Utilizing the SWAT model & machine learning for predicting microcystin & geosmin occurrence in Cheney Reservoir

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Background

- Fertilizers and pesticides from crop fields
- Threaten fish, shellfish, mammals, birds, and even human's life
- Ongoing monitoring and early detection is critical

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Goal

- The overarching goal of the study is to explore how we can utilize machine learning methods to predict microcystins (MCs) and geosmin before they pose a threat to humans.

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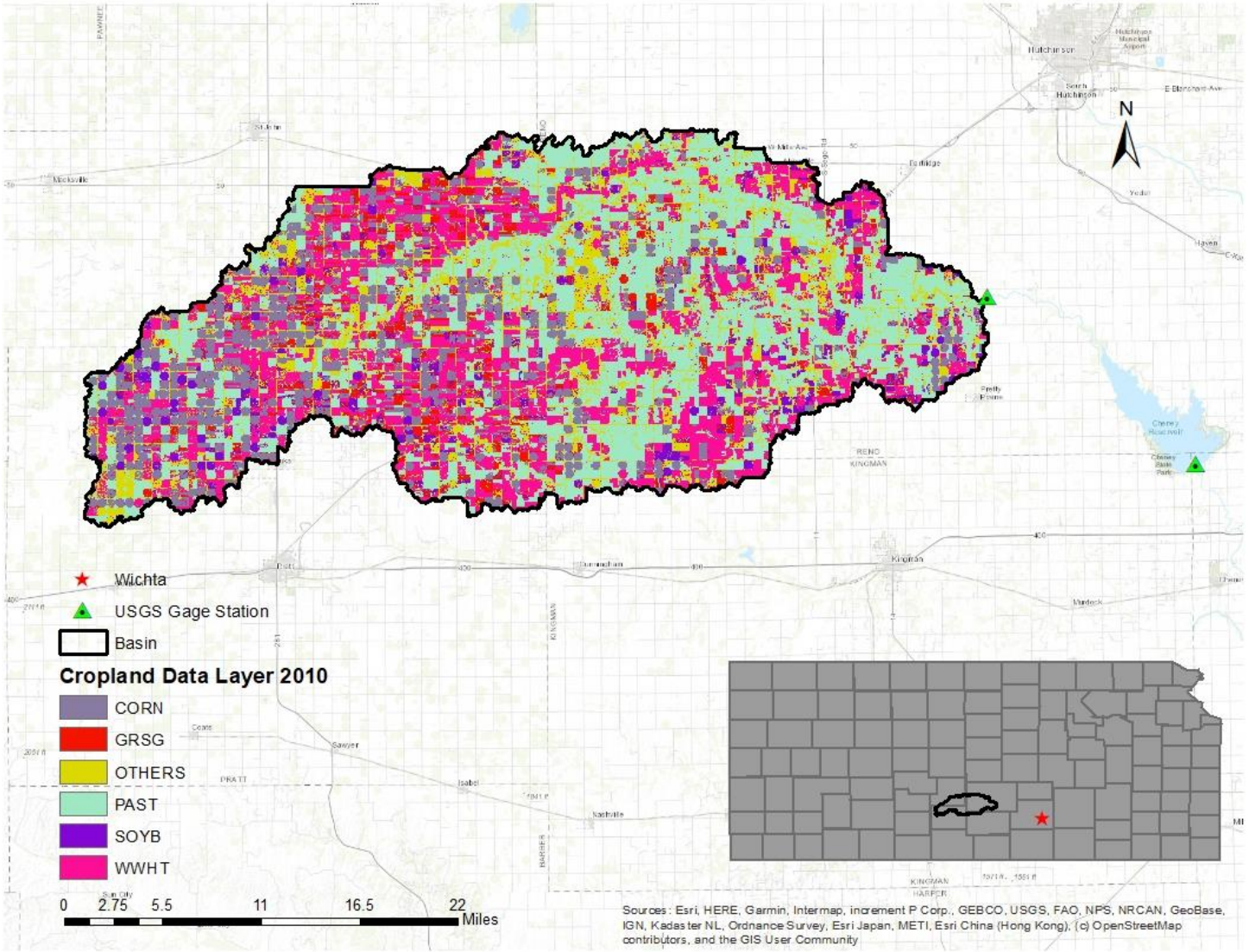
Study Area



- One of the major drinking-water sources for the city of Wichita

Source: The Cropland Data Layer (CDL) 2010

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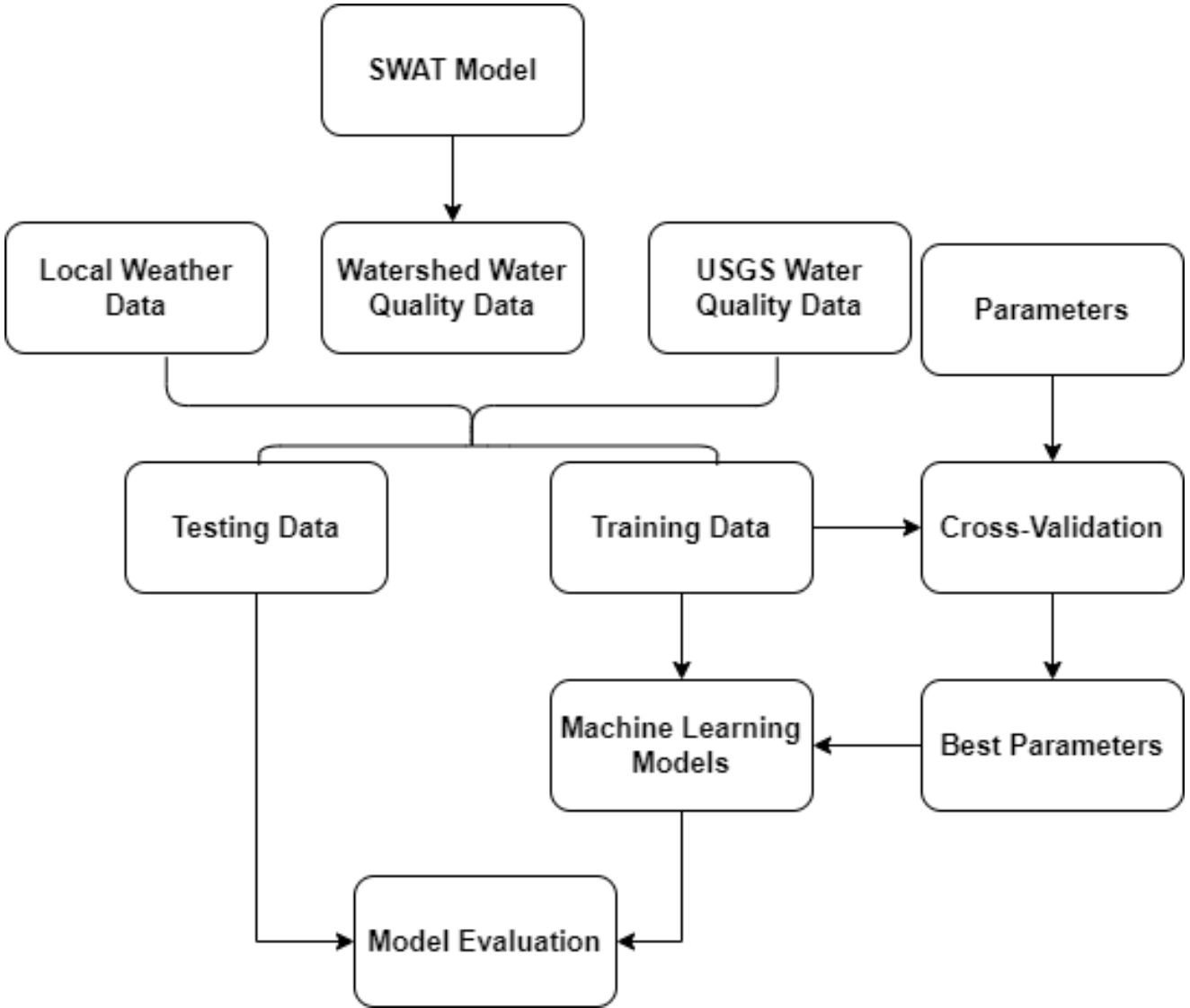
Workflow

Local Weather Data:

- Precipitation
- Air Temperature
- Wind Speed
- Wind Direction



USGS Water Quality Data:

- pH
- Electrical Conductivity
- Turbidity
- Chlorophyll
- Dissolved Oxygen
- Elevated Surface Water Temperature

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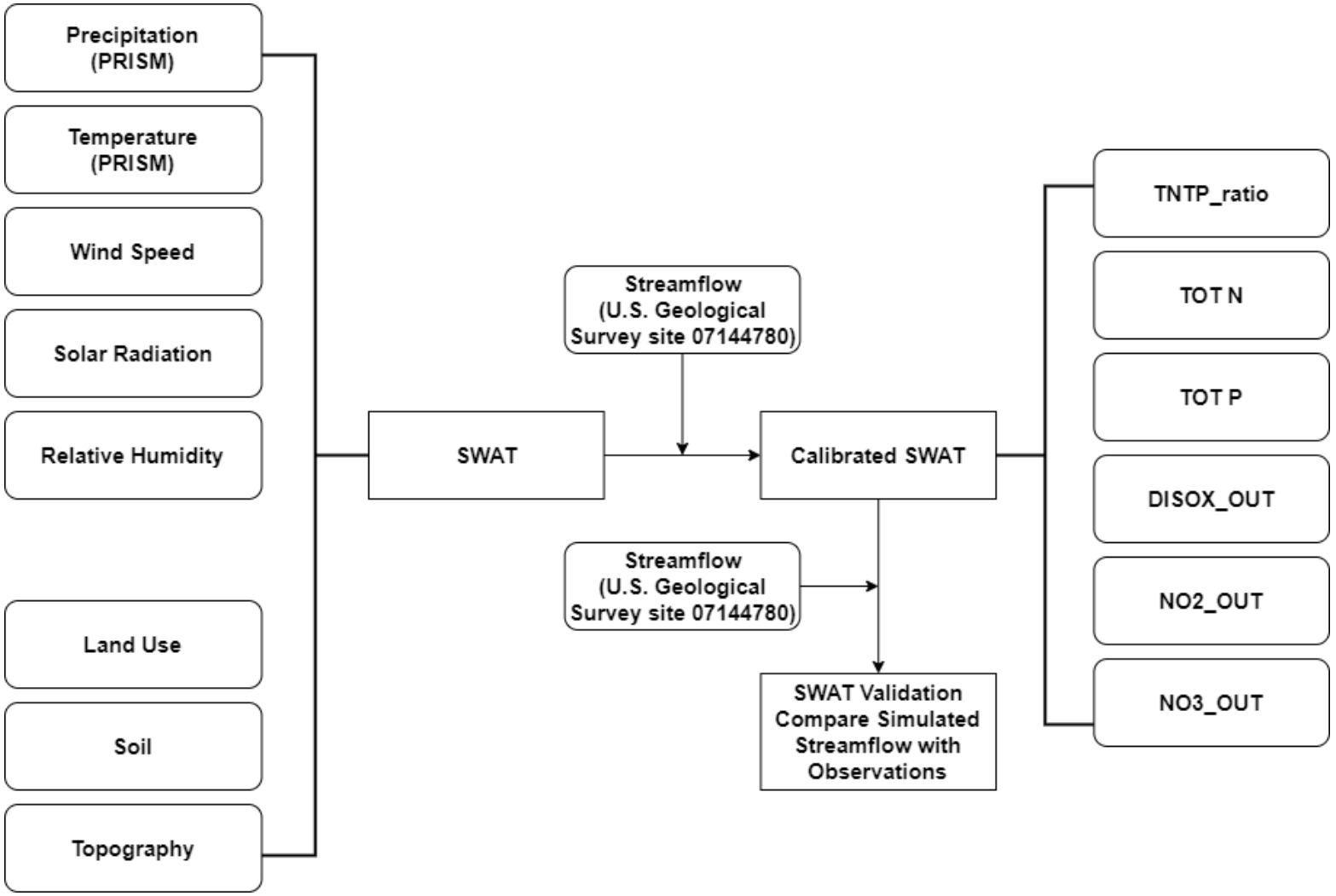
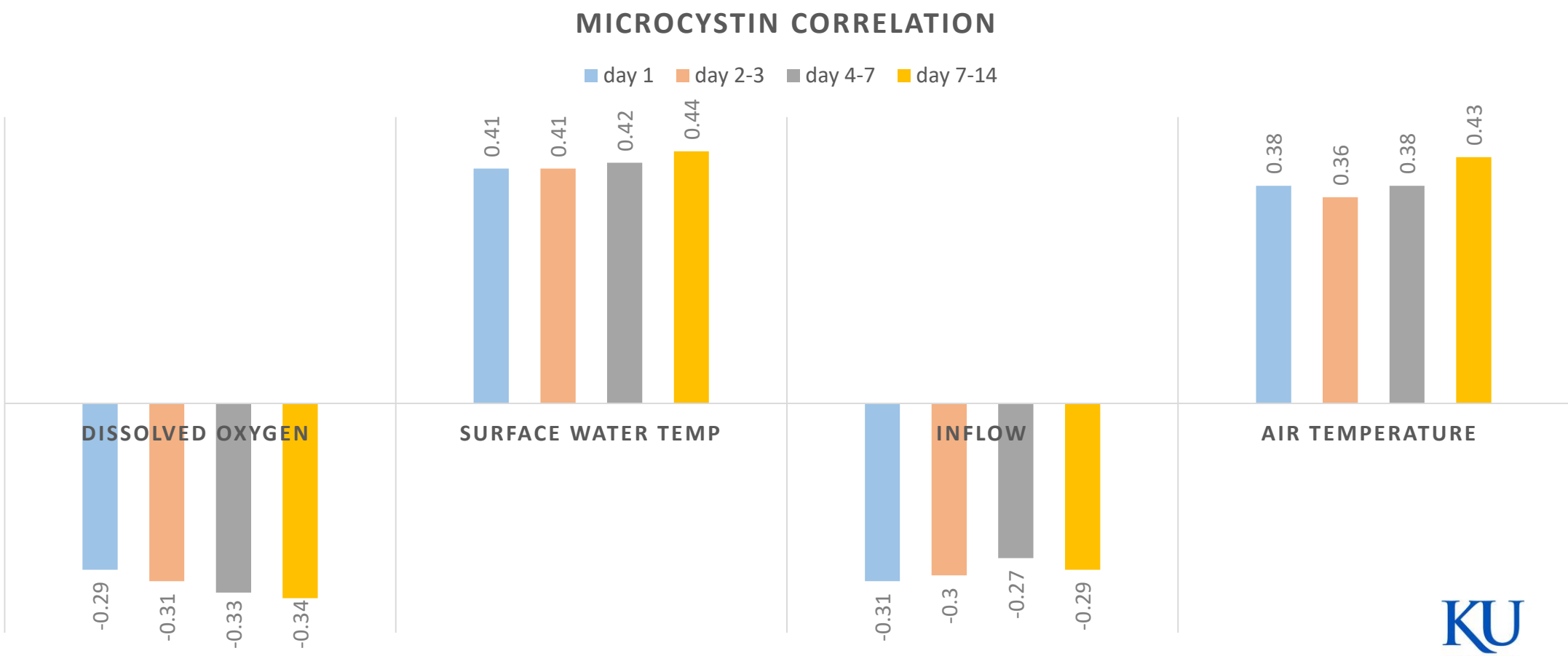
Workflow



R^2 >= 0.6
Nash coefficient >= 0.5
-25 % <= PBIAS <= 25 %

	Training (2010-2016)		Validation (2017-2018)	
	Uncalibrated	Calibrated	Uncalibrated	Calibrated
NSE	-3.1	0.5	-2.8	0.6
Pbias	124.5	-15.6	87.4	-18.9
R^2	0.8	0.8	0.6	0.7

Discussion



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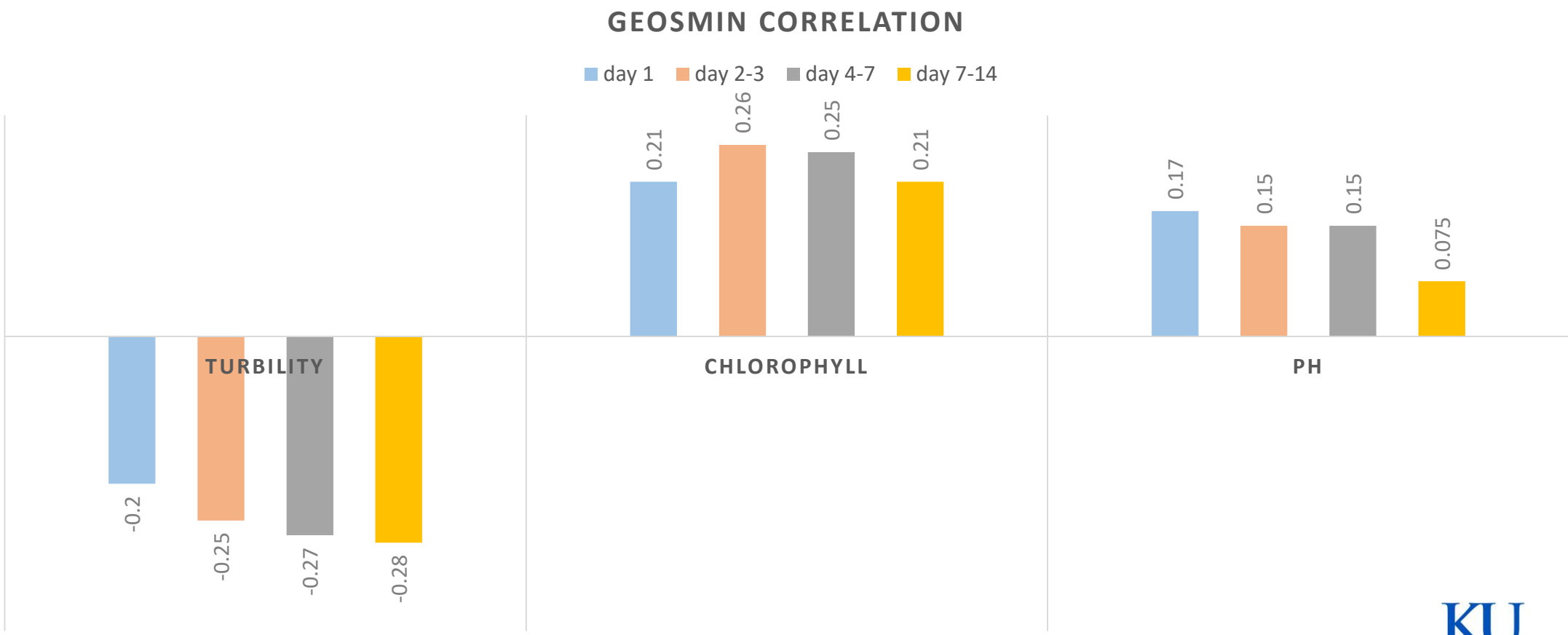
Discussion



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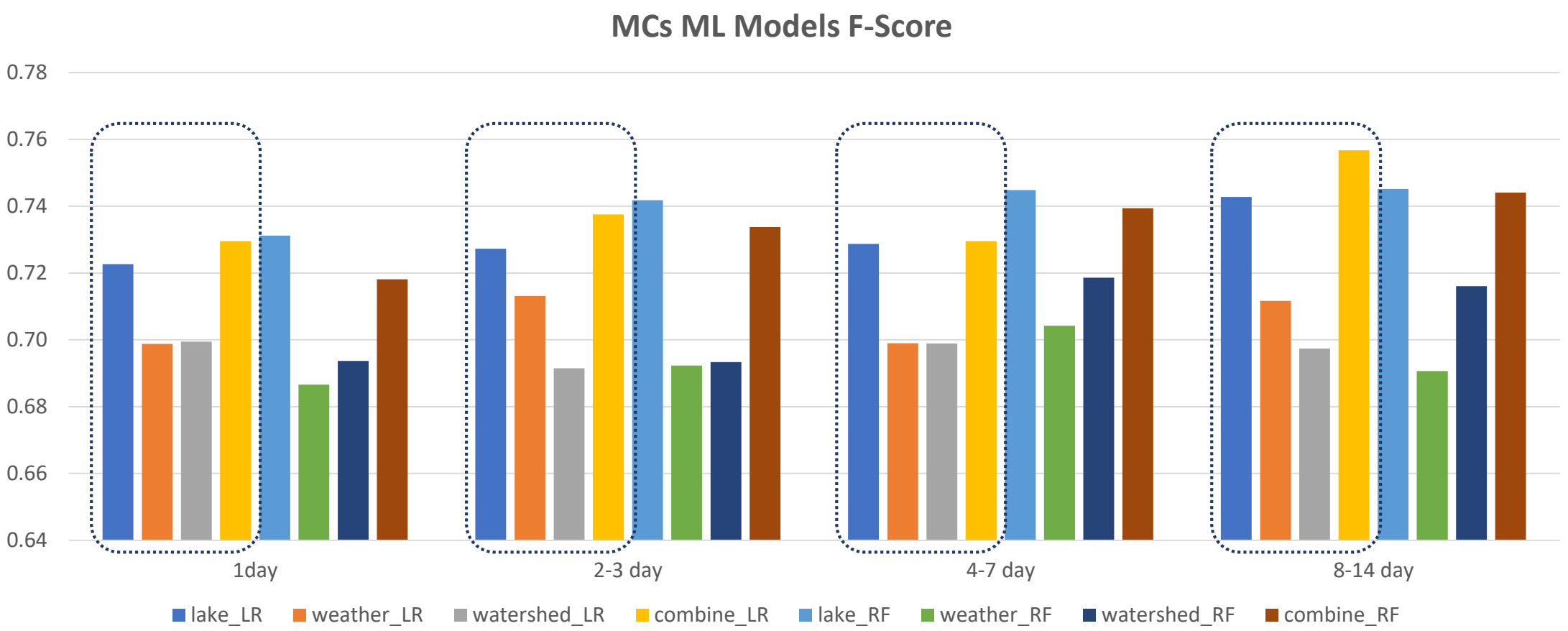
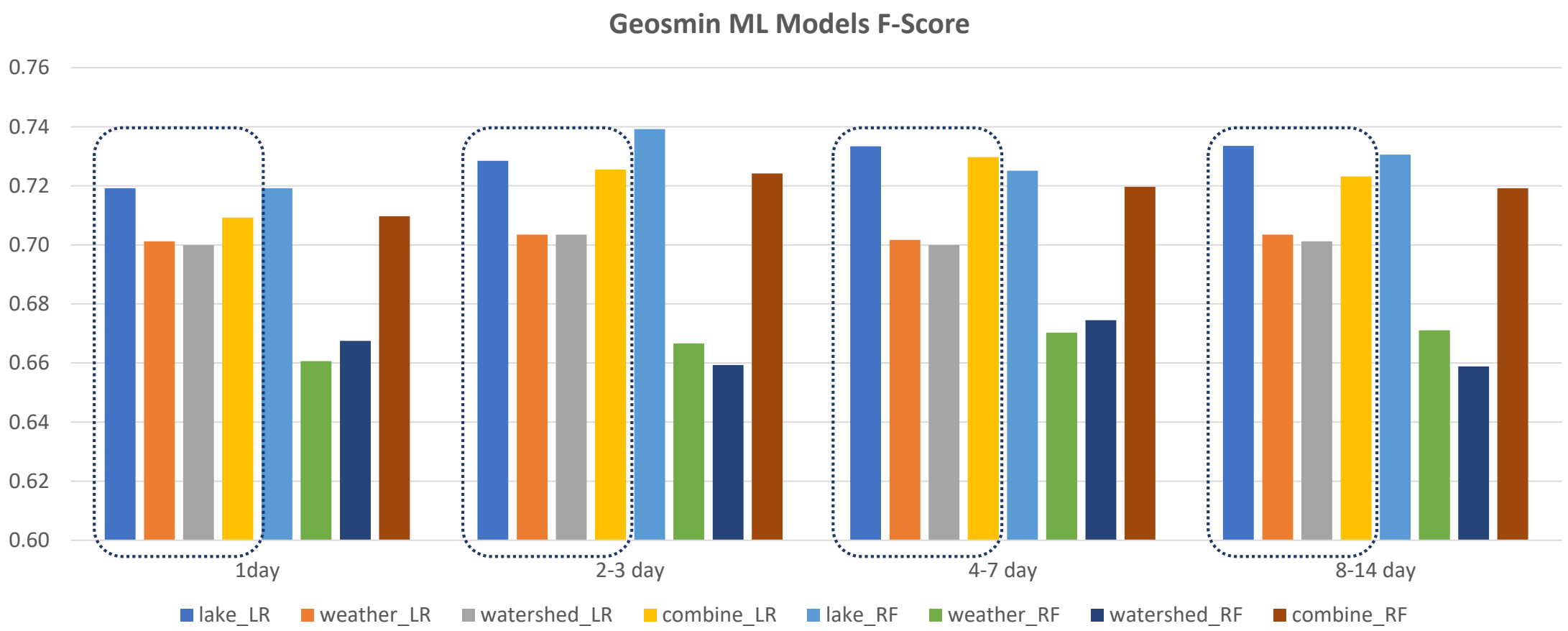
Discussion


MCs ML Models F-Score
0.78
0.76
0.74
0.72
0.70
0.68
0.66
0.64
1day
2-3 day
4-7 day
8-14 day
lake_LR
weather_LR
watershed_LR
combine_LR
lake_RF
weather_RF
watershed_RF
combine_RF

Discussion


Geosmin ML Models F-Score
0.76
0.74
0.72
0.70
0.68
0.66
0.64
0.62
0.60
1day
2-3 day
4-7 day
8-14 day
lake_LR
weather_LR
watershed_LR
combine_LR
lake_RF
weather_RF
watershed_RF
combine_RF

Discussion

Variable Importance

	Reservoir (Water)	Watershed	Weather
Microcystin	pH; Elevated Surface Water Temperature; Dissolved Oxygen	Inflow; TOTN/TOTP	Air Temperature; Low Wind Speed; Precipitation

Elevated surface water temperature and pH in the reservoir were the strongest predictors of MC, and weather variables linked to relatively low wind speeds were also predictive of blooms up to 8-14 days before MCs were detected.

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Discussion

Variable Importance

	Reservoir (Water)	Watershed	Weather
Geosmin	Chlorophyll; Electrical Conductivity; Turbidity	Inflow; TOTN/TOTP	Air Temperature; Low Wind Speed; High Wind Speed; Precipitation

Chlorophyll in the reservoir was the strongest predictors of geosmin.

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Conclusion

- The results suggest that toxin producing blooms in Cheney Reservoir potentially can be predicted more than a week in advance, which could allow water managers to pro-actively prepare advanced drinking water treatments and mitigate toxin or taste-and-odor events in finished drinking water.

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