2021 Final Report Summary Sheet

Grantee Information

Project Title: Detection and attribution of recent changes in phosphorus loadings in the Illinois River watershed

Institution: Illinois State Water Survey, University of Illinois at Urbana-Champaign

Primary Investigator: Momcilo Markus

NREC Project #

Is your project on target from an IMPLEMENTATION standpoint? ☒ Yes ☐ No
If you answered "no" please explain:

Is your project on target from a BUDGET standpoint? ☒ Yes ☐ No
If you answered "no" please explain:

Based on what you know today, will you meet the objectives of your project on-time and on-budget? ☒ Yes ☐ No
If you answered "no" please explain:

Have you encountered any issues related to this project? ☐ Yes ☒ No
If you answered "yes" please explain:

Have you reached any conclusions related to this project that you would like to highlight? ☒ Yes ☐ No
If you answered "yes" please explain:

Approximately 78% of the increased TP load in the Illinois River at Valley City appeared to come from the drainage area along the mainstem of the Illinois River downstream of Marseilles, and another 22% came from the Sangamon River. The magnitude of the contribution from the Sangamon River was similar in magnitude to an increase in TP discharged from the Sanitary District of Decatur.

For subwatersheds with less than nine percent developed area (i.e., predominantly agricultural watersheds), increases in TP yield were highly correlated with increases in water yield from 1989-96 to 2015-18. For subwatersheds with more than 9% developed area, changes in TP yield were uncorrelated to changes in water yield, probably because of the influences of human population density and wastewater treatment technologies employed.

Riverine TP loads were correlated with a variety of factors, but additional research is needed to determine whether these correlations reflect cause-and-effect relationships.

Have you completed any outreach activities related this project? Or do you have any activities planned? ☒ Yes ☐ No
If you answered "yes" please explain and provide details for any upcoming outreach:

Presentations have been given to the North Branch Chicago River Watershed Council (August 11, 2021) and the annual conference of the Illinois Nutrient Loss Reduction Strategy (Nov 10, 2021).

Please write a detailed summary report that includes: Details of each objective and the progress made towards its competition, planned research activities for 2022, major accomplishments, any preliminary findings or data relevant to the project, relevant budgeting, and any publications or outreach accomplished from the research. Please **include a one page summary with relevant data tables or graphs and pictures related to the project that you would like included in the NREC end of the year report.**

The Illinois River is a major contributor of phosphorus (P) to the Mississippi River and the Northern Gulf of Mexico. Illinois has adopted a goal of reducing riverine P loads in the state by 25% by 2025 relative to 1980-96 baseline period. Despite this interest and large reductions in P discharge from the Metropolitan Water Reclamation District of Greater Chicago (MWRD), total phosphorus (TP) loads at the downstream monitoring location at Valley City, Illinois have increased 30% relative to the baseline period. The objectives of this study are to quantify long-term variation in P loads in the Illinois River and its tributaries and identify factors that may be causing the observed variations.

We calculated river loads of P, total suspended solids, and other potentially related constituents at 44 locations in the Illinois River Basin using Weighted Regressions on Time Discharge and Season with Kalman filtering (WRTDS-K), riverine concentrations from IEPA and USGS, and river flow data from USGS (Figure 1, Table 1). We also compiled data on land cover and point sources of P in the basin and conducted correlation and regression analyses that might identify factors contributing to increased riverine P loads.

Analysis of incremental TP loads in different sections of the Illinois River and its tributaries indicates there was a considerable deposition of P in the segment of the basin between Marseilles (site #18 in Figure 1) and Valley City (site #42 in Figure 1), excluding monitored tributaries, during 1989-96. This portion of the river system is very flat and known to accumulate sediment. During 2015-19, this section of the basin shifted from being a net sink to being a net source of P and this shift represented 78% of the increased TP load at Valley City. We were unable to quantify the precise causes for this shift, but identified suggestive correlations that require additional research to determine causality: increased discharge, increased chloride concentrations, reduced sulfate concentrations and an increased portion of TP in dissolved form, which may be less susceptible to deposition than particulate P.

The greatest increase in TP load and yield occurred in the mainstem subwatershed between Marseilles and Henry (location #44 in Figure 1), and was associated with an eight-fold increase in water yield. Water samples were collected less frequently at Henry during 2015-19 (6.4 samples/yr) than at other sites (average 9 samples/yr), which may reduce the accuracy in the load estimate at Henry.

Increased load from the Sangamon River at Oakford represented 22% of the increased load at Valley City, and this increase was similar in magnitude to an increase in point source P discharge from the Sanitary District of Decatur. The combined changes from the other monitored tributaries below Marseilles (including a reduction in load from the Spoon River) represented only 2.4% of the increased load at Valley City, which offset a similarly sized load reduction at Marseilles.

In the upper Illinois River Basin, riverine TP load reductions occurred downstream of some point source facilities operated by MWRD, Lake County WRD and Thorn Creek WRD. But these and possibly other load reductions were offset by increased loads in suburban areas where the population had increased (DuPage River) and an agricultural basin (Mazon River). TP loads in the Kankakee at Wilmington and the Illinois River at Marseilles changed very little from 1989-96 to 2015-19.

Across the basin (Figure 2), changes in incremental TP yields from 1989-96 to 2015-19 from subwatersheds with less than 9% developed landcover were highly correlated with changes in incremental water yield. For subwatersheds with landcover more than 9% developed landcover, changes in incremental TP yield were unrelated to changes in incremental water yield, as these watersheds were more likely to be influenced by point sources.

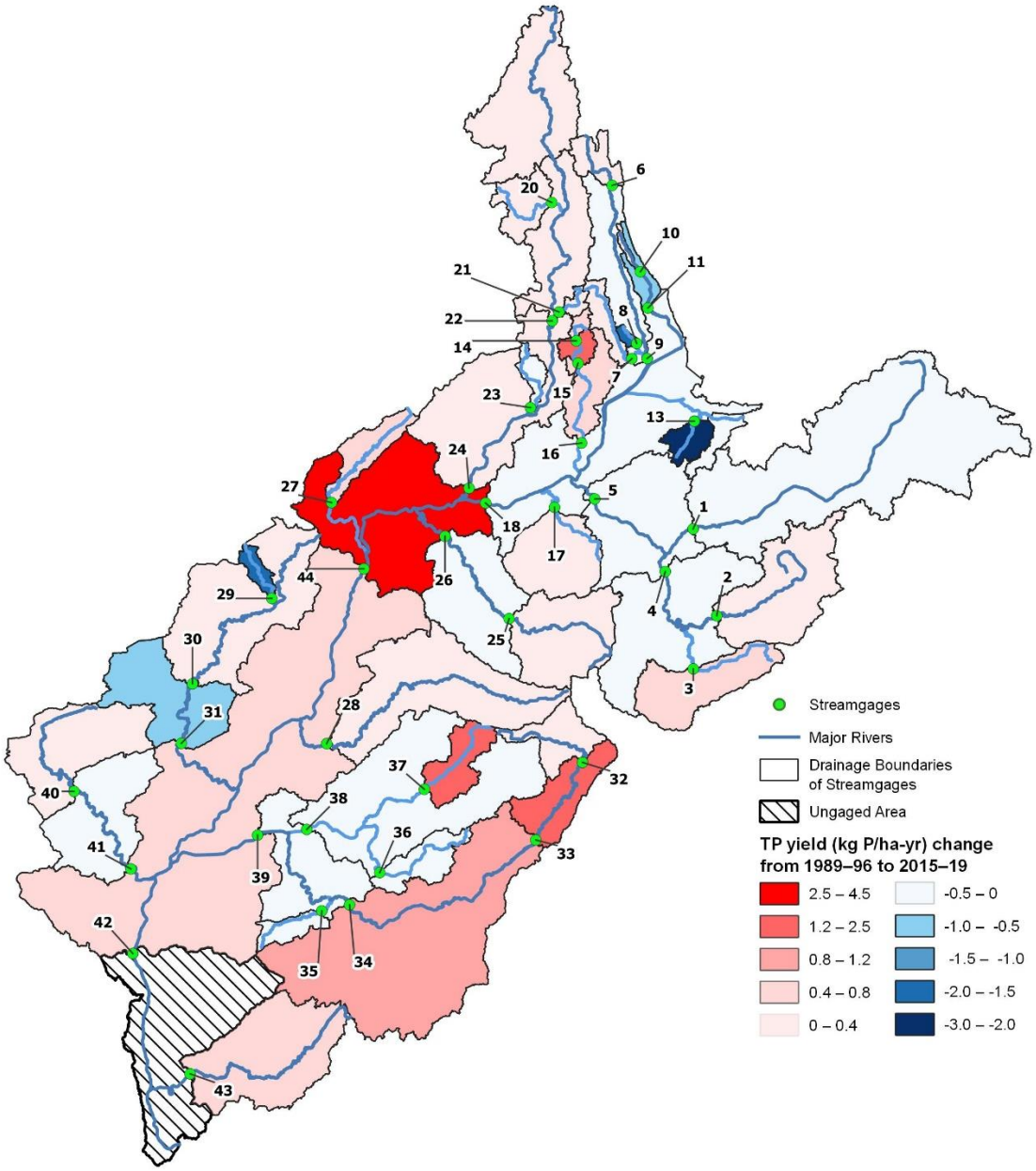

Figure 1. Changes in incremental TP yields from 1989-96 to 2015-19. (See Table 1 for monitoring location names.)

Table 1. River monitoring locations used in this study.

ID # in Fig. 1,	USGS Streamgage	IEPA Site	Stream Name	Drainage Area (sq. mi.)
1	05520500	F-02	Kankakee River at Momence	2,294
2	05525000	FL-04	Iroquois River at Iroquois	686
3	05525500	FLI-02	Sugar Creek at Milford	446
4	05526000	FL-02	Iroquois River near Chebanse	2,091
5	05527500	F-16	Kankakee River near Wilmington	5,150
6	05527800	G-08	Des Plaines River at Russell	123
7	05531500	GL-09	Salt Creek at Western Springs	115
8	05532000	GLA-02	Addison Creek at Bellwood	17.9
9	05532500	G-39	Des Plaines River at Riverside	630
10	05534500	HCCC-02	North Branch Chicago River at Deerfield	19.7
11	05536000	HCC-07	North Branch Chicago River at Niles	100
12	05536195	HB-42	Little Calumet River at Munster	90
13	05536275	HBD-04	Thorn Creek at Thornton	104
14	05539900	GBK-09	West Branch Du Page River near West Chicago	28.5
15	05540095	GBK-05	West Branch Du Page River near Warrenville	90.7
16	05540500	GB-11	Du Page River at Shorewood	324
17	05542000	DV-04	Mazon River near Coal City	455
18	05543500	D-23	Illinois River at Marseilles	8,259
19	05545750	DT-35	Fox River at New Munster	811
20	05548280	DTK-04	Nippersink Creek near Spring Grove	192
21	05550500	DTG-02	Poplar Creek at Elgin	35.2
22	05551000	DT-09	Fox River at South Elgin	1,556
23	05551700	DTD-02	Blackberry Creek near Yorkville	70.2
24	05552500	DT-01	Fox River near Dayton	2,642
25	05554500	DS-06	Vermilion River at Pontiac	579
26	05555300	DS-07	Vermilion River near Leonore	1251
27	05556500	DQ-03	Big Bureau Creek at Princeton	196
28	05568000	DK-12	Mackinaw River near Green Valley	1,073
29	05568800	DJL-01	Indian Creek near Wyoming	62.7
30	05569500	DJ-09	Spoon River at London Mills	1,072
31	05570000	DJ-08	Spoon River at Seville	1,636
32	05570910	E-29	Sangamon River at Fisher	240
33	05572000	E-18	Sangamon River at Monticello	550
34	05576500	E-26	Sangamon River at Riverton	2,618
35	05577500	EL-01	Spring Creek at-Springfield	107
36	05579500	EIG-01	Lake Fork near Cornland	214
37	05580000	EIE-04	Kickapoo Creek at Waynesville	227
38	05582000	EI-02	Salt Creek near Greenview	1,804
39	05583000	E-25	Sangamon River near Oakford	5,093
40	05584500	DG-04	La Moine River at Colmar	655
41	05585000	DG-01	La Moine River at Ripley	1,293
42	05586100	D-32	Illinois River at Valley City	26,743
43	05587000	DA-06	Macoupin Creek near Kane	868
44	05558300	D-09	Illinois River at Henry	13,435

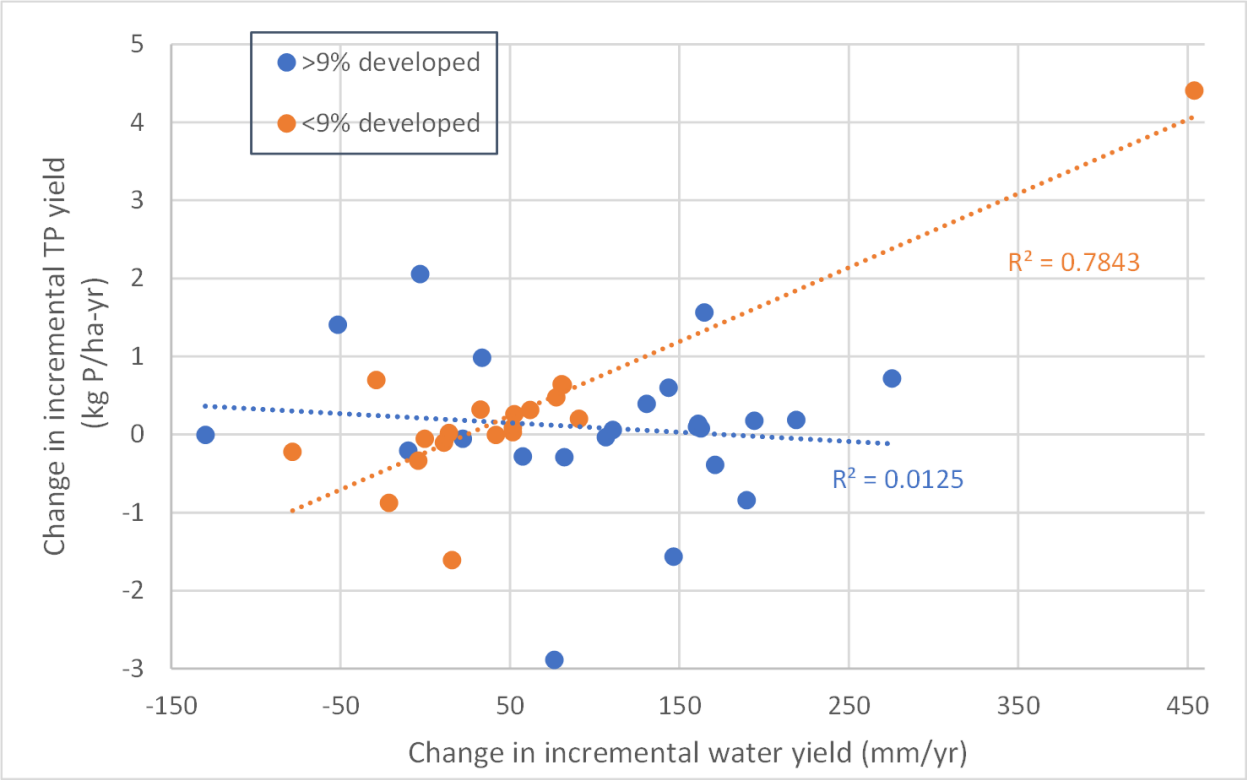

Figure 2. Change in incremental TP yield from 1989-96 to 2015-19 in Illinois River subbasins plotted against changes in incremental water yield for watersheds with more than 9% developed land cover (n=19) and those with less than 9% developed land cover (n=23).