

Designing and implementing ecological monitoring of Urban Ecological Infrastructure (UEI): A case-study.

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Introduction

- Growing use of UEI to address urban sustainability challenges necessitates transdisciplinary co-production of UEI design, monitoring and maintenance among teams of urban researchers and practitioners.
- How this co-production process unfolds specifically in UEI-based projects has not been studied in the Phoenix Metro Area.

- Here we present preliminary results of a case-study of a co-produced design process and monitoring program for a small-scale stormwater UEI project – the bioretention basins at ASU Orange Mall and Student Pavilion re-development project.

Experimental design and methods

Design Process

- We conducted 12 in-depth, semi-structured interviews (~45-60 minutes) with key project personnel in Summer and Fall 2018. Participants were selected from a range of academic researchers to public and private practitioners involved in project design, construction, and maintenance.
- Interviews focused on characterizing the design process, as well as identifying challenges, opportunities, and outcomes associated with the co-production of UEI monitoring protocols.

Ecological Monitoring

- We led a collaborative effort, together with researchers and practitioners, to co-develop an eco-hydrological monitoring protocol to assess post-construction UEI performance (Figure 3).

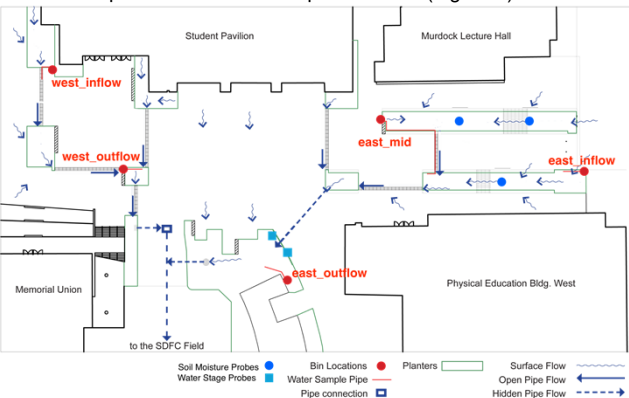


Figure 2. Orange Mall experimental design. Symbols indicate water flow dynamics and the location of various sampling equipment.

- We installed equipment on-site in August 2018. Equipment was used to monitor site performance during storm events where basins experienced full flooding and achieved runoff between basins (~precipitation >0.25 in)

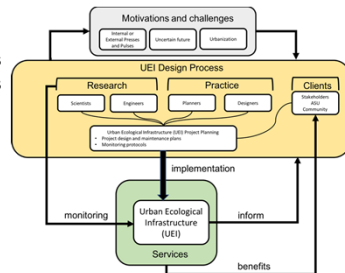


Figure 1. Conceptual framework. Illustrates the co-production processes associated with UEI design, maintenance, and monitoring.

Results

1. Monitoring Protocol

Data type	Metric	Equipment	Method
Hydrology	Water Quality	ISCO 6700/6712 auto-sampler + ISCO 720 bubbler module	Sample collection triggered by rain,
	Water Quantity	V-notch weir + ONSET water level autologger	Autologging probe
Ecology	Transpiration	LICOR 6400XT Infrared Gas Analyzer (IRGA)	Scale in time space using leaf area index (LAI)
	Climate	EarthNetworks and MCFDX meteorological stations	Data access/download
Biogeochemistry	Soil moisture	ONSET 10HS Soil Moisture Smart Sensor	Autologging probe

Figure 3. Co-produced monitoring protocol for Orange Mall.

- Co-produced monitoring protocol emphasizes self-identified practitioner data needs while aligning with broader research agendas (CAP LTER stormwater sampling) for cross-site comparability.

2. Water Quality and Quantity

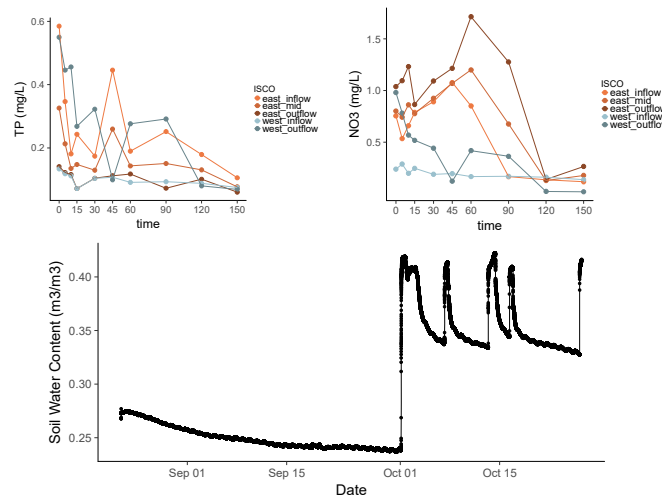


Figure 4. Site photos. Left Photograph: Bioswale at Orange Mall during October 2018 storm event. Middle photograph: IRGA being used to measure transpiration rates of *Simmondsia chinensis*. Right Photograph: ISCO installation with enclosure installed at Orange Mall.

Results

3. Key themes: challenges and opportunities associated with aridland UEI-based projects

Category	Theme	Example Quotes
Challenges	Arid cities	<ul style="list-style-type: none"> "One of the things that, I think, we've discussed in the past is this idea that here they don't get tested very often. There's not even a—if you have a bioretention basin, the chances of them actually seeing it working are really low." "You know, it was overwhelming. I'm not an engineer, but I mean I kept talking to the engineer and like, 'This is what I want to do.' 'Yeah, yeah, yeah, but that's not how we do it.'" "[Contractors] are actually more integral... in ways that you don't really think about until it's too late. For example, not on the Orange Mall Project, but on the Nelson Project, which is also on campus. We just were not collaborative enough and there was a breakdown in communication in regards to the soils and how the soils need to be dealt with."
	Institutional	<ul style="list-style-type: none"> "[Usually] there's no money, no time to even think about monitoring long-term, or really understanding how it perform. We will go back to the site to see, 'Oh, wow, this is our design. Cool!' 'I think it might be an uphill battle in many of the cities because it's probably a lower priority than other types of things that are going on'."
	Resources	<ul style="list-style-type: none"> "This Orange Mall project provides a really cool opportunity to do that for this type of landscaping because there's this interwovenness of oh, yeah, we should use infiltration basins. Now there's a chance to actually test that and use that as evidence going forward."
Opportunities	Evidence	<ul style="list-style-type: none"> "Here especially at ASU, we have a huge educational component. So to be able to demonstrate that in a very public and open way is—was also a very interesting and exciting benefit."
	Education	

4. Key themes: design process and outcomes associated with aridland UEI-based projects

Category	Theme	Example Quotes
Design Process	Drivers – why UEI?	<ul style="list-style-type: none"> "...without a lot of maintenance"
	Monitoring	<ul style="list-style-type: none"> "Now, whether or not we actually go for certification or not is—certification is an added bonus, but we are trying to stick to and espouse the principles behind SITES in all of our projects."
Outcomes	Capacity-building	<ul style="list-style-type: none"> "...so there has been that carryover to Nelson, which is great—because again, we just have more knowledge—we have more understanding of what it is that we need to do." "This has become a window of opportunity for our program, for me to hopefully take on the lead to start and build this research initiative into the campus design."
	Institutional learning	<ul style="list-style-type: none"> "That was one of those things where we all, as a team, didn't see the pieces where they needed to go, and now I understand it as a site operator, I need to be educating not just the contractor, but the subs better because they need to understand it. Some guy comes out and tests the soil. They don't know why the soil is being tested."

Discussion and preliminary conclusions

- Overall nutrient loading decreased throughout storm events, and the system appears to be more effective at taking up P in comparison to N
- Co-produced, relevant data and feedback on design performance is valued by practitioners and used to improve future UEI design and efficacy
- Participation in co-produced UEI design processes and monitoring can lead to significant capacity building and institutional learning for researchers and practitioners
 - Ex: Next phase of UEI development at ASU will now monitor entire construction process and post-design utilizing Before-After-Control-Reference-Intervention (BACRI) principles.

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