Using Integrative Passive Sampling Devices to Obtain More Meaningful and Cost Effective Data on Impacts from Stormwater Runoff

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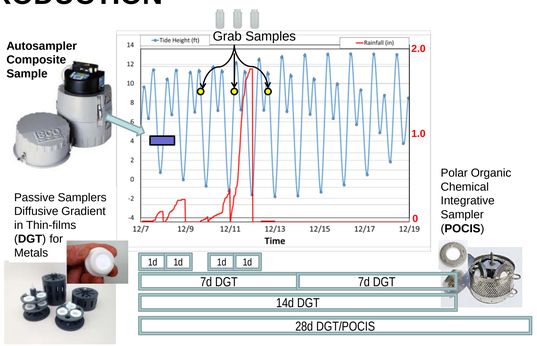
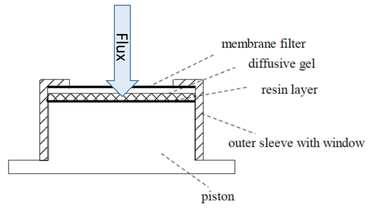
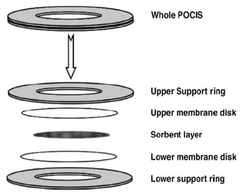
INTRODUCTION



- Grab (and composite) stormwater samples may not be representative of stormwater impacts to the receiving environment, as they may miss the 'pulse' of contaminants
- Total recoverable metal concentrations used in compliance monitoring are not biologically meaningful
- Composite autosampling has limitations (reliability, cost)
- Integrative passive sampling includes Diffusive Gradients in Thin Film (DGT) and Polar Organic Chemical Integrative Samplers (POCIS)
  - Time-averaging, relatively inexpensive, no major equipment set up, and lower likelihood for sample contamination
- DGTs and POCIS are being evaluated in a continuous ambient monitoring program at near-shore locations within the Puget Sound Naval Shipyard and in nearby commercial and residential areas
- DGTs are being evaluated for end-of-pipe monitoring and value towards assessment of best management practices (BMPs) at Naval Base San Diego

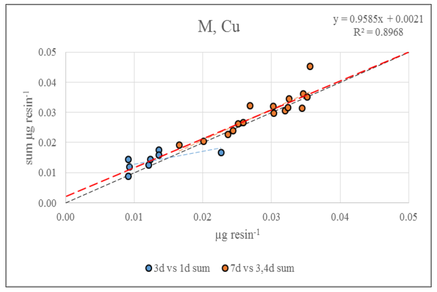


DGTs provide a time-averaged concentration of labile (biologically available) metal concentrations following diffusion through a gel layer and permanent binding to a resin layer (Chelex-100)(Davison and Zhang 2012).

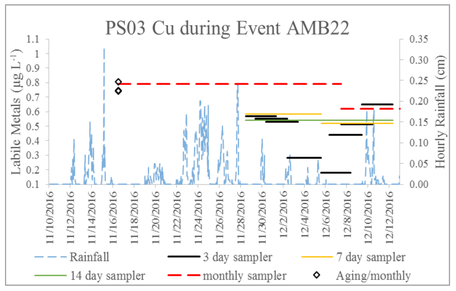


POCIS (Alvarez et al. 2010) sample weakly hydrophobic (log K_{ow} up to 4) organic contaminants following strong binding to a polymeric sorbent (hydrophilic-lipophilic-balanced; HLB).

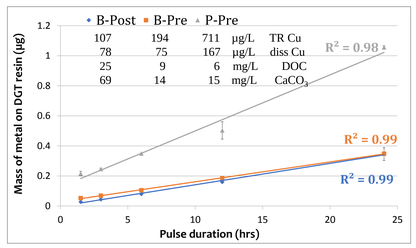
RESULTS



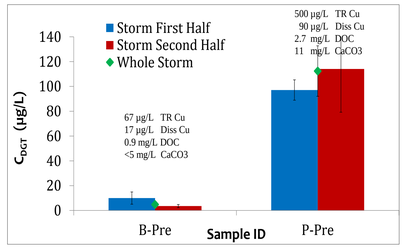
Cu mass accumulated on DGTs over 1,3, 4, & 7 days shows linear uptake over time in seawater field deployments. The mass can be converted to the time weighted average of labile metals in the system by factoring the diffusional properties, area, and deployment time.



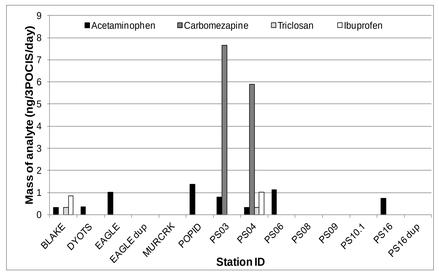
Time-averaged copper concentrations at time points ranging from 3 to 28 days; 3-day exposures show higher resolution, while 7-14 day exposures show averages over similar time periods.

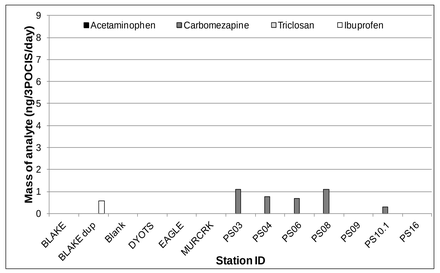


Linear loading of copper on to DGT Chelex-100 resin between 1.5-24 h durations in copper solutions. Shows detectable metal loading during short pulses.



Comparison of first half and second half of ~24 hr storm in comparison with DGT samplers placed for full storm into freshwater drains. The 'B-Pre' and 'P-Pre' sample IDs represent untreated stormwater (prior to BMP treatment) the Biofiltraiton and Paver sites shown in photographs (at right).





Examples of pharmaceutical mass accumulation on POCIS following sampling from sites at PSNS and nearby reference sites during 2016-2017 (March 2016 [left] and August-October 2016 [right]).

(Above left) Stations within Puget Sound Naval Shipyard and Intermediate Maintenance Facility bordering Sinclair Inlet, and nearby commercial and residential sampling locations for DGT and POCIS monitoring; (above right) retrieval of passive samplers.

Application of a unique DGT approach for real time monitoring of metals in storm drains (above left) in short term (≤ 24 h) exposures at two impervious sites at Naval Base San Diego (leveraged with NESDI #497) with focus on drains sampled before and after BMP treatment (above right).

CONCLUSIONS

- Integrative passive samplers show promise towards biologically relevant assessment of stormwater discharges and associated contaminants of concern in receiving water monitoring.
- Highly sensitive and reproducible results that support trace level changes in metal availability (DGT) and weakly hydrophobic (POCIS) contaminants in a marine estuary have been demonstrated.
- End of pipe DGT sampling promising, but requires additional work to address possible issues associated with low ionic strength rainwater and highly dynamic stormwater discharges.
- Passive sampling devices provide supplemental data and may be able to reduce costly traditional monitoring.
- Results to date should promote improved public and regulatory understanding of stormwater impacts to receiving water bodies.

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