Estimated Changes in Phosphorus Export from Developed Land Under Future Climate Hydrology

Modeling Workgroup Quarterly Review
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2019 Climate Change Documentation:

Section **4.5** - Phosphorus Loss Sensitivity to Climate Change

Section **4.5.2** – Developed Land

P sensitivity to cc-driven changes in hydrology on developed land

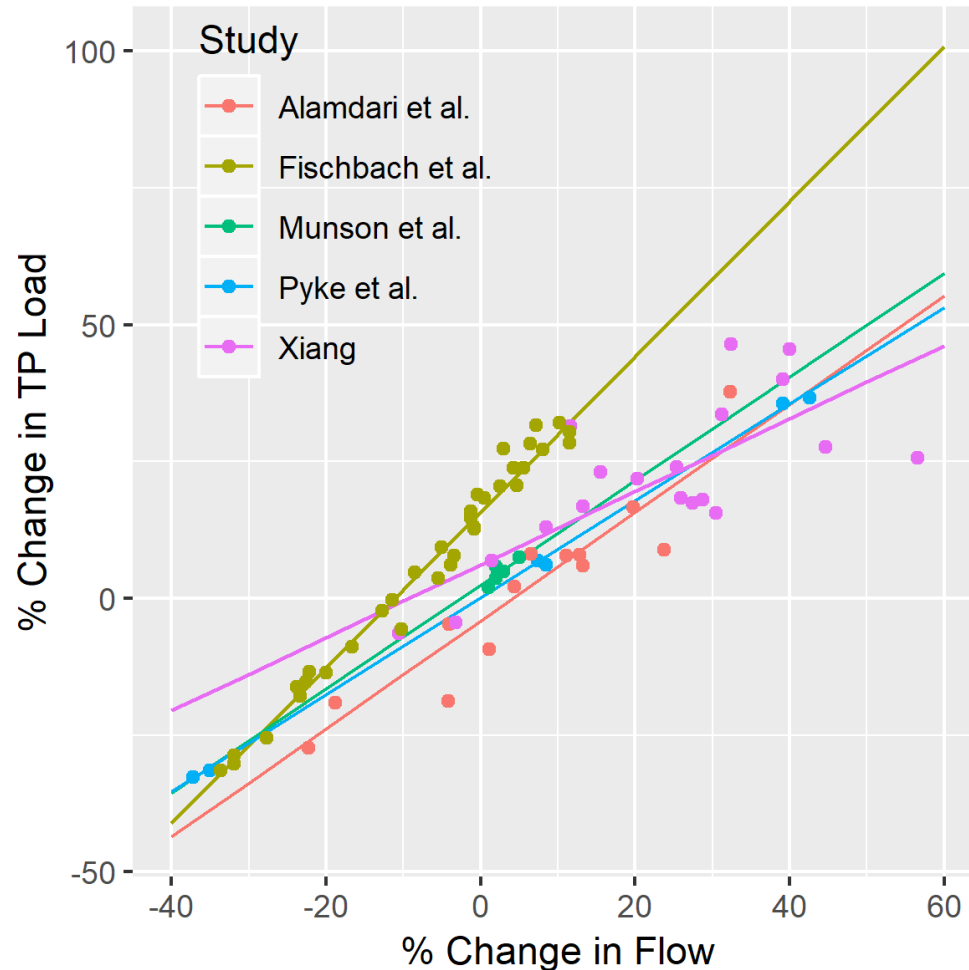1. Literature review

2. Analysis of NSQD data

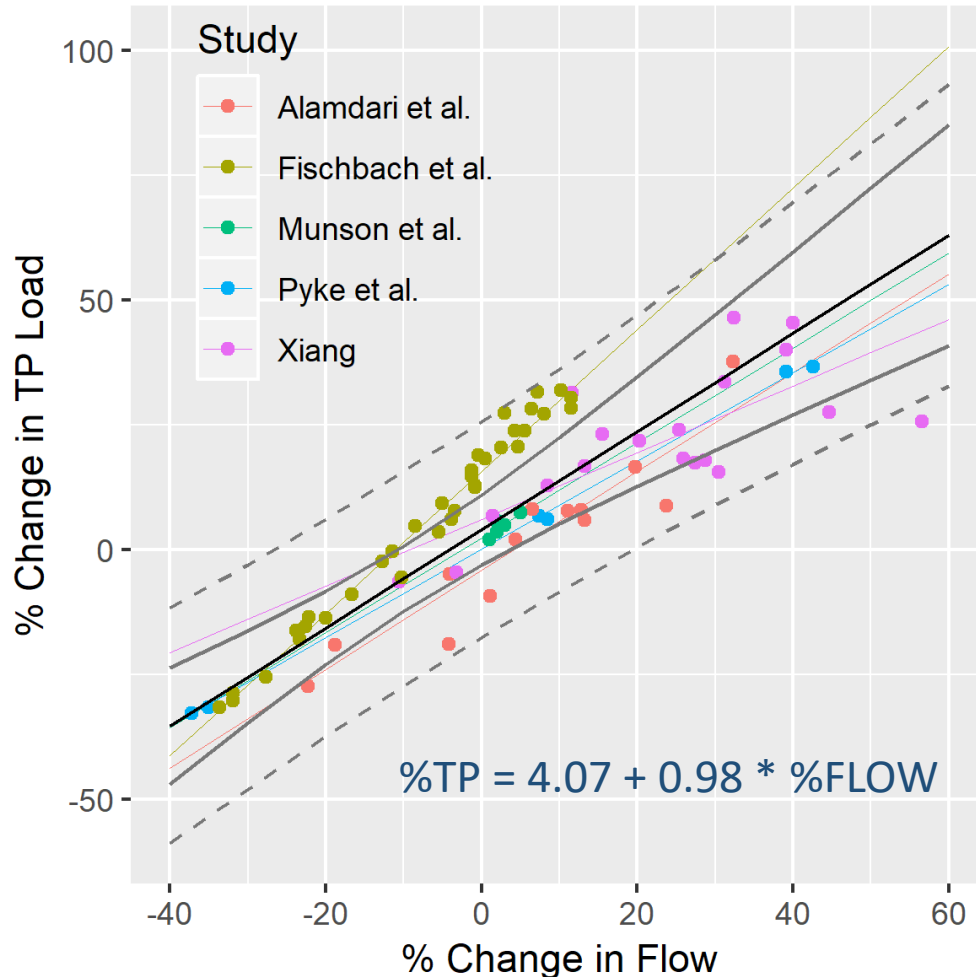# P sensitivity to cc-driven changes in hydrology on developed land

1. Literature review

P sensitivity to cc-driven changes in hydrology on developed land – Literature review

Reference	Site	Area (km²)	Land use	Model	Climate simulation approach	T change
Pyke et al. 2011	Naval Air Station, MA	5.7	Built environment with 64-71% open space	SG WATER	Delta change factor	Not assessed
Alamdari et al. 2017	Difficult Run watershed, VA	150	57% urban development; 8% commercial/industrial; 11% transportation; 24% open space	SWMM	GCM	-1.2/+4.1 °C
Munson et al. 2015	Alewife Brook watershed, MA	22	61% residential; 11% commercial; 11% open land; 17% other	Multiple regression	Analysis of historical climate variability	+1/+5%
Tong et al. 2006	Lower Great Miami watershed, OH	3600	71% agricultural; 17% forest; 12% urban	BASINS	Delta change factor	+2/+4 °C
Xiang, 2017	Wilde Lake watershed, MD	4.9	Fully built out, 32% impervious	SWAT	GCM	-0.2/+7.2 °C
Fischbach et al. 2015	Patuxent River watershed, MD	2479	22% developed; 18% agricultural; 9% grassland; 50% forest	CBP 5.3.2	GCM	+0.7/+2.8 °C

P sensitivity to cc-driven changes in hydrology on developed land – Literature review

P sensitivity to cc-driven changes in hydrology on developed land – Literature review

Study
- Alamdari et al.
- Fischbach et al.
- Munson et al.
- Pyke et al.
- Xiang

%TP = 4.07 + 0.98 * %FLOW

Parameter	Mean	95% CI
Intercept	4.07	-2.95, 11.1
Slope	0.98	0.67, 1.29

P sensitivity to cc-driven changes in hydrology on developed land

2. Analysis of NSQD data

P sensitivity to cc-driven changes in hydrology on developed land – NSQD data

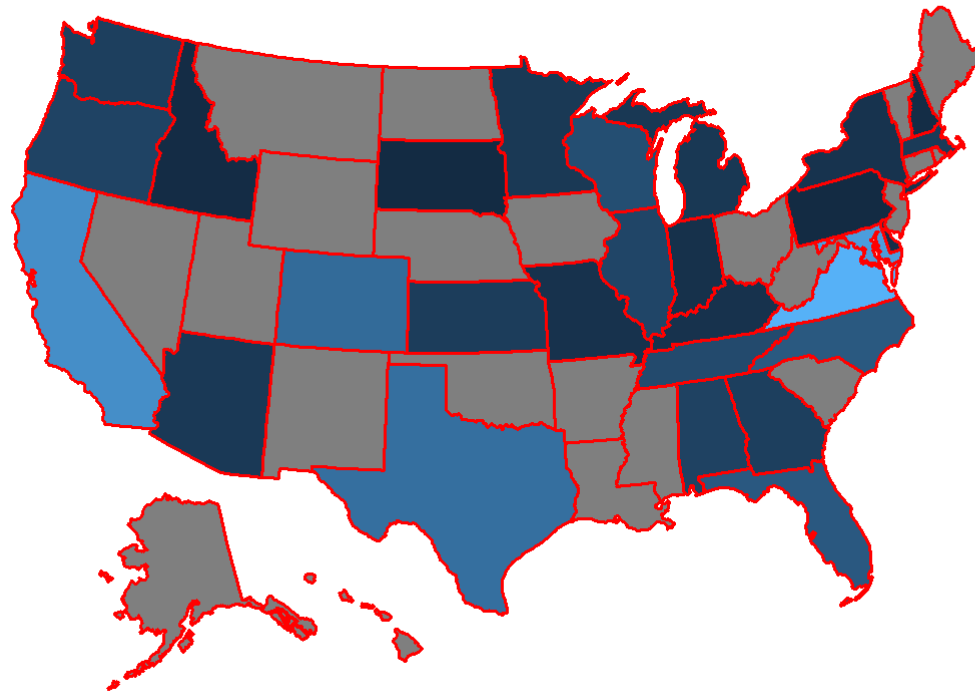## National Stormwater Quality Database

Version 4.02 - January 2015
(http://www.bmpdatabase.org/nsqd.html)

Full dataset:

9051 storm events
594 sampling sites
87 counties
30 states

P sensitivity to cc-driven changes in hydrology on developed land – NSQD data

National Stormwater Quality Database

Version 4.02 - January 2015
(http://www.bmpdatabase.org/nsqd.html)

Storm events with TP
and rainfall data:

4419 storm events
351 sampling sites
57 counties
22 states

N sampling events

600

400

200

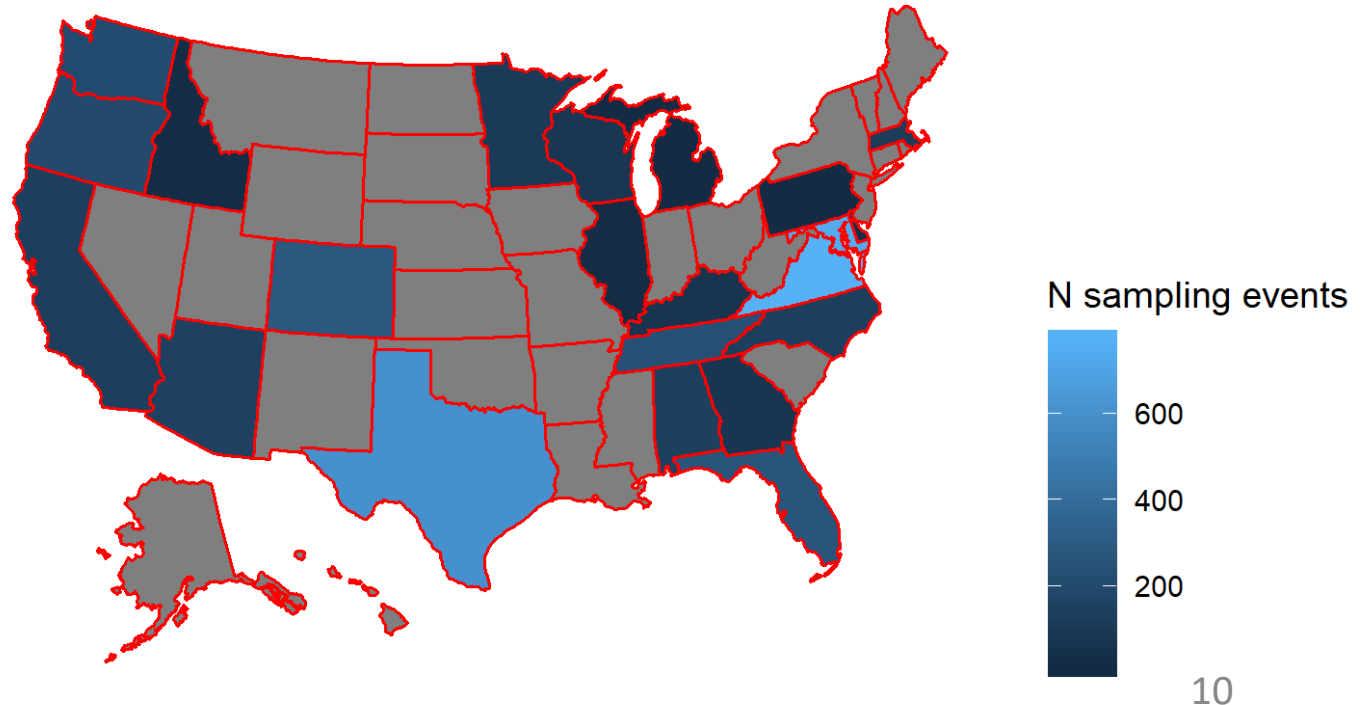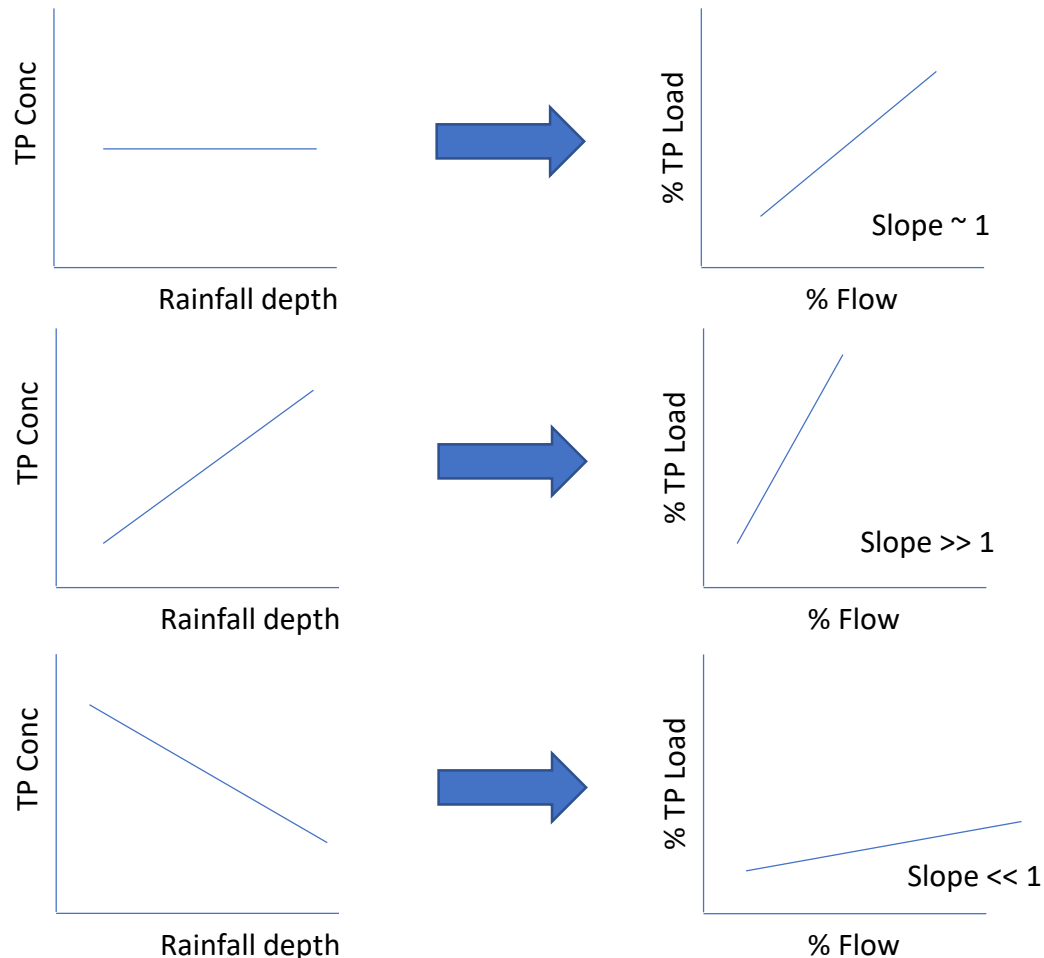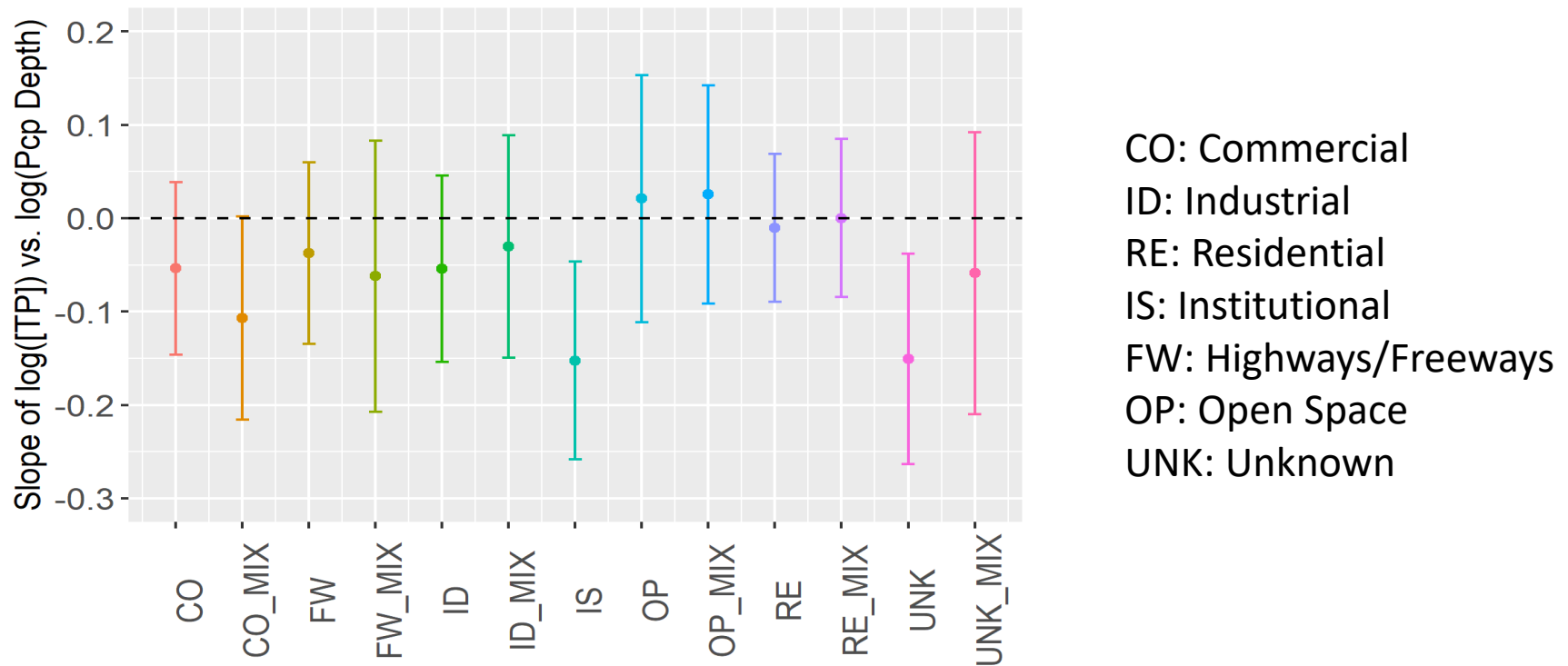# P sensitivity to cc-driven changes in hydrology on developed land – NSQD data

National Stormwater Quality Database

P sensitivity to cc-driven changes in hydrology on developed land – NSQD data

National Stormwater Quality Database

CO: Commercial
ID: Industrial
RE: Residential
IS: Institutional
FW: Highways/Freeways
OP: Open Space
UNK: Unknown

Majority of land uses exhibit a regression slope not significantly different from zero

Consistent with 1:1 relationship between %Flow and %TPLoad

Comparison with TP load sensitivities in non-developed land uses

Percent changes estimated between 2025 and 1995 climate conditions across land segments

Load Sources	% Change in TP Load per Unit % Change in Flow
Grain with Manure	1.54
Full Season Soybeans	1.72
Pasture	0.96
Forest	1.41
Crops	1.41
Pasture & Hay	1.16
Natural	1.27
Developed	**1.00**

Comparison with TP load sensitivities in non-developed land uses

Distribution across P6 land segments when comparing 2025 and 1995 climate conditions

Percentile	% Impervious Area	% Change in Flow	% Change in Stormflow	% Change in Stormflow / % Change in Flow
95%	55%	5.4%	7.0%	2.70
75%	39%	3.6%	5.2%	1.69
50%	32%	2.6%	4.0%	1.50
25%	27%	1.7%	2.8%	1.32
05%	22%	0.8%	1.5%	1.15

Load Sources	% Change in TP Load per Unit % Change in Stormflow
Grain with Manure	0.86
Full Season Soybeans	0.97
Pasture	0.42
Forest	0.49
Crops	0.79
Pasture & Hay	0.51
Natural	0.49
Developed	**0.67 (0.37 – 0.87)***

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Seeking approval of

Section 4.5.2 – Developed Land

of 2019 Climate Change Documentation

Main outcome: Introduce 1:1 relationship between % change in TP and % change in flow on developed land uses in P6 Watershed Model