

Urban and non-urban runoff quality in the Middle Rio Grande

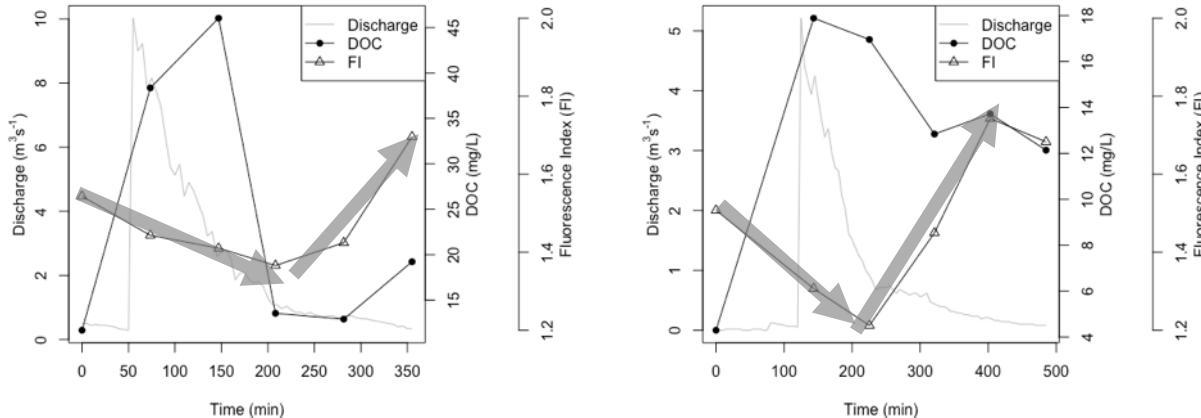


Peter Regier^{1,2}, Ricardo González-Pinzón^{1,2}, Dave Van Horn³, Justin Reale⁴, Aashish Khandewal^{1,2}, Justin Nichols^{1,2}

¹University of New Mexico Department of Civil, Construction & Environmental Engineering, ²University of New Mexico Center for Water and the Environment, ³University of New Mexico Department of Biology, ⁴U.S Army Corps of Engineers, Albúquerque District

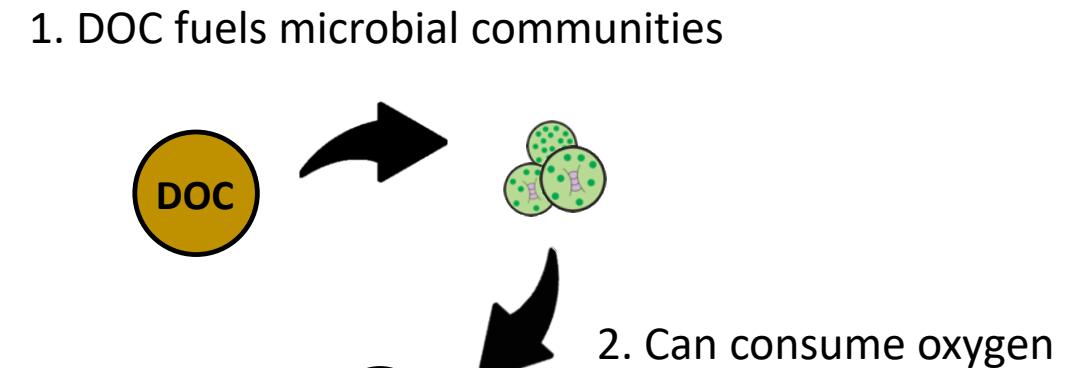
Motivation

Follow-up: dissolved organic carbon (DOC) flushed from urban landscape during storms



Wise et al. 2019 (J. Arid. Environ.)

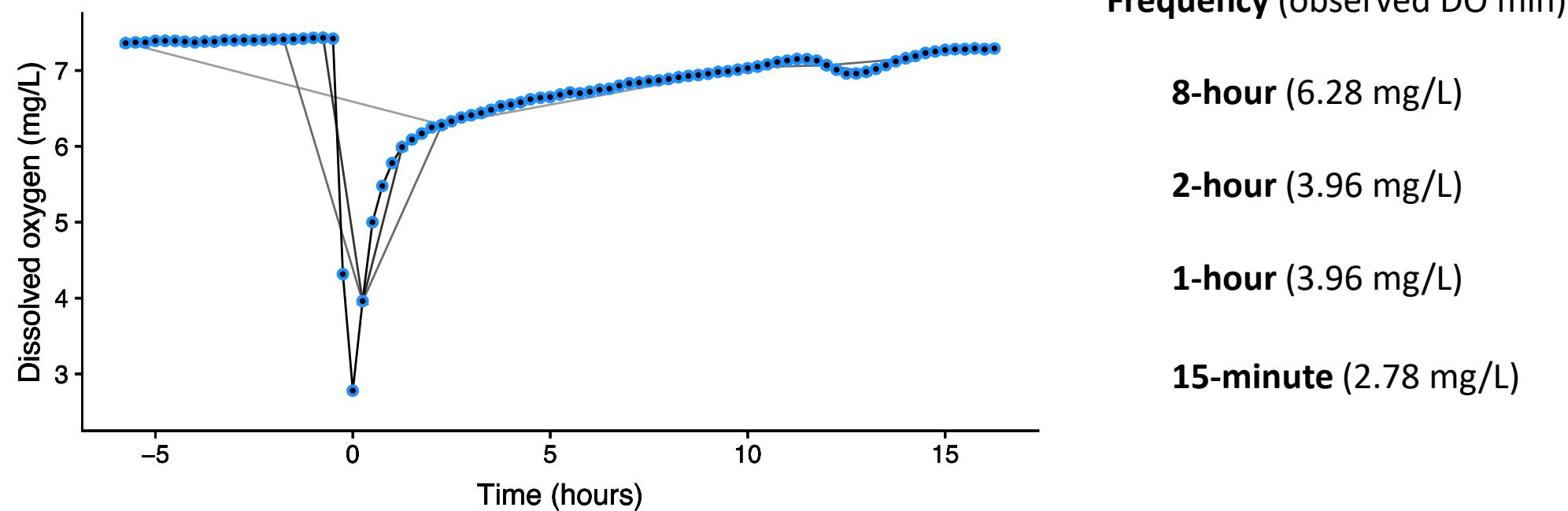
Consistent change in fluorescence index (FI)
from microbial to terrestrial sources



Does carbon mobilized from the urban landscape drive oxygen demand?

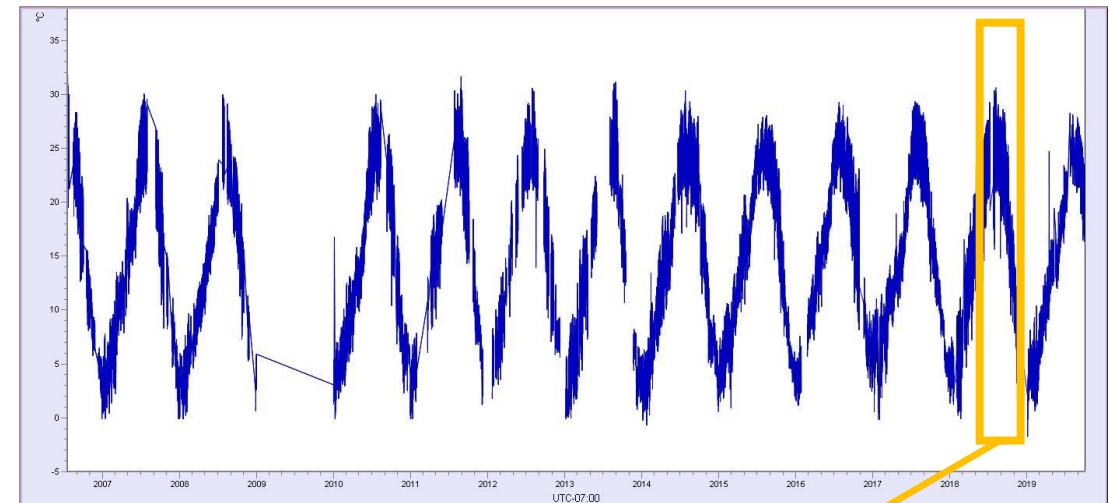
Importance of high-frequency data

Monsoon storm dissolved oxygen (DO) sag



Goal: Use sensors to capture rapid water quality changes in the MRG

Where and when



June to October 2018

Sensors and corrections



YSI EXO2 sondes

All sites: Temperature, specific conductivity (SpCond), dissolved oxygen (DO), pH, turbidity

Alameda only: fluorescent dissolved organic matter (fDOM) – DOC proxy



Seabird SUNA

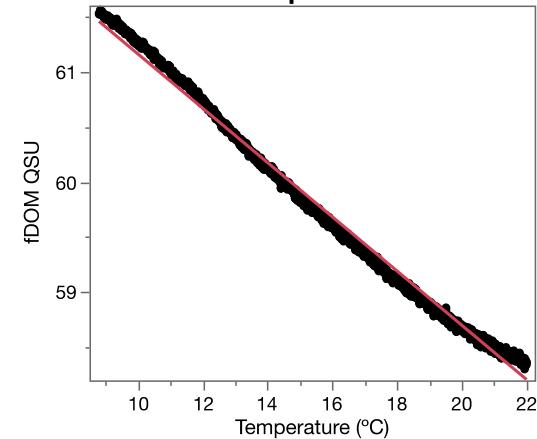
Alameda only: nitrate and UV absorbance



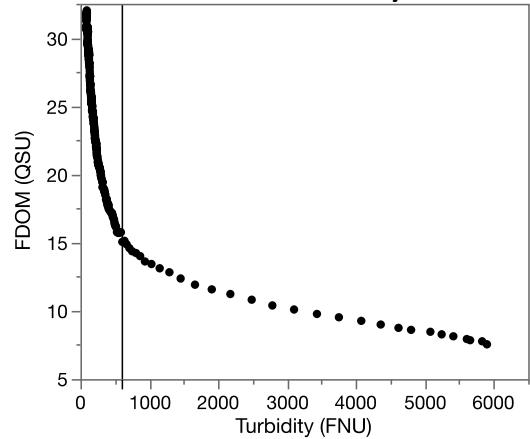
fDOM corrections

1. Temperature (quenching)
2. Suspended solids (scatter)
3. Dissolved solids (absorbance)

1. Temperature

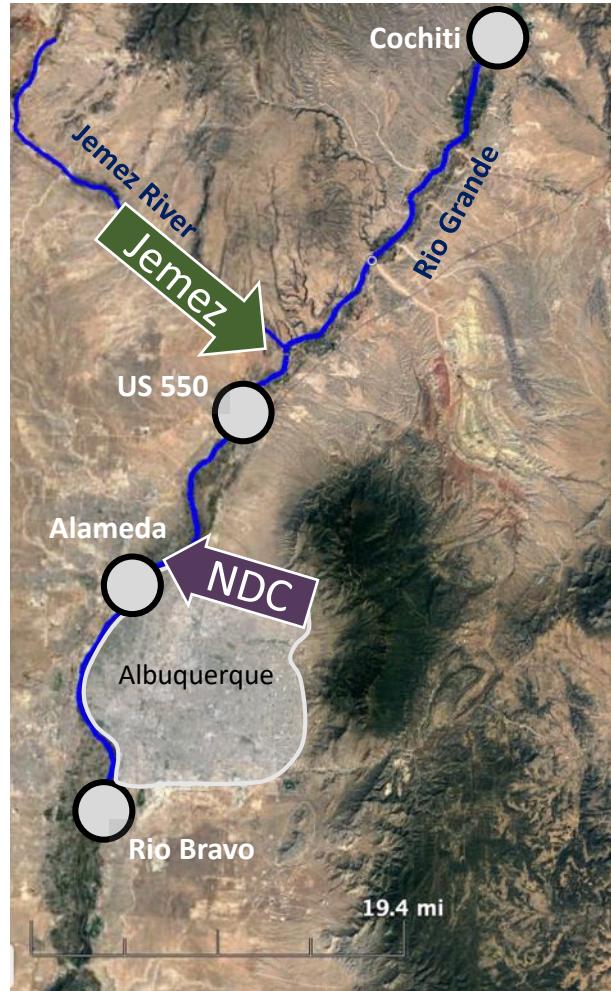


2. Turbidity



- No absorbance correction: lack of quality *in situ* data
- Corrected values up to 40% higher than uncorrected

Urban and non-urban inputs



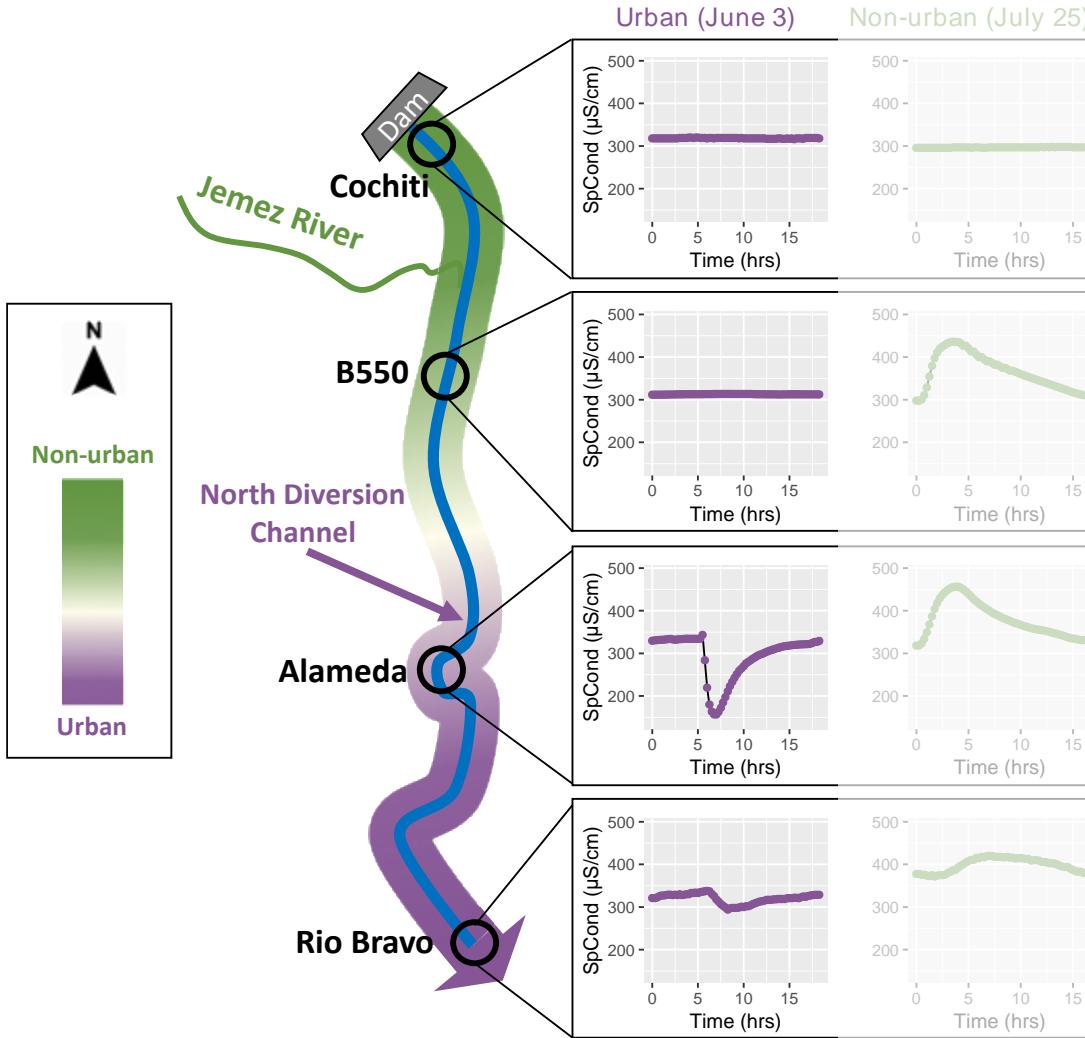
Baseflow controlled by Cochiti Dam

Non-urban inputs
Jemez River (gauged)
ephemeral channels (ungauged)

Urban inputs
North Diversion Channel (NDC, gauged)
other gauged/ungauged inputs

Complex sources (many ungauged)
**How to distinguish runoff from
urban or non-urban catchments?**

Sp. conductivity as a proxy for runoff source



Urban storm

- No signature at either site upstream of NDC
- Strong conductivity sag at Alameda
- Weaker sag at Rio Bravo

Non-urban storm

- Spike at B550 – downstream of Jemez River
- Spike persists at Alameda
- Weaker spike at Rio Bravo

Identifying urban/non-urban events

1. Change in quickflow hydrograph
2. Clear change in SpCond at Alameda
3. High-quality sensor data

Storm events

15 events identified: 10 urban, 5 non-urban

Table 1 Storm event hydrology and water quality measured at Alameda

Date (mm/dd/yy)	Type	Physical properties				Biogeochemical properties		
		Stormflow*	$\delta\text{-SpCond}$	$\delta\text{-Temp}$	$\delta\text{-Turbidity}$	$\delta\text{-DO}$	$\delta\text{-pH}$	$\delta\text{-fDOM}^{**}$
5/21/18	Urban	230.70	-202.83	-10.70	529.36	2.58	0.25	—
6/3/18	Urban	153.57	-186.70	4.87	200.10	-4.65	—	265.63
6/16/18	Urban	210.19	-238.93	3.51	213.65	-5.65	—	300.43
7/30/18	Urban	344.70	-262.52	-10.49	2115.26	-2.42	0.92	161.79
8/1/18	Urban	182.14	-207.80	3.02	-4774.73	-2.97	0.40	80.21
8/2/18	Urban	87.31	-98.25	1.62	-2065.46	-4.46	0.41	61.28
8/17/18	Urban	33.40	-52.80	1.56	40.81	-1.29	-0.21	109.00
8/22/18	Urban	218.48	-181.00	1.70	10516.27	-1.94	-0.33	139.24
9/19/18	Urban	76.31	-125.63	7.09	105.91	-1.91	-0.48	149.40
10/30/18	Urban	49.20	-106.20	-0.88	64.10	-1.14	-0.27	70.54
7/25/18	Non-urban	209.41	139.90	-4.12	7628.05	-0.67	—	—
8/1/18	Non-urban	61.26	269.27	4.28	11040.62	-3.02	-0.43	—
8/11/18	Non-urban	106.79	967.15	3.02	8099.33	-1.80	-0.16	—
8/18/18	Non-urban	68.62	695.50	4.69	7895.76	-1.77	-0.42	—
10/15/18	Non-urban	41.29	1218.65	1.58	8881.19	-0.35	-0.18	—
Average Urban		150.59	-162.20	1.33	712.88	-2.94	0.06	148.61
Average Non-urban		97.47	658.09	1.89	8708.99	-1.52	-0.30	—

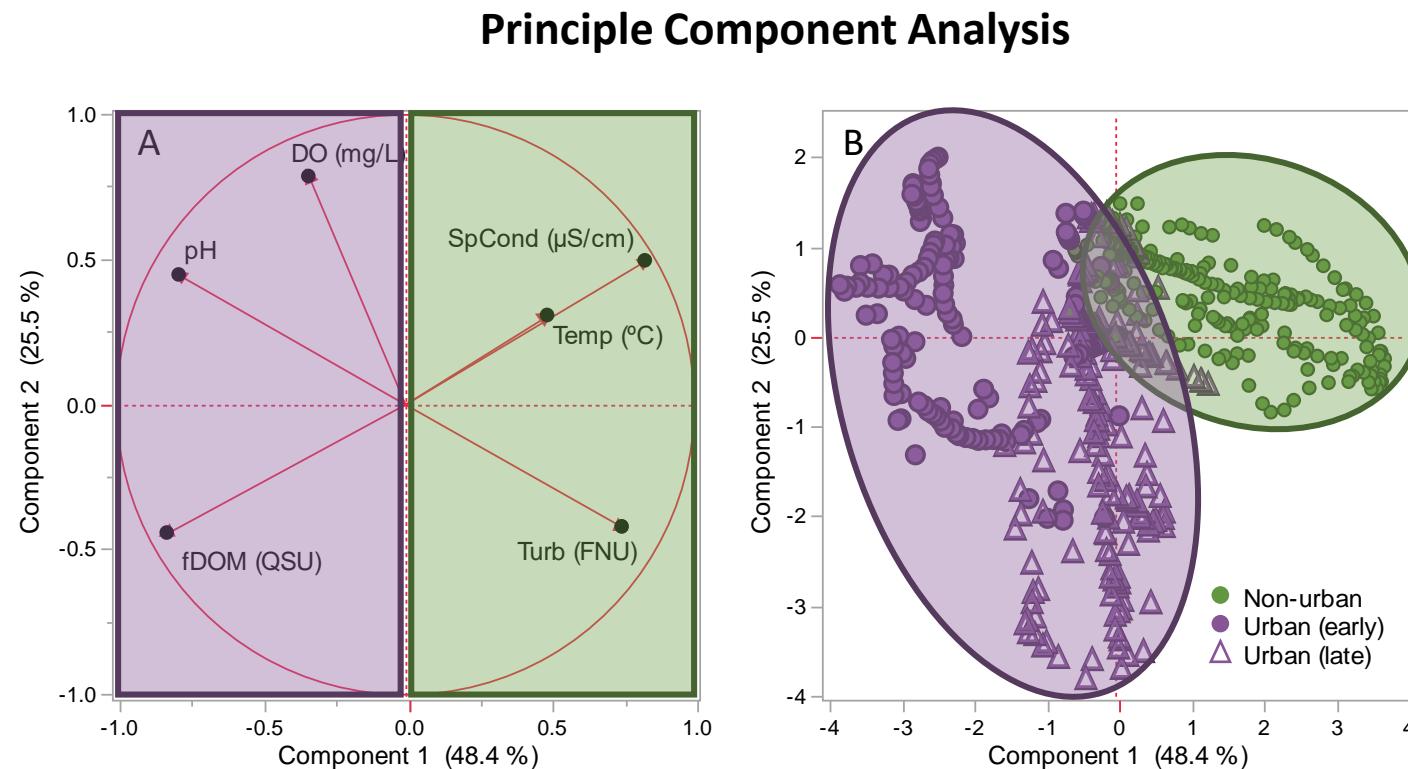
* Stormflow measured as direct runoff excluding baseflow, and reported in thousands of m³

** no fDOM data reported for non-urban events due to poor data quality

General patterns

- **Temperature** generally increases
- Much larger average **turbidity** increases for non-urban events (~10x)
- **DO** sags average 2x larger for urban than non-urban events
- Change in urban **pH** response through season
- Increased **fDOM** (proxy for DOC) for urban – estimated avg: +9.3 mg C / L
- Limited **nitrate** data suggest increase

Water quality relationships



Storms divided by PC1

- **Urban:** negative PC1
- **Non-urban:** positive PC1

Variables divided by PC1

- Physical: positive PC1
- Biogeochemical: negative PC1

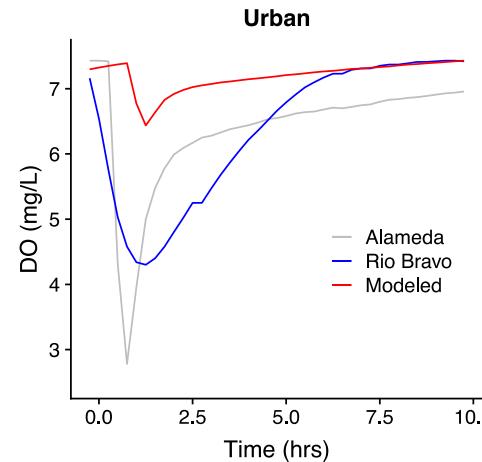
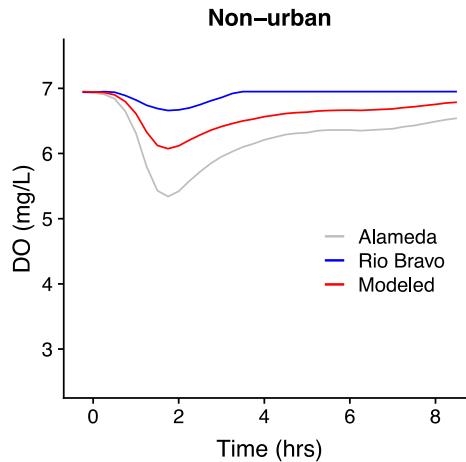
Distinct drivers by storm type

- Urban storms associated with biogeochemical processes
- Non-urban storms associated with physical processes

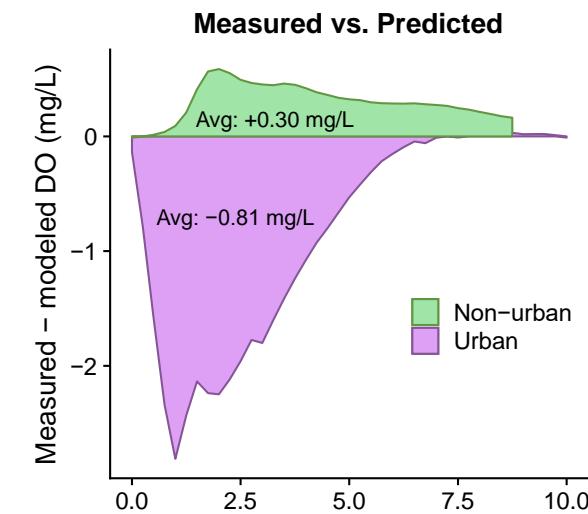
Modeling oxygen demand

Transfer function modeling

- Data-driven, derive relationship between upstream and downstream signatures
- **Step 1:** fit function using conservative tracer (SpCond) between Alameda and Rio Bravo
- **Step 2:** apply function to predict conservative DO transport at Rio Bravo based on Alameda



Non-urban sag over-predicted – reaeration
Urban sag under-predicted – oxygen demand

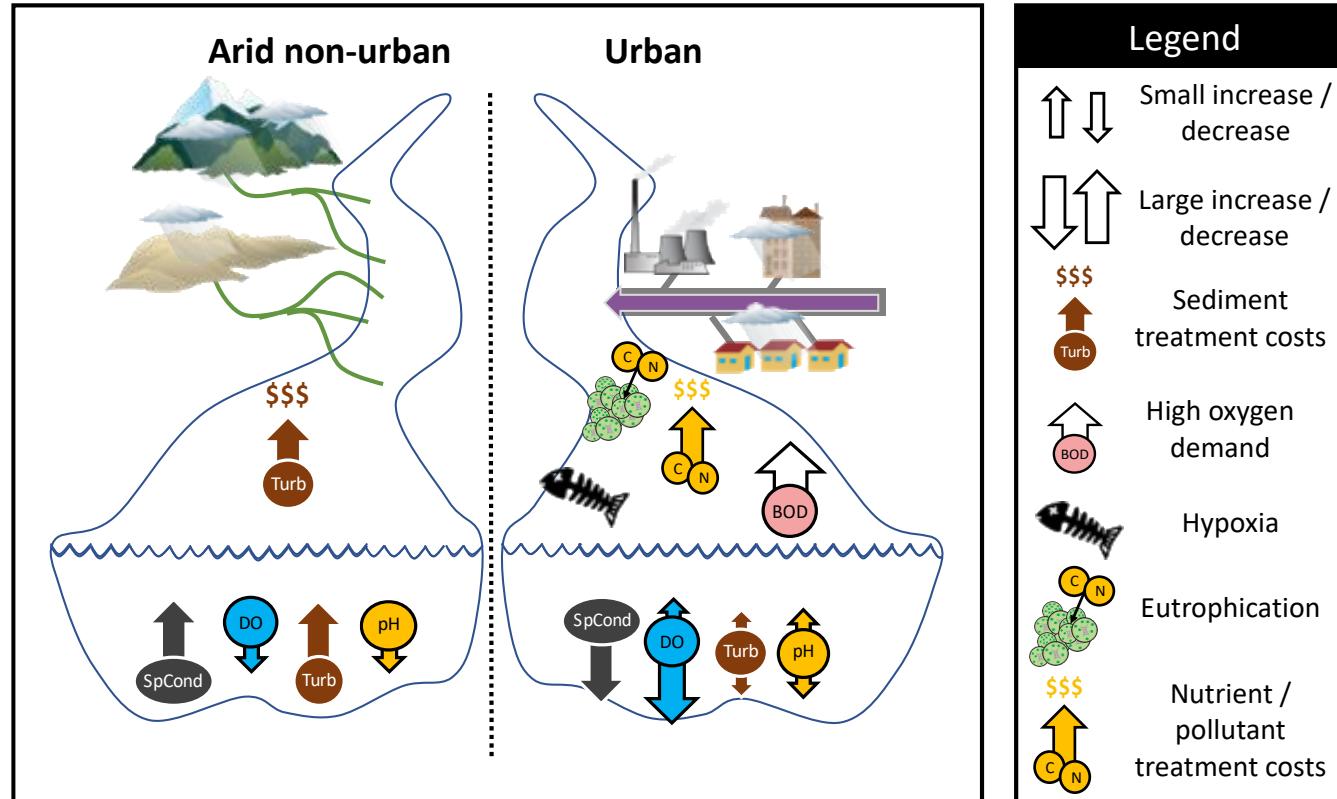


Non-urban: no clear oxygen demand

Urban: continued oxygen demand

Urban oxygen demand: likely driven by DOC and nutrients flushed from urban landscape

Conceptual model



Urban concerns: oxygen demand, nutrient-driven eutrophication and hypoxia, treatment costs

Non-urban concerns: sediment treatment costs for drinking water

Urban stormwater quality based on literature ($n=22$) is **similar across biomes** spanning rainfall of 217-3810 mm/year



Take-aways

Conductivity is a useful proxy to provide runoff source information in the MRG

Urban storms associated with higher nutrients (C and N) and higher oxygen demand

In general, biogeochemical drivers for urban events, physical for non-urban

Similar urban water quality responses across climates

Acknowledgements

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