Effects of Urban Stormwater Infrastructure and Spatial Scale on Nutrient Export and Runoff from Semi-Arid Urban Catchments

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Background

The modification of the land surface and hydrologic networks due to urbanization has driven changes in stormwater runoff processes and nutrient export to downstream systems. Previous research has focused on the effects of impervious areas and land cover, but the role of urban drainage infrastructure (engineered hydrologic networks) and spatial scale in stormwater hydrology and biogeochemistry is largely unstudied.

Research Objective

To understand the role of drainage infrastructure for controlling exports of nutrients in stormwater runoff.

Study Site

We conduct this research in Scottsdale and Tempe, AZ, urban areas that are drained by a range of stormwater infrastructure including: surface runoff, pipes, retention basins, and natural washes. Catchments were selected with similar land use (residential), but varying drainage infrastructure and drainage area.

Site Name	Drainage Area	Infrastructure
Encantada	~5 ha	Street Runoff
Pierce	~8 ha	Street Runoff
Med Wash/Ret	~23.5 ha	Wash and Ret Basin
Martin Residence	~23 ha	Wash
Camelback	~45 ha	Pipe
Kiwanis Park	~106 ha	Pipe
Bella Vista	~120 ha	Wash
Montessori	~125 ha	Washes and Retention Basins

Methods

We instrumented 8 urban catchments with ISCO automated water samplers, rain gages, and flow meters to characterize urban stormwater chemistry and hydrology. Stormwater samples were collected every 5-15 minutes during each storm event and analyzed for species of nitrogen (N), phosphate (PO_4), dissolved organic carbon (DOC), chloride (Cl^-), suspended solids, and particulate N and P. We show a subset of data from a single storm, on October 5, 2010.

Runoff and total nitrogen export from 4 study catchments during Oct 5, 2010 storm.

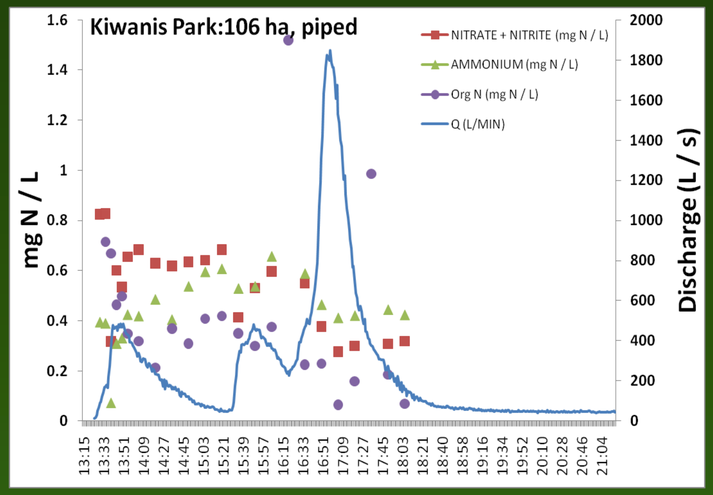
Catchment Name	Drainage Area (ha)	Infrastructure	Total Rainfall (mm)	Total Runoff (L)	Total N Export (kg N)	N Export (kg / ha)
Kiwanis Park	106	Pipes	15.75	9809009	10.50	0.10
Bella Vista	120	Washes	24.38	15317534	29.92	0.25
Montessori	125	Washes and Ret Basins	21.34	2577670	7.31	0.06
Pierce	8	Surface runoff	14.99	657638	1.67	0.21

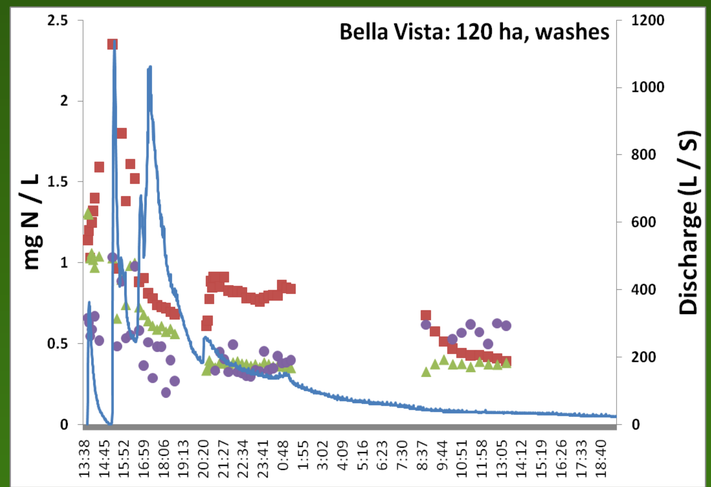
Conclusions

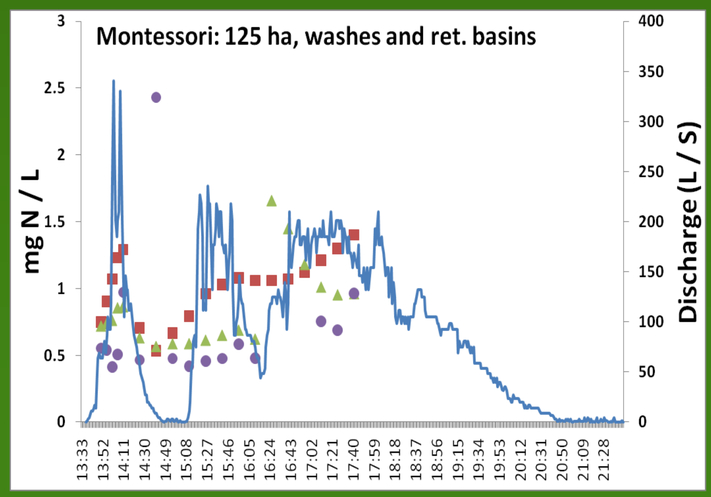
We find high variation in nitrogen export from urban catchments.
Total loads of N per area during a single storm vary by a factor of 5, despite similar land use.
Patterns in N concentration during the storm vary across catchments.

Next steps

Address effects of storm characteristics, compare these effects across catchments.
Compare export of additional analytes (PO_4, Cl, DOC).
Assess role of altered hydrology vs biological processes.
Balance N budget with estimates of inputs and sources of N to runoff.







Concentrations of N species in runoff and discharge from three watersheds during the October 5, 2010 storm.

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