The influence of storm characteristics and catchment structure on particulate organic matter transport in an arid city

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Introduction

Changes in hydrology with urbanization

- Channelization, stormwater infrastructure, and variations in surface permeability control storm water movement
- Stormwater is an important carrier of **particulate organic matter (POM)**; thus, changes in hydrology influence POM transport
- Organic matter deposition can have various impacts on local and downstream ecosystems

Figure 1. Street stormwater infrastructure

How do storm characteristics and urban infrastructure control the movement of particulate organic matter during runoff events?

Methods

Samples were taken from catchments within the Phoenix metropolitan area

Figure 2. Catchment infrastructure map

- Five monitoring sites were chosen within the Phoenix metropolitan area. Each represented different catchment infrastructures: street, wash, pipe, and retention basin drainage
- Automatic water sampling equipment monitored and sampled (n=277) stormwater flow. This equipment provided continuous flow data, allowing for the calculation of total discharge

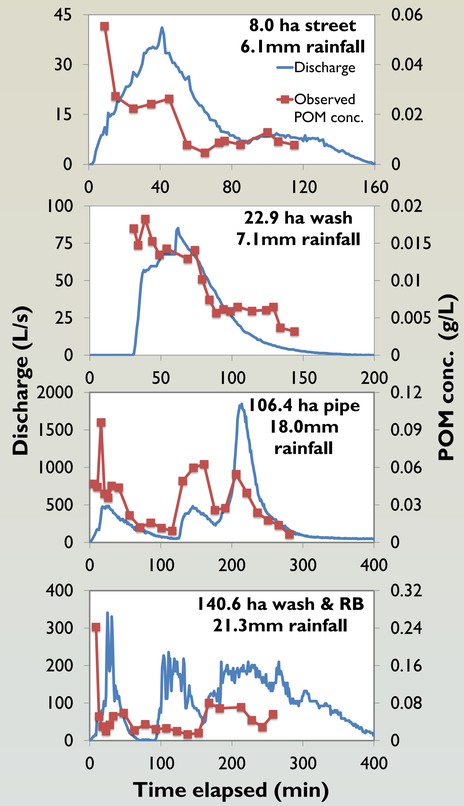
Analysis to determine POM concentration was performed on each stormwater sample. Multiple regression models were created to extrapolate these discrete measurements of POM concentration across the entire event hydrograph and to determine event based POM export.

Multiple regression model
22.9 ha wash site – December 29, 2010

Summary:	**r^2 = 0.896**		**n = 29**	
Term	Estimate	Std. error	t ratio	Prob>|t|
Discharge/time elapsed	0.01549	0.00469	3.30	0.0028*
1/time elapsed	1.18452	0.11211	10.57	<0.0001*

Results

Within-event POM dynamics vary across catchment size and infrastructure type



Street drainage: rapid transport of POM through the system, resulting in an exponential decline in POM concentration.

Wash drainage: linear decrease in POM concentration through the event despite changes in flow characteristics.

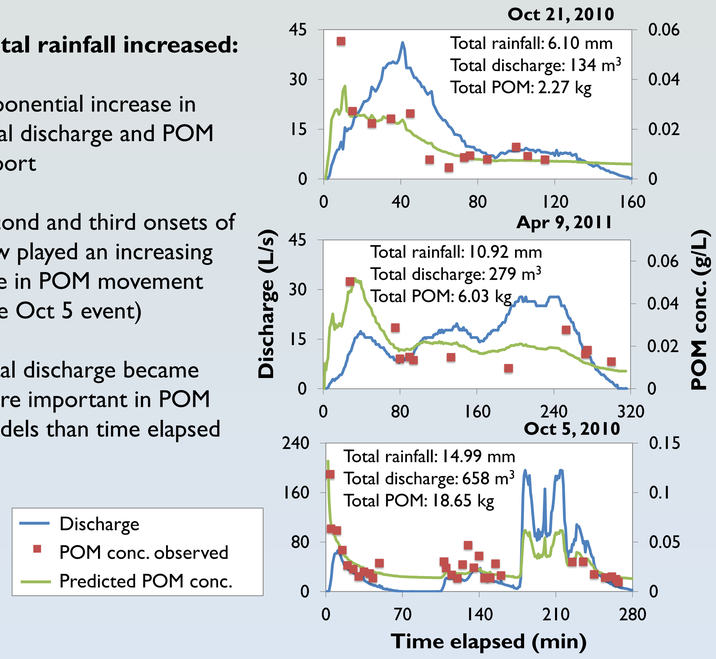
Pipe drainage: Increases in POM concentration with increases in flow; magnitude of POM concentration increases dropped with successive flow peaks.

Wash and retention basin (RB): High POM concentrations with the onset of flow. Concentrations remained low during a second flow peak; a third peak produced increased POM concentrations indicating increased catchment connectivity.

Total rainfall influences total discharge and POM export in an eight hectare, street drainage catchment

As total rainfall increased:

- Exponential increase in total discharge and POM export
- Second and third onsets of flow played an increasing role in POM movement (see Oct 5 event)
- Total discharge became more important in POM models than time elapsed



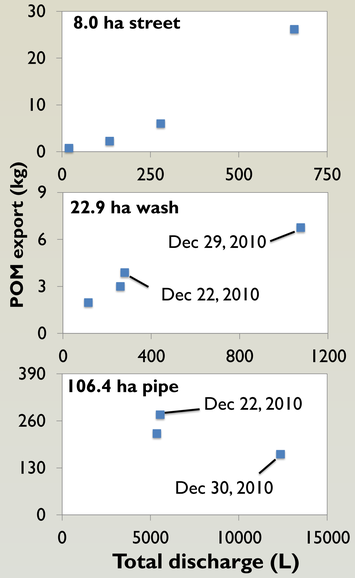
Results (cont.)

Stormwater infrastructure affects POM movement

Street drainage: POM export increased nonlinearly with total discharge, indicating that POM movement was transport-limited at this site.

Wash drainage: POM export increased linearly with discharge. Short periods of time between the plotted events may explain this; less time between events might equate to less POM available for transport.

Pipe drainage: due to short periods of time between events, this efficient and well connected infrastructure quickly exhausted the system of POM.



Conclusion and Discussion

System complexity obscures clear conclusions but basic relations can be hypothesized

Many factors influence urban hydrology, making clear relationships difficult to characterize. However, the presented data allow for the formulation of basic hypotheses to be tested with additional events and more detailed hydrological analysis.

POM export is influenced by:

Antecedent conditions – Conditions prior to an event control the amount of POM available for transport, and thus POM export.

Catchment connectivity and land cover – Flow generated across an urban catchment varies according to surface characteristics; lawns will generate runoff differently than streets. These differences also influence POM transport.

Catchment size and infrastructure – Catchment size and infrastructure play an important role in the movement of POM, however, the exact nature of these relationships is complex.

Final results could be used by many stakeholders

Planners, policy makers, and regulators:

Refine stormwater infrastructure to benefit local needs, for example, maintain stable, desirable nutrient levels in local reservoirs.

Local businesses and residents:

Use this knowledge to make more informed decisions about landscaping and local environments.

Conservationists:

Use this knowledge to help understand the impact of urban systems on local or downstream ecosystems.

Acknowledgements: Many thanks to CAP-LTER and associated faculty Dr. Steven Earl, Dr. Nancy Grimm, Kate Elrod, & Rebecca Hale, for their help with this project. This research was funded by National Science Foundation grants, numbers 0918373 & 1026865. Thanks to Dr. Margaret Nelson and the COURS class.