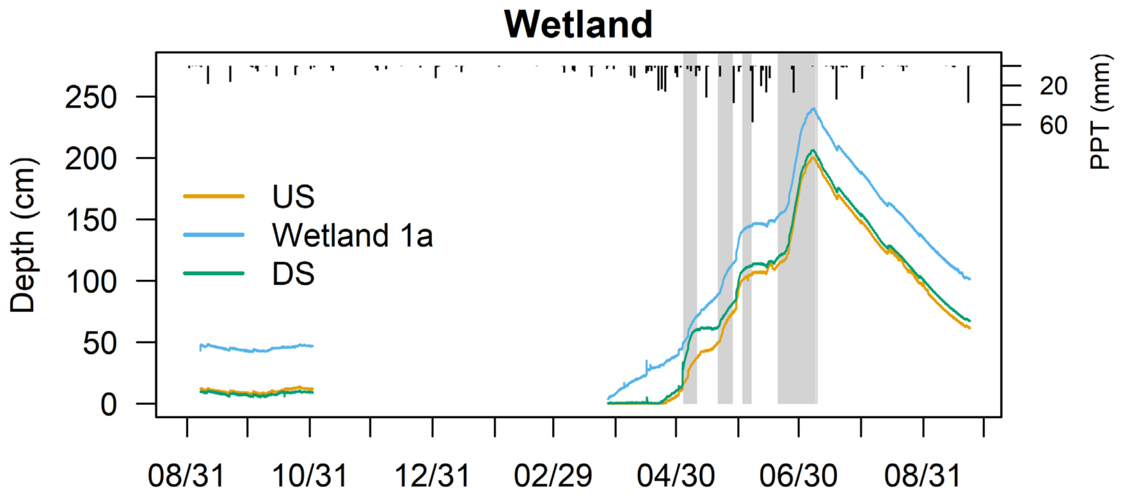
Research Overview

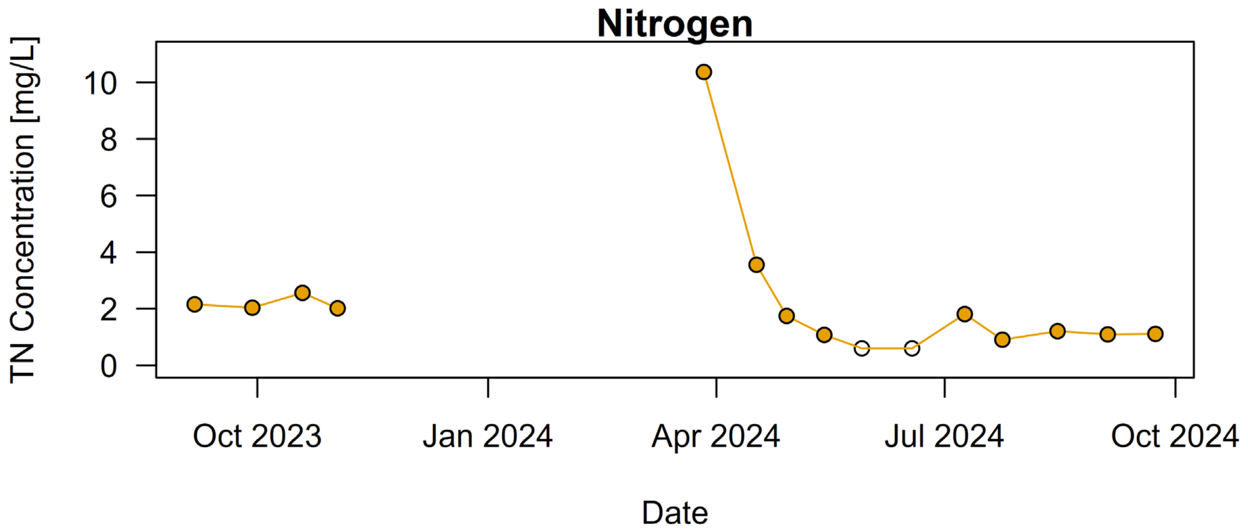
Wetland **monitoring** (2023 – 2024) and

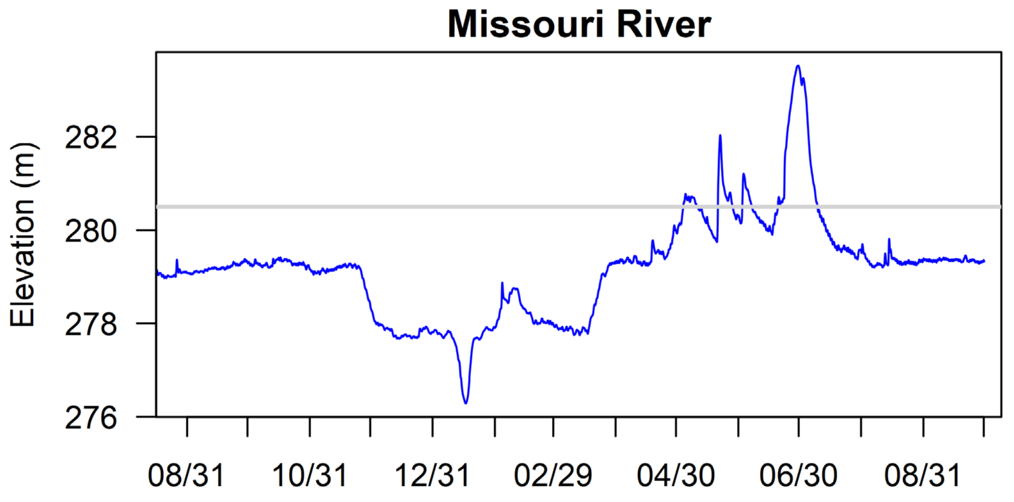


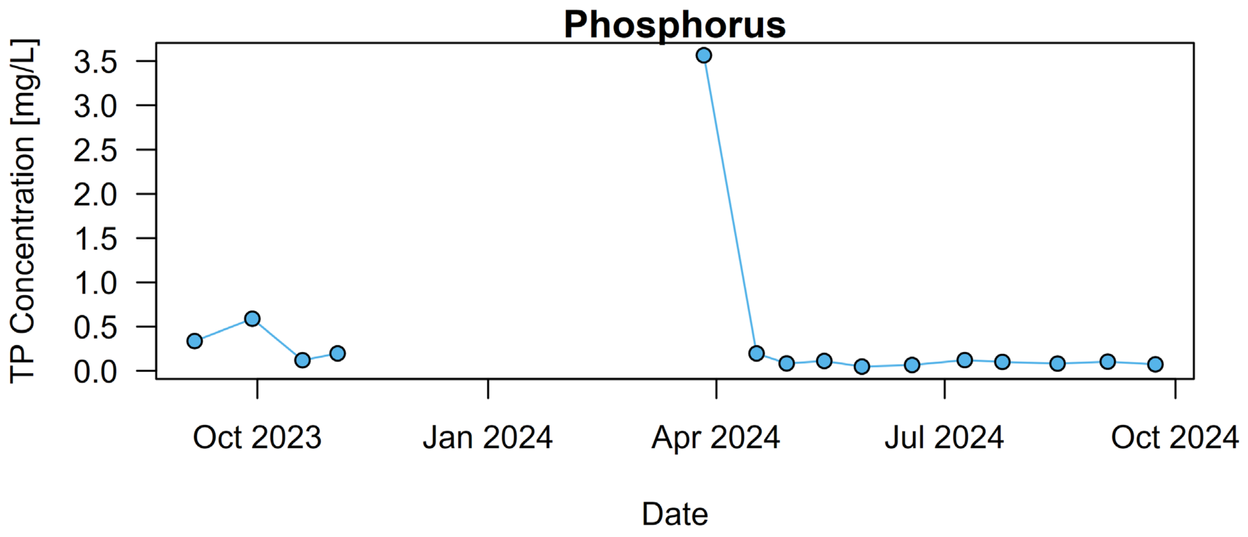
Watershed and wetland **modeling** (2013- 2024)

Wetland Monitoring

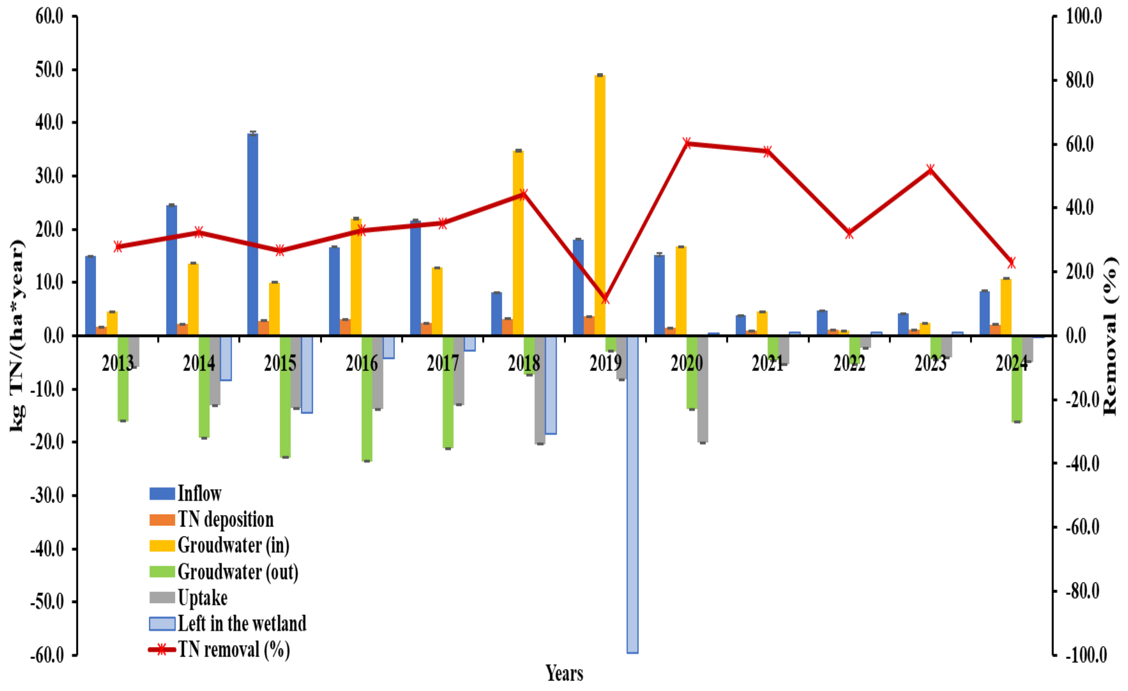


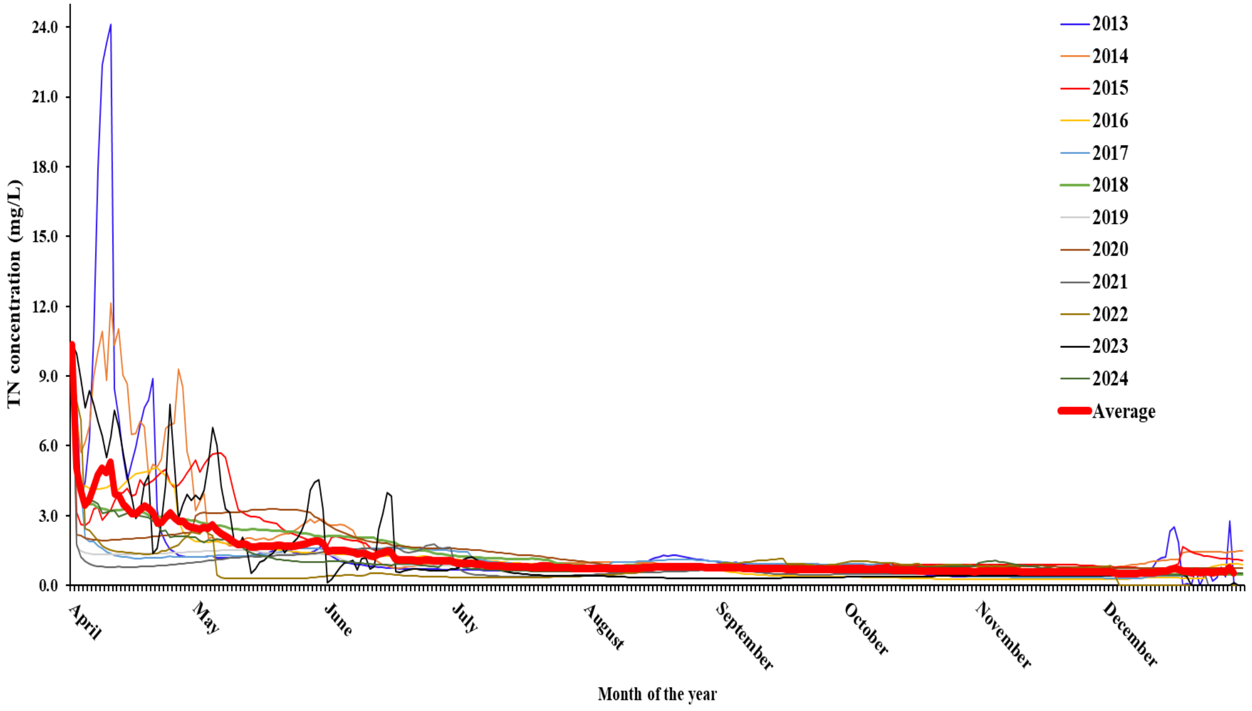






Wetland Modeling TN

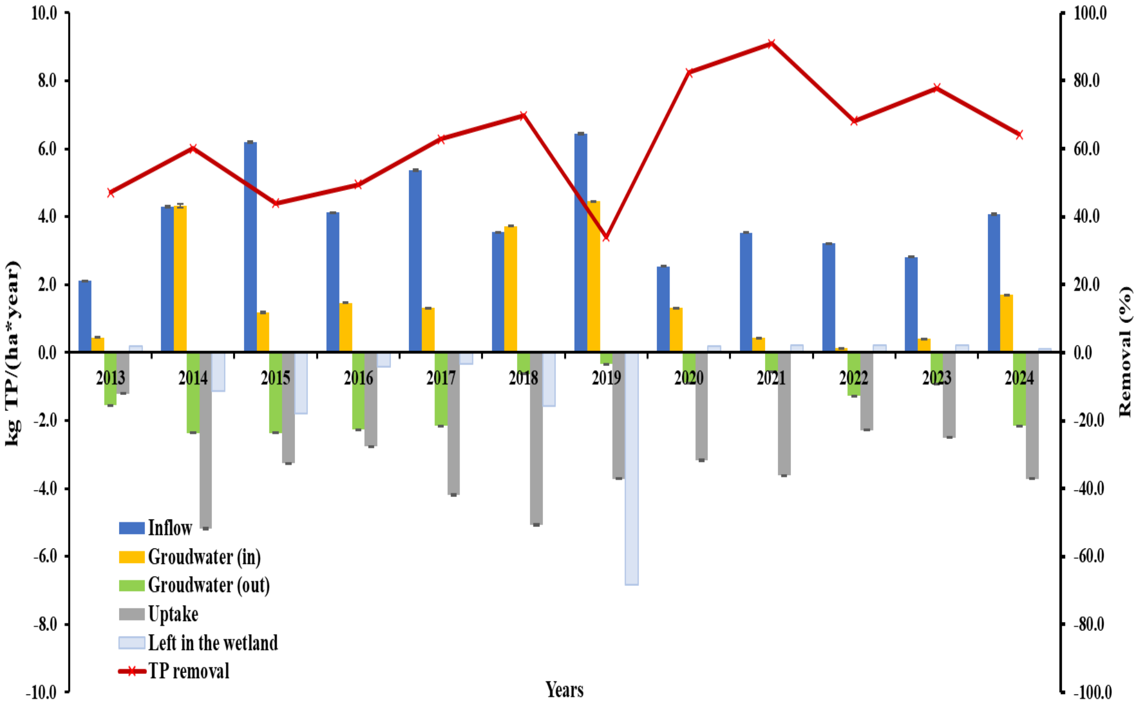


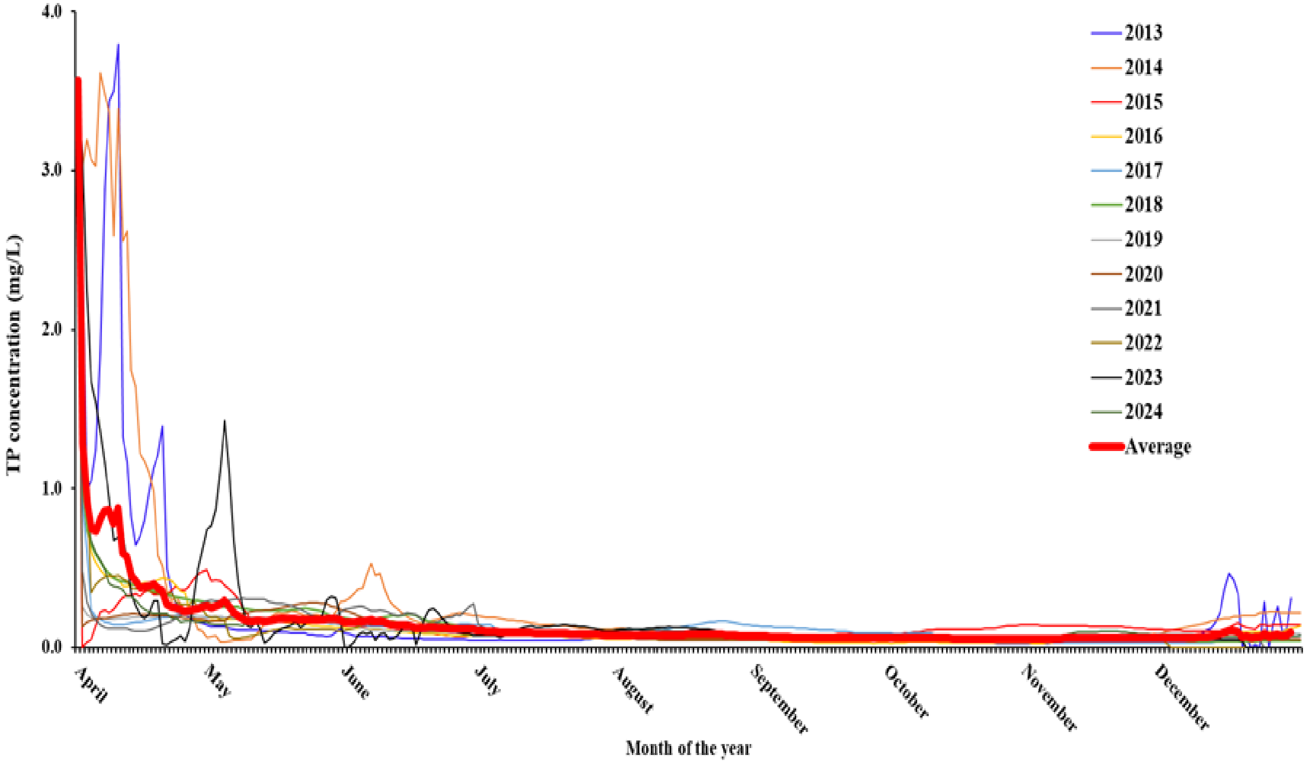


Total inflow: 31.6 (kg. ha^{-1}. year^{-1})

Mean **36.4%** TN Removal

Wetland Modeling TP

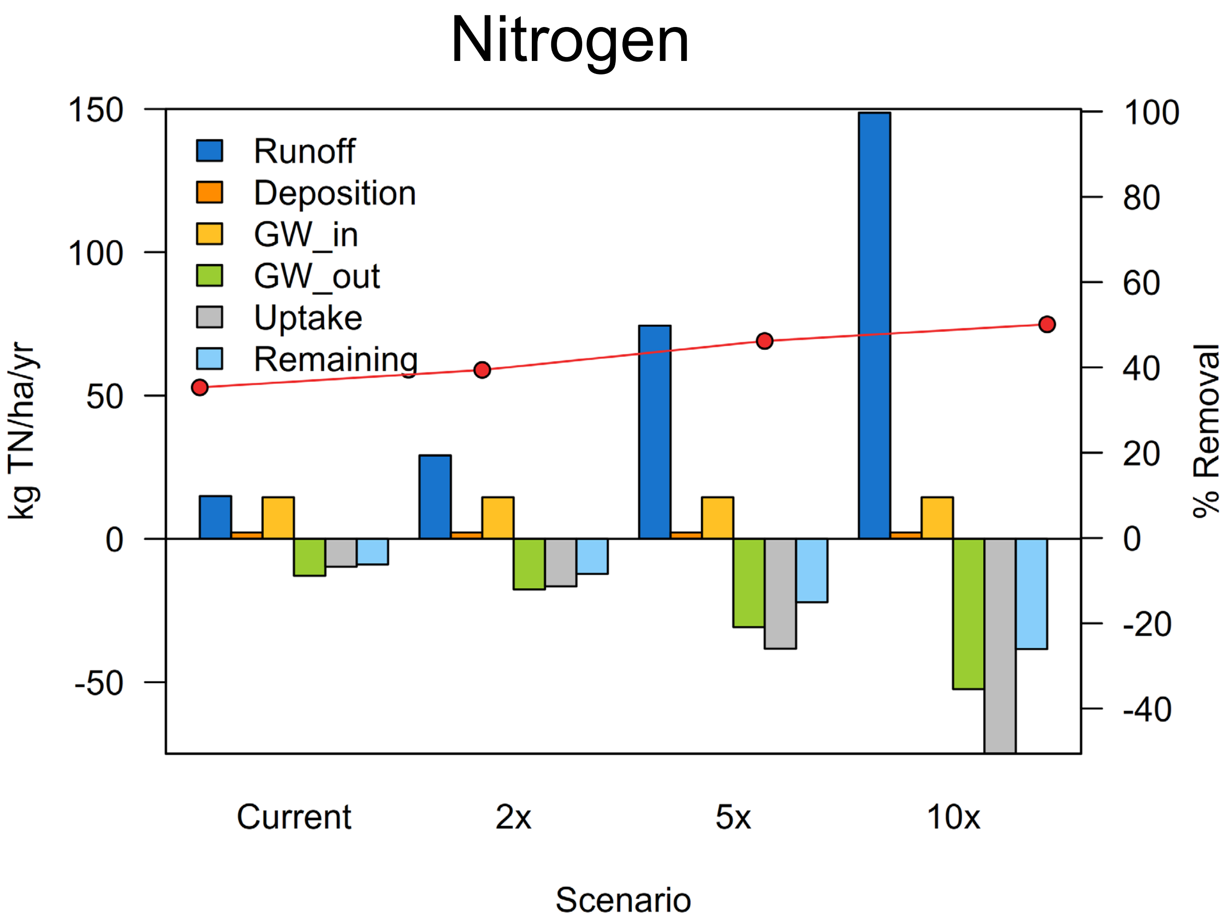




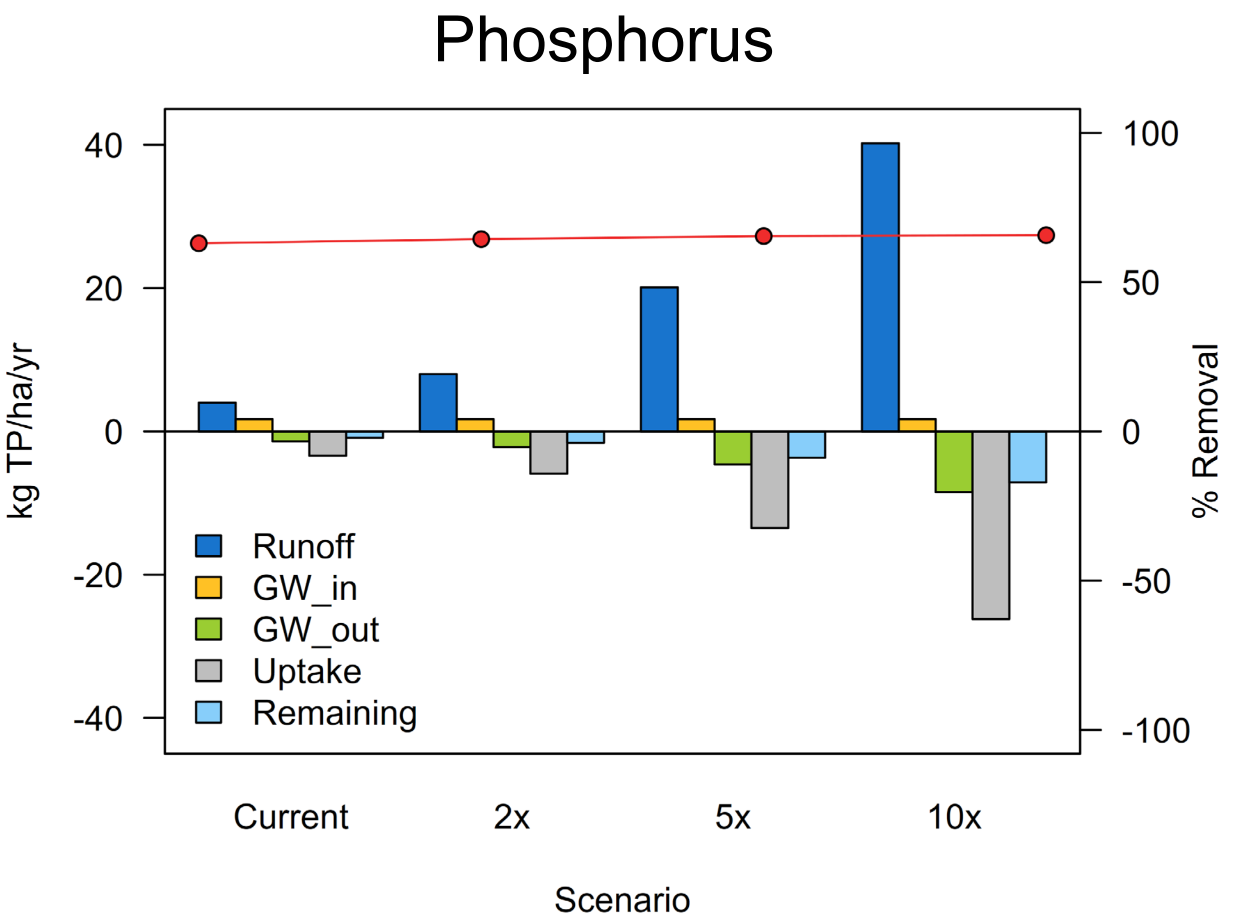
Total inflow: 5.7 (kg. ha^{-1}. $year^{-1}$)

Mean **62.6%** TP Removal

Wetland Modeling Increased Loading



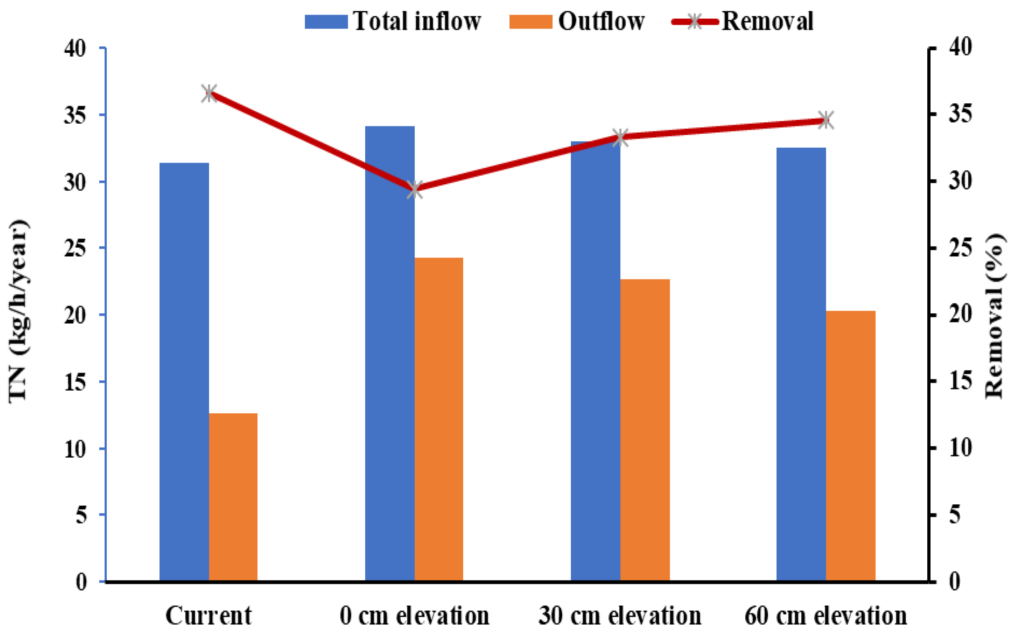
36.4 to 50%



63.0 to 65.2%

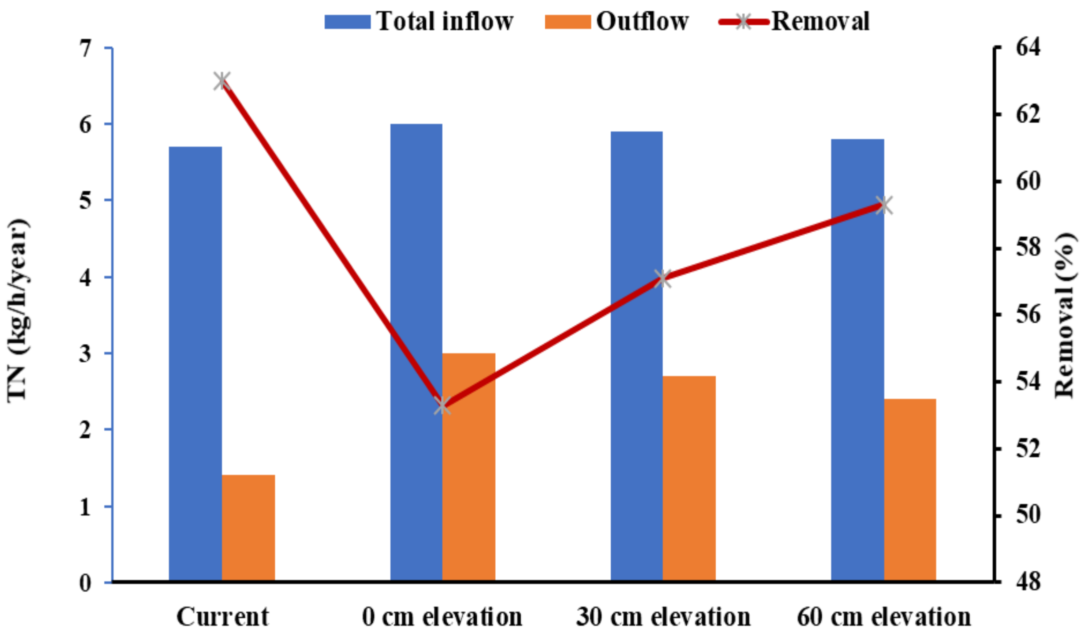
Wetland Modeling- Adding outflow pipe

Nitrogen



36.4 to 29.4%

Phosphorus



63.0 to 53.3%

Conclusions

- Effective removal of both N (avg. 36.6% removal) and P (avg. 63.0% removal)
- Wetland receives relatively low nutrient loads for its size
  - TN: 31.4 kg/ha/yr (lit. range 21.2-25,000 kg/ha/yr)[1]
  - TP: 5.7 kg/ha/yr (lit. range 0.3-3,700 kg/ha/yr)[1]
- Future designs need to account for MO River influence and estimates of watershed loading rates to effectively size wetlands

[1]Land et al. (2016)

Acknowledgements

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Photo: © Dave Crane