

20th Annual

CAP LTER All Scientists Meeting and Poster Symposium



Friday, January 5, 2018

SkySong

**CAP LTER Twentieth All Scientists Meeting
and Annual Poster Symposium
January 5, 2018
Synergy I and II, Building 3,
Skysong, Scottsdale, Arizona**

- 8:30 a.m.** Registration, coffee, and tea; poster setup
- 9:00 a.m.** **State of the Program Address**
Dan Childers, Director, CAP LTER and Professor, School of Sustainability
- 9:20 a.m.** **Keynote Presentation: Quantifying Spatial Heterogeneity of Urban Landscapes and Its Effects on Urban Climate**
Weiqi Zhou, Professor, Chinese Academy of Sciences
- 10:30 a.m.** **Interdisciplinary Research Theme Updates #1**
- | | |
|---|---|
| Water and Fluxes
Becky Ball, Associate Professor, School of Mathematical and Natural Sciences | Adapting to City Life
Paige Warren, Research Assistant Professor, University of Massachusetts-Amherst |
| Climate and Heat
David Hondula, Assistant Professor, School of Geographical Sciences and Urban Planning | Parks and Rivers
Heather Bateman, Associate Professor, College of Integrative Science and Arts |
- 11:15 a.m.** **Poster Session #1**
- 12:45 p.m.** **Lunch**
- 2:00 p.m.** **CAP Service Awards**
- 2:15 p.m.** **Interdisciplinary Research Theme Updates #2**
- | | |
|---|--|
| Urban Design
Paul Coseo, Assistant Professor, Herberger Institute for Design & the Arts | Residential Landscapes and Neighborhoods
Sharon Hall, Associate Professor, School of Life Sciences |
| Governance and Institutions
Abigail York, Associate Professor, College of Liberal Arts and Sciences | Scenarios and Futures
David Iwaniec, Assistant Professor, Georgia State University |
- 3:15 p.m.** **Poster Session #2**
- 5:00 p.m.** **Adjourn, CAPpy Hour at Bitters**

2018 CAP LTER Poster Symposium

Posters are listed alphabetically by first author with poster location number in parentheses.

*Indicates a student poster.

Poster Session #1	Poster Session #2
*Beauclaire Reyes, Bailey, Steger, Wheeler and Hall (1)	*Moen, Hackney, and Johnson. (2)
*Boehme (3)	*Boehme and Albuquerque (4)
*Nguyen and Westerhoff (5)	*Paine, Berisha, Rowe, Hoefler, Singh, Puranam, Feisst, and Hall (6)
*Colbert, Grunspan, and Quay (7)	*Pandorf and Westerhoff (8)
*Davidson, Cook, Grimm, and Iwaniec (9)	*Davidson, Kim, Chester, Cook, Grimm and Iwaniec (10)
*Perez-Ruiz, Vivoni, and Templeton (11)	Reichman, Prosser, and Rugland. (12)
Earl (13)	Ribeiro, Wheeler, Steger, and Hall. (14)
*Elser, Cook, Barbosa, and Grimm (15)	*Russell and Neuer (16)
Grimm, McPhillips, Hale, and Earl (17)	*Sanchez, Coseo, and Cheng. (18)
*Hester and Gordon (19)	*Stuhlmacher, Goldblatt, Georgescu, Clinton, Tellman, Hanson, and Khandelwal (20)
*Ishtiaque, Shrestha, and Chhetri (21)	*Votaw (22)
*Kim, Eisenberg, Bondank, Chester, Mascaro, and Underwood. (23)	*Wang, Wang, Myint, and Wang(24)
*Kubicki, Childers, and Sanchez (25)	*Wheeler, Collins, Grimm, Clark, Sponseller, and Hall (26)
Lewis, Bateman, Weiss, and Hall (27)	*Wright, Hondula, Wilson, Kurtz, Watkins, Chakalian, Larson, and Harlan (28)
*Lopez-Castrillo and Vivoni (29)	*Zhang, Middel, and Turner (30)
Markoff, Chester, Eisenberg, Miller, Zimmerman, Davidson, and Seager (31)	*Zhao, Sailor, and Wentz. (32)
McPhillips, Newell, and Grimm (33)	Larson, Andrade, Meerow, and Coseo (34)

Speaker Bio



Weiqi Zhou

Professor of Urban Ecology
State Key Laboratory of Urban and Regional Ecology
Research Center for Eco-Environmental Sciences
Chinese Academy of Sciences

Quantifying spatial heterogeneity of urban landscapes and its effects on urban climate.

Spatial heterogeneity has myriad influences on ecosystem processes, ecosystem services, and thus the sustainability of urban areas. It acts as a medium for urban design, planning, and management to determine how processes affecting sustainability can operate and interact. Therefore, how spatial heterogeneity is conceptualized and measured in cities is crucial for ecological understanding of urban ecosystems, and for enhancing sustainability. Here I first discuss the different ways in which ecology IN versus ecology OF the city affect how to conceptualize, model and map urban spatial heterogeneity. I present a new framework to guide the comparisons of spatial heterogeneity under the two paradigms, and an approach that explicitly recognizes the patchiness of hybrid social and biophysical nature of heterogeneity in urban ecosystems. Using the effects of spatial configuration of landscape features on surface temperatures as an example, I then exemplify how the hybrid approach under the ecology OF the city paradigm helps better understand the effects of spatial heterogeneity on ecological processes. The analyses were conducted in three cities, Baltimore and Sacramento in the USA, and Beijing, China. The results showed that spatial configuration of landscape features significantly affected surface temperatures, but the magnitude of impacts and its relative importance to landscape composition varied by cities, highlighting the importance and benefits of cross-city comparisons. Finally, I give a brief introduction to the Beijing Urban Ecosystem Research Station, the by far only urban site within the Chinese Ecological Research Network (CERN), and discuss the challenges and opportunities on urban long-term ecological research in China.

Biography

Dr. Weiqi Zhou is a professor in the State Key Laboratory of Urban and Regional Ecology, Research Center for Eco-Environmental Sciences, Chinese

Academy of Sciences. Dr. Zhou received his PhD from the University of Vermont. Before he joined the Research Center for Eco-Environmental Sciences, he was a postdoc fellow at the University of California-Davis. Dr. Zhou is broadly interested in urban and landscape ecology with respect to spatial heterogeneity of the landscape. He integrates field observations, remote sensing and modeling to understand the structure of urban socio-ecological systems and its link to ecological function. He works across many disciplines including landscape ecology, urban ecology, remote sensing, and GIS, and works with a variety of scientists through his involvement in collaborative projects. The interdisciplinarity of his work has allowed him to develop innovative approaches and tools to have a better understanding of the structure of urban socio-ecological systems and its link to ecological function.

List of Posters

* Indicates student poster.

ADAPTING TO CITY LIFE

*Boehme, Cameron S. *Grass or rock: Where are the lizards in suburban communities?*

*Boehme, Cameron S., and F. S. Albuquerque. *Decline of bird species richness in Phoenix metropolitan area over sixteen years.*

*Colbert, Julia K., Emily W. Grunspan, and Raymond G. Quay. *Collaboration for change: Using WaterSim in local and rural water education efforts in Arizona.*

Lewis, Jesse S., Heather L. Bateman, Katherine C. B. Weiss, and Sharon J. Hall. *Patterns of the wildlife community across the gradient of urbanization in the Phoenix Valley.*

McPhillips, Lauren E., Shannon M. Newell, and Nancy B. Grimm. *Stormwater infiltration patterns in vacant lots in the Phoenix metropolitan area.*

*Moen, Claire E., Jennifer Hackney, and James C. Johnson. *The urban heat island's impact on ecdysone levels during development of western black widows, *Latrodectus hesperus*.*

Reichman, Anne, Paul Prosser, and Erin Rugland. *ASU Project Cities.*

CLIMATE AND HEAT

*Colbert, Julia K., Emily W. Grunspan, and Raymond G. Quay. *Collaboration for change: Using WaterSim in local and rural water education efforts in Arizona.*

Markolf, Samuel A., Mikhail Chester, Daniel Eisenberg, Thaddeus Miller, Rae Zimmerman, Cliff Davidson, and Thomas Seager. *The role of social-ecological-technological systems (SETS) in the vulnerability and resilience of infrastructure.*

McPhillips, Lauren E., Shannon M. Newell, and Nancy B. Grimm. *Stormwater infiltration patterns in vacant lots in the Phoenix metropolitan area.*

*Paine, Garth, Visar Berisha, Helen Rowe, Kyle Hoefler, Aishwarya Pratap Singh, Srinivas Puranam, Sabine Feisst, and Sharon J. Hall. *EcoSonics - Psychoacoustic diversity modeling for environmental management.*

*Russell, Jazmine B., and Susanne Neuer. *Utilizing remotely sensed data to monitor algal blooms and water quality in Arizona reservoirs.*

*Wang, Chenghao, Chuyuan Wang, Soe W. Myint, and Zhi-Hua Wang. *Spatial and temporal variability of satellite-based aerosol optical depth in the dynamic urban environment.*

*Wright, Mary K., David M. Hondula, Lauren Wilson, Liza C. Kurtz, Lance E. Watkins, Paul C. Chakalian, Kelli L. Larson, and Sharon L. Harlan. *Degrees of desire: Household preferences are key determinants of indoor temperatures in Phoenix.*

*Zhang, Yujia, Ariane Middel, and Billie L. Turner II. *Evaluating the effects of vertical urban forms on land surface temperature using Google Street View images.*

*Zhao, Qunshan, David J. Sailor, and Elizabeth A. Wentz. *Impact of tree locations and arrangements on outdoor microclimates and human thermal comfort in an urban residential environment.*

EDUCATION AND MANAGEMENT

Earl, Stevan R. *The CAP LTER information management system: Data management for project investigators and the scientific community.*

*Votaw, Alexandra. *Providing tools for increased participation and improved sustainable practices to the Phoenix metropolitan community through environmental education.*

GOVERNANCE AND INSTITUTIONS

*Colbert, Julia K., Emily W. Grunspan, and Raymond G. Quay. *Collaboration for change: Using WaterSim in local and rural water education efforts in Arizona.*

*Ishtiaque, Asif, Milan Shrestha, and Netra Chhetri. *Urbanization in the Himalayas? Detecting loss of agricultural land due to urban growth in the Kathmandu Valley, Nepal.*

*Kim, Yeowon, Daniel A. Eisenberg, Emily N. Bondank, Mikhail V. Chester, Giuseppe Mascaro, and B. Shane Underwood. *Fail-safe and safe-to-fail adaptation: Decision-making for urban flooding under climate change.*

Reichman, Anne, Paul Prosser, and Erin Rugland. *ASU Project Cities.*

Markolf, Samuel A., Mikhail Chester, Daniel Eisenberg, Thaddeus Miller, Rae Zimmerman, Cliff Davidson, and Thomas Seager. *The role of social-ecological-technological systems (SETS) in the vulnerability and resilience of infrastructure.*

McPhillips, Lauren E., Shannon M. Newell, and Nancy B. Grimm. *Stormwater infiltration patterns in vacant lots in the Phoenix metropolitan area.*

PARKS AND RIVER

*Boehme, C. S. *Grass or rock: Where are the lizards in suburban communities?*

*Boehme, Cameron S., and F. S. Albuquerque. *Decline of bird species richness in Phoenix metropolitan area over sixteen years.*

Lewis, Jesse S., Heather L. Bateman, Katherine C. B. Weiss, and Sharon J. Hall. *Patterns of the wildlife community across the gradient of urbanization in the Phoenix Valley.*

*López-Castrillo, Ivan E., and Enrique R. Vivoni. *Hydrologic modeling of South Mountain under an extreme event and implications for downstream urban growth and ecological design alternatives.*

McPhillips, Lauren E., Shannon M. Newell, and Nancy B. Grimm. *Stormwater infiltration patterns in vacant lots in the Phoenix metropolitan area.*

*Pandorf, Madelyn, and Paul Westerhoff. *Addition of graphite nanoparticles to enhance growth and reduce nutrient leaching in lettuce cultivation.*

*Russell, Jazmine B., and Susanne Neuer. *Utilizing remotely sensed data to monitor algal blooms and water quality in Arizona reservoirs.*

RESIDENTIAL LANDSCAPES AND NEIGHBORHOODS

*Beauclaire Reyes, Christal, Alyssa Bailey, Laura Steger, Megan M. Wheeler, and Sharon J. Hall. *Plant species diversity and community composition of yard types in Phoenix, AZ.*

*Boehme, C. S. *Grass or rock: Where are the lizards in suburban communities?*

*Ishtiaque, Asif, Milan Shrestha, and Netra Chhetri. *Urbanization in the Himalayas? Detecting loss of agricultural land due to urban growth in the Kathmandu Valley, Nepal.*

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Reichman, Anne, Paul Prosser, and Erin Rugland. *ASU Project Cities.*

*Zhang, Yujia, Ariane Middel, and Billie L. Turner II. *Evaluating the effects of vertical urban forms on land surface temperature using Google Street View images.*

*Zhao, Qunshan, David J. Sailor, and Elizabeth A. Wentz. *Impact of tree locations and arrangements on outdoor microclimates and human thermal comfort in an urban residential environment.*

SCENARIOS AND FUTURES

*Colbert, Julia K., Emily W. Grunspan, and Raymond G. Quay. *Collaboration for change: Using WaterSim in local and rural water education efforts in Arizona.*

*Davidson, Melissa J., Elizabeth M. Cook, Nancy B. Grimm, and David M. Iwaniec. *Sustainable Future Scenarios 2060.*

*Davidson, Melissa J., Yeowon Kim, Mikhail V. Chester, Elizabeth M. Cook, Nancy B. Grimm, and David M. Iwaniec. *Downscaling regional scenarios: The application of social-ecological-technological framework.*

*Kim, Yeowon, Daniel A. Eisenberg, Emily N. Bondank, Mikhail V. Chester, Giuseppe Mascaro, and B. Shane Underwood. *Fail-safe and safe-to-fail adaptation: Decision-making for urban flooding under climate change.*

*López-Castrillo, Ivan E., and Enrique R. Vivoni. *Hydrologic modeling of South Mountain under an extreme event and implications for downstream urban growth and ecological design alternatives.*

McPhillips, Lauren E., Shannon M. Newell, and Nancy B. Grimm. *Stormwater infiltration patterns in vacant lots in the Phoenix metropolitan area.*

*Nguyen, Thuy, and Paul Westerhoff. *Upstream wastewater discharges impact two –thirds of surface water treatment plants in Texas, USA.*

*Paine, Garth, Visar Berisha, Helen Rowe, Kyle Hoefler, Aishwarya Pratap Singh, Srinivas Puranam, Sabine Feisst, and Sharon J. Hall. *EcoSonics - Psychoacoustic diversity modeling for environmental management.*

Reichman, Anne, Paul Prosser, and Erin Rugland. *ASU Project Cities.*

*Stuhlmacher, Michelle F., Ran Goldblatt, Matei Georgescu, Nicholas Clinton, Beth Tellman, Gordon Hanson, and Amit K. Khandelwal. *30-meter resolution urban classification in Google Earth Engine.*

*Ishtiaque, Asif, Milan Shrestha, and Netra Chhetri. *Urbanization in the Himalayas? Detecting loss of agricultural land due to urban growth in the Kathmandu Valley, Nepal.*

*Kubicki, Sierra, Daniel L. Childers, and Christopher A. Sanchez. *Seasonal and spatial patterns of net aquatic primary productivity in an aridland constructed treatment wetland.*

Larson, Kelli L., Riley Andrade, Sara Meerow, and Paul Coseo. *Perceived ecosystem services and disservices: Preliminary findings and development of reliable survey measures.*

*López-Castrillo, Ivan E., and Enrique R. Vivoni. *Hydrologic modeling of South Mountain under an extreme event and implications for downstream urban growth and ecological design alternatives.*

Markolf, Samuel A., Mikhail Chester, Daniel Eisenberg, Thaddeus Miller, Rae Zimmerman, Cliff Davidson, and Thomas Seager. *The role of social-ecological-technological systems (SETS) in the vulnerability and resilience of infrastructure.*

McPhillips, Lauren E., Shannon M. Newell, and Nancy B. Grimm. *Stormwater infiltration patterns in vacant lots in the Phoenix metropolitan area.*

Reichman, Anne, Paul Prosser, and Erin Rugland. *ASU Project Cities.*

Sanchez, Christopher A., Paul Coseo, and Chingwen Cheng. *Understanding co-production in urban ecological design: Design processes to support "Designed Experiments".*

*Stuhlmacher, Michelle F., Ran Goldblatt, Matei Georgescu, Nicholas Clinton, Beth Tellman, Gordon Hanson, and Amit K. Khandelwal. *30-meter resolution urban classification in Google Earth Engine.*

*Zhang, Yujia, Ariane Middel, and Billie L. Turner II. *Evaluating the effects of vertical urban forms on land surface temperature using Google Street View images.*

*Zhao, Qunshan, David J. Sailor, and Elizabeth A. Wentz. *Impact of tree locations and arrangements on outdoor microclimates and human thermal comfort in an urban residential environment.*

WATER AND FLUXES

*Colbert, Julia K., Emily W. Grunspan, and Raymond G. Quay. *Collaboration for change: Using WaterSim in local and rural water education efforts in Arizona.*

*Elser, Stephen E., Elizabeth M. Cook, Olga Barbosa, and Nancy B. Grimm. *Water quality in wetlands along an impervious surface gradient in Valdivia, Chile.*

*Hester, Cyrus M., and Gwyneth W. Gordon. *Urban versus rural trends in trace metal concentrations as indicated by the spines of long-lived cacti.*

Grimm, Nancy B., Lauren E. McPhillips, Rebecca L. Hale, and Stevan R. Earl. *Urban desert streams do not conform to the urban stream syndrome.*

*Kubicki, Sierra, Daniel L. Childers, and Christopher A. Sanchez. *Seasonal and spatial patterns of net aquatic primary productivity in an aridland constructed treatment wetland.*

*López-Castrillo, Ivan E., and Enrique R. Vivoni. *Hydrologic modeling of South Mountain under an extreme event and implications for downstream urban growth and ecological design alternatives.*

McPhillips, Lauren E., Shannon M. Newell, and Nancy B. Grimm. *Stormwater infiltration patterns in vacant lots in the Phoenix metropolitan area.*

*Perez-Ruiz, Eli R., Enrique R. Vivoni, and Nicole P. Templeton. *Urban land cover type influences CO₂ fluxes within Phoenix, Arizona.*

*Ribeiro, Caitlin, Megan M. Wheeler, Laura Steger, and Sharon J. Hall. *Shrubs alter patterns of inorganic soil nitrogen availability in native desert parks across metropolitan Phoenix.*

*Russell, Jazmine B., and Susanne Neuer. *Utilizing remotely sensed data to monitor algal blooms and water quality in Arizona reservoirs.*

Wheeler, Megan M., Scott L. Collins, Nancy B. Grimm, Christopher Clark, Ryan A. Sponseller, and Sharon J. Hall. *Nutrient enrichment alters annual plant diversity in the northern Sonoran Desert.

Abstracts

All abstracts are listed alphabetically by first author. * indicates student poster.



Beauclaire Reyes, C.¹, A. Bailey², L. Steger¹, M. M. Wheeler¹, and S. J. Hall¹. *Plant species diversity and community composition of yard types in Phoenix, AZ.

People create and maintain residential yards to provide different types of ecosystem services. Using native plants in landscaping can support native pollinators and wildlife, but it is not clear in what types of landscapes people are mostly likely to include native plants. We ask, what types of yards in Phoenix have the highest number of native plants and greatest similarity to desert vegetation? We compared plant composition in native desert ecosystems with four types of residential yards: yards dominated by either passively or actively managed turfgrass lawns, yards with primarily desert-like (xeric) landscaping, and yards certified by the National Wildlife Federation as wildlife habitat. We predicted that residents who invested in wildlife certification would be more likely to include native plants in their landscaping, while lawn-dominated yards and yards with more passive managers would be less likely to include native plants. Using ordination techniques, we found that yards with similar types of front landscaping had more similar plant communities and that yard plant communities were more similar to each other than to native desert. Of the yard types considered, xeriscape plant species compositions were most similar to deserts while wildlife certified yards supported the highest number of native species. Alternative yard landscaping practices may be a useful tool to conserve native diversity, but a better understanding of how and why people choose to incorporate native plants into their landscaping is needed to evaluate its broad potential for increasing native diversity in urban areas.

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Boehme, C. S. *Grass or rock: Where are the lizards in suburban communities?

Maricopa County is the fastest growing county in the United States. Communities are encroaching closer to wildlands, increasing the urban-wildland interface. There is a demand to understand how this encroachment affects native lizard species. Previous studies have observed that wildland areas and areas that are more rural are more species rich and have more species evenness than urban areas. Studies have also shown that neighborhoods with xeriscape have similar function and structure to wildlands. If residential communities in the urban-wildlife interface use xeriscape, then will species richness, abundance, and evenness increase? We are interested in first verifying that there are differences within lizard populations between xeric and mesic habitats. Secondly, we will document if xeric habitats are similar to wildland habitat in lizard richness, abundance, and evenness. We conducted ten, 200-meter transects within the Las Sendas Community in northeast Mesa, Arizona, five in xeriscape and five in mesic habitat. We also conducted five, 200-meter transects in the Utery Mountain Regional Park directly east of the Las Sendas Community. Our results confirmed that mesic, xeric, and wildland habitats are different in lizard abundance and richness with mesic and wildland habitats being most dissimilar. The results showed that neighborhoods with xeriscape will be more similar to that of natural habitat in lizard richness and abundance than mesic habitats, and that communities can take action to increase lizard abundance and richness by implementing landscaping that better mimics natural habitat.

Science and Mathematics, College of Integrative Sciences and Arts, Arizona State University, 7271 E Sonoran Arroyo Mall, Suite 233, Mesa, AZ 85212



Boehme, C. S., and F. S. Albuquerque. *Decline of bird species richness in Phoenix metropolitan area over sixteen years.

Maricopa County has grown considerably in the last two decades, and there is a growing interest in studying how bird populations have been affected. Previous studies conducted in the Phoenix metropolitan area have documented declines of abundance and richness of birds in riparian habitats. Herein, we investigated whether richness also declines throughout urban habitat areas within the Phoenix metropolitan area and what environmental factors may explain this decline. Specifically, we documented, for the first time, (1) how species richness varies across years annually throughout the urban area, and (2) whether richness varies across urban habitats. We used bird census surveys collected over a 16-year period throughout the Phoenix urban area from 2000 to 2016 and conducted Kruskal-Wallis test to determine whether the mean rank of species richness throughout and within

urban habitats were the same. Our results showed that there is a change in bird species richness annually throughout the Phoenix metropolitan over a 16-year period. The results of this study are necessary to compare annual changes in species richness as they relate to changes in climate and environmental variables.

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Colbert, J. K., E. W. Grunspan, and R. G. Quay. *Collaboration for change: Using WaterSim in local and rural water education efforts in Arizona.

Central Arizona has planned for its future water supply, but not for its future water leaders. Decision Center for a Desert City (DCDC), a unit of the Julie Ann Wrigley Global Institute of Sustainability, has partnered with Arizona Community Foundation (ACF) to inspire future water leadership in the state. In 2016, ACF awarded DCDC with a \$100,000 grant to engage with community leaders to make a positive impact in Arizona. For over a decade, DCDC has been using a dynamic, interactive tool called WaterSim to help with decision making under uncertainty. Now, DCDC is using this web-based tool in classrooms throughout central Arizona to educate students in grades 7-12 about water supply and demand, as well as the potential impacts of policy choices and climate change in the Phoenix metropolitan area. Since the grant was awarded in 2016, DCDC has trained 37 teachers to use WaterSim Phoenix in their classrooms, impacting thousands of students in the state. In addition, we plan to train 20 more teachers and community college faculty members by spring of 2018. In September 2018, DCDC received a second grant of \$95,376 to educate and engage rural Arizona communities. DCDC will incorporate WaterSim Arizona and Smithsonian's Museum on Main Street WaterStories to provide water education coinciding with Smithsonian's touring exhibition called Water/Ways. DCDC is working on this project in collaboration with ACF, Smithsonian's Museum on Main Street, and Arizona Humanities. The Water/Ways exhibition will visit twelve rural Arizona community host sites from June 2018-March 2020.

Decision Center for a Desert City, Arizona State University, PO Box 878209, Tempe, AZ 85287-8209



***Davidson, M. J.¹, E. M. Cook², N. B. Grimm^{1,3}, and D. M. Iwaniec⁴.
*Sustainable Future Scenarios 2060.***

Urban sustainability and resilience are important guiding visions for cities. Urban ecology can bring useful perspectives on the future development of cities, but requires collaborative approaches to address city planning and management needs. We co-develop scenarios to explore alternative social-ecological-technological futures using three distinct methodological approaches. We explored adaptive, strategic, and transformative futures. Adaptive futures are developed in response to extreme events. Strategic futures are projected forward using existing municipal goals and targets. Transformative futures are back-casted from radically transformed visions of sustainability. This project integrates plausibility-based futures (what is most likely to happen) and desirability-based futures (what we would like to happen). Through collaborative workshops with community, municipal, and academic stakeholders, we identified key priorities and strategies that decision makers are using to frame urban development and address climatic extreme events (i.e., flood, drought, and heat). We also identified systems and normative conflicts and trade-offs within the distinct future pathways. Development of these scenarios allows us to contrast diverse alternative future pathways and explore interacting strategies for urban sustainability and resilience. This project demonstrates how scenario construction can enhance research and decision-making capacity for long-range sustainability planning.

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Davidson, M. J.¹, Y. Kim¹, M. V. Chester², E. M. Cook³, N. B. Grimm⁴, and D. M. Iwaniec⁵. *Downscaling regional scenarios: The application of social-ecological-technological framework.

Scenarios are an important tool for assessing potential social-ecological changes for a location, and can be explored across a region, city, or neighborhood. CAP LTER future scenarios were co-developed with practitioners in 2014-2016 for the Phoenix region, but these regional scenarios may not reflect solutions and values preferred at local scales (i.e., neighborhood/village). Therefore, the next step of the scenario development aims to downscale scenarios to explore localized futures. It is important to understand what strategies are being promoted at different scales of governance and how they may vary within the region. In this study, we focus on adaptation strategies addressing climate risks such as heat, drought, and flood. We use a social-ecological-technological systems (SETS)

approach to elucidate the range of adaptation perspectives in regional planning documents and the Phoenix Area Social Survey (PASS). Together, we combine qualitative categorization of SET strategies and quantitative statistical comparison. We find heat mitigation by engineered infrastructure are well represented across villages. Engineered infrastructural solutions are major adaptation strategies endorsed across the region. On the other hand, local governments promote public spaces as retention basins to capture rain and mitigate floods, yet there is a lack of awareness around retention basin function in some neighborhoods. The results are useful for future localized scenario development processes by providing bottom-up strategies from PASS, top-down strategies from regional plans, and the spatial heterogeneity of adaptation perspectives. Our study supports our hypothesis on the need for downscaled scenarios and provides new insights for practitioners facilitating stakeholder engagement.

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Earl, S. R. *The CAP LTER information management system: Data management for project investigators and the scientific community.*

Unprecedented amounts of information are available to investigators in our increasingly connected world. At the same time, there is a growing expectation of investigators to share not just their research findings but their research data as well (all CAP LTER investigators are asked to provide their research data upon conclusion of their investigation). The CAP LTER addresses the challenges of the long-term curation and dissemination of research data with a robust Information Management System (IMS) that benefits both CAP LTER investigators and the broader scientific community. The CAP LTER IMS facilitates the ingestion of research data and metadata that are housed in the CAP LTER and LTER Network data repositories, providing long-term storage and access to research data. Research data in these repositories are also cataloged by the DataONE federation, which greatly enhances their discoverability. Through these resources, data from the CAP LTER's long-term monitoring programs, and the work of previous investigators are available to the community as building blocks for future research efforts. Submitting data through the CAP LTER meets the data publishing requirements set by funders and publishers, and each data set is given a unique Digital Object Identifier (DOI) that a data provider may reference. The CAP LTER Information Manager and the Global Institute of Sustainability Informatics Team are available to assist with the data

publishing process, and to provide guidance regarding effective approaches to research data management to elevate the efficacy of both data publication and the overall research endeavor.

Julie Ann Wrigley Global Institute of Sustainability, Arizona State University, PO Box 875402, Tempe, AZ 852875402



Elser, S. E.¹, E. M. Cook², O. Barbosa³, and N. B. Grimm¹. *Water quality in wetlands along an impervious surface gradient in Valdivia, Chile.

Urban expansion changes native ecosystems, which may limit ecosystem services and alter their function. Past research has documented that an increased area of impervious surfaces alters flow patterns and increases the concentrations of nutrients in nearby waterways. Valdivia, Chile is a medium-sized city that contains large urban wetlands that may be important for mitigating water pollution. However, wetland area has declined due to development. Here, we test the hypothesis that water quality in wetlands will change along an impervious surface gradient, defined by quantifying the amount of impervious surface in the area within a 200-m radius of sampling sites. We sampled water from 82 locations in Valdivia's wetlands and predicted that concentrations of ammonium, nitrate, and phosphate would decline along the impervious surface gradient. Linear regressions showed that the concentration of nitrate declined along the urban to rural gradient ($p < 0.05$, $R^2 = 0.34$), but that there were no relationships between impervious surface area and ammonia and phosphate. We then split sites into categories of Low, Medium and High amounts of surrounding impervious area. We found that there were significant differences in nitrate concentrations between the High and Low sites and the Medium and Low sites, but not between the Medium and High sites ($p < 0.05$). There were no significant differences for phosphate and ammonia. These results suggest that impervious surfaces do influence water quality in Valdivia's wetlands, and we are awaiting results of in situ experiments to determine whether this is also true of the nutrient retention efficiency.

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Grimm, N. B.^{1,2}, L. E. McPhillips², R. L. Hale³, and S. R. Earl². *Urban desert streams do not conform to the urban stream syndrome.*

It is almost dogma that the 'urban stream syndrome' results in dramatic changes in stream hydrology, such as higher peak flows, lower base flows, and greater flashiness. However, this has not been definitively tested for aridlands, which are themselves characterized by these very same hydrograph properties. We analyzed long-term (>15-year) records of streamflow in 34 watersheds of central and southern Arizona to determine how hydrograph characteristics varied across a range of development. Metrics such as flashiness index, coefficient of variation of flow, and number of days with no flow were calculated for daily discharge values from 15 small (<10,000 ha) and 19 large (>10,000 ha) catchments. We found no relationships of hydrologic parameters to urbanization when we considered all catchments; however, when we considered only catchments small enough to escape major hydrologic alteration (such as damming or diversion), we found that flashiness index and coefficient of variation of daily flow both decreased with % development in the watershed. This relationship is opposite that found for many streams in more humid regions. We explored mechanisms that might explain this pattern by relating hydrologic parameters to % retention in watersheds. Although we were able to obtain these data for only six watersheds, there was a significant negative relationship between coefficient of variation of daily flow and % retention. We conclude that the urban stream syndrome does not apply in aridland systems; instead, urbanization may in fact increase water retention and reduce the impact of high flows on stream ecosystems.

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Hester, C. M.¹, and G. W. Gordon². *Urban versus rural trends in trace metal concentrations as indicated by the spines of long-lived cacti.

CAP LTER researchers have shown that the Phoenix metropolitan area hosts elevated levels of potentially-toxic heavy metals, such as copper, lead, and zinc. Yet information is lacking on how and why metal levels have changed with time. To investigate this, a novel paleoecological approach was developed with support from the CAP graduate student grant program. Ninety-six sequentially-grown spines were collected from saguaro cacti (*Carnegiea gigantea*) inhabiting urban and rural field sites. These spines were then ground with a liquid nitrogen ball mill, dissolved using a combination of strong acids (i.e., HNO₃, HF, HCl), and digested via

microwave irradiation. The resulting solutions were then evaporated to near dryness, diluted to a known volume, and elementally-analyzed via inductively coupled plasma mass spectrometry (ICP-MS). The trace metal concentrations derived from these techniques were then examined statistically using a combination of signal decomposition and breakpoint techniques to identify long-term trends and regime shifts. This poster summarizes our preliminary findings, with a particular emphasis on comparing inter-annual trends in metal concentrations between the two sites. In addition to developing a paleoecological technique well-suited for arid environments, this project offers insights on an urban biogeochemical trend (i.e., metal enrichment) observed globally. Rich spatio-temporal perspectives, such as this, are critical for determining whether urban pollution is a product of contemporary or antiquated practices (e.g., mobile source emissions vs. early 20th Century smelting, respectively). Doing so can enable urban ecologists, decision-makers, and others to more efficiently allocate limited resources in pursuit of healthier, and more sustainable, urban environments.

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Ishtiaque, A.¹, M. Shrestha², and N. Chhetri³. *Urbanization in the Himalayas? Detecting loss of agricultural land due to urban growth in the Kathmandu Valley, Nepal.

Rapid urban growth of Kathmandu Valley of Nepal in the last four decades is emblematic of the current urbanization trend sweeping across the Himalayan foothills. Urbanization in mountain areas does not get much attention in urban sustainability literature, leaving much of their complex socio-ecological systems—particularly the social drivers and the significant impacts on ecosystem services—for speculation and generalization. Using Landsat series images of 1989, 1999, 2009 and 2016, we detected, quantified and analyzed the changing dynamics in land systems. This valley has experienced pell-mell growth in this period, transforming from a historic valley of small cities and towns into a metropolitan city by 2016. The detected changes in land system were analyzed in the light of a set of proximate causes and drivers of the major socio-economic changes. The results show that urban area expanded up to 412% in last three decades and the most of this expansion occurred with the loss of 31% agricultural land. The majority of the urban growth occurred between 1989 and 2009, and the valley continues to expand along the major roads, significantly altering the cityscape of the valley. The centrality feature of Kathmandu Valley and the massive surge in rural-to-urban migration acted as the

primary proximate causes of the sprawling residential areas and rapid conversions of agricultural areas.

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Kim, Y.¹, D. A. Eisenberg², E. N. Bondank², M. V. Chester², G. Mascaro², and B. S. Underwood³. *Fail-safe and safe-to-fail adaptation: Decision-making for urban flooding under climate change.

As climate change affects precipitation patterns, urban infrastructure may become more vulnerable to flooding. Flooding mitigation strategies must be developed such that the failure of infrastructure does not compromise people, activities, or other infrastructure. "Safe-to-fail" is an emerging paradigm that broadly describes adaptation scenarios that allow infrastructure to fail but control or minimize the consequences of the failure. Traditionally, infrastructure is designed as "fail-safe" where they provide robust protection when the risks are accurately predicted within a designed safety factor. However, the risks and uncertainties faced by urban infrastructures are becoming so great due to climate change that the "fail-safe" paradigm should be questioned. We propose a framework to assess potential flooding solutions based on multiple infrastructure resilience characteristics using a multi-criteria decision analysis (MCDA) analytic hierarchy process algorithm to prioritize "safe-to-fail" and "fail-safe" strategies depending on stakeholder preferences. Using urban flooding in Phoenix, Arizona as a case study, we first estimate flooding intensity and evaluate roadway vulnerability using the Storm Water Management Model for a series of downpours that occurred on September 8, 2014. Results show the roadway types and locations that are vulnerable. Next, we identify a suite of adaptation strategies and characteristics of these strategies, and attempt to more explicitly categorize flooding solutions as "safe-to-fail" and "fail-safe" with these characteristics. Lastly, we use MCDA to show how adaptation strategy rankings change when stakeholders have different preferences for particular adaptation characteristics.

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Kubicki, S.¹, D. L. Childers², and C. A. Sanchez². *Seasonal and spatial patterns of net aquatic primary productivity in an aridland constructed treatment wetland.

The Tres Rios constructed treatment wetland (CTW), located in Phoenix, AZ, is an effective method for tertiary wastewater treatment. Previous research suggests that despite the uniquely hot and dry conditions the Tres Rios CTW operates in, the system continues to successfully deliver its designed tertiary treatment services. Yet, how aquatic productivity varies in space and time in aridland CTW systems, and potentially contributes to the treatment process, is not well understood. We present bi-monthly data on aquatic net primary productivity (ANPP) and aquatic respiration measured at the inflow and outflow of a single treatment cell in the Tres Rios CTW from May 2017 to November 2017. Six clear and six dark bottles were filled with the water from each site, and initial concentrations of dissolved oxygen (DO) were measured with a YSI model 52 DO probe. The bottles were set to incubate for several hours in situ, and then final dissolved oxygen concentrations were measured with the DO probe. DO measurements were recorded simultaneously in percent saturation (%) and concentration (mg/L). Initial findings suggest rates of ANPP and respiration are higher over the summer months (higher temperatures) and decrease as temperatures decline. Rates were also found to be higher at system inflow compared to outflow. We plan to continue measurements through a full year of data to further establish temporal and spatial patterns of ANPP and respiration, as well as investigate key regulating variables.

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Larson, K. L.^{1,2}, R. Andrade¹, S. Meerow¹, and P. Coseo³. *Perceived ecosystem services and disservices: Preliminary findings and development of reliable survey measures.*

Research on ecosystem services (ES) has largely focused on the ecological functions or economic valuation of the benefits provided by ecosystems. Far less research has examined what people think about these services, and very little had examined how people view disservices (i.e., risks or environmental problems). We analyzed data from the Phoenix Area Social Survey (PASS)—collected in the summer of 2017 for twelve case study neighborhoods—to fill this gap. Specifically, we present the conceptual and methodological approach used to operationalize perceptions about a wide variety of urban ecosystem services and disservices. We also present preliminary findings on residents' perceptions about the dis/services in their

neighborhoods, and how those are inter-correlated in meaningful ways that reflect views about specific benefits and risks in local urban environments. On average, residents positively perceive the services provided by their neighborhoods, especially for aesthetic and recreational value as well as for bird habitat and stormwater control. Based on factor and correlation analyses, distinctive dimensions of perceived dis/services include: biodiversity (desirable biota versus undesirable pests), regulating disservices (including heat stress, flooding, environmental risks), aesthetic tastes (natural beauty versus messiness), recreational benefits (for physical, social, and nature-related activities) and societal problems (crime and health-related). These composite variables will facilitate additional research on diverse benefits and risks in urban ecosystems, in addition to the factors that drive them. Such studies can aid practitioners in designing, planning, and managing more socially responsive cities and urban ecological infrastructure.

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Lewis, J. S.¹, H. L. Bateman¹, K. C. B. Weiss², and S. J. Hall². *Patterns of the wildlife community across the gradient of urbanization in the Phoenix Valley.*

Species distributions and community assemblies of mammals vary based on patterns of urbanization. Urban exploiters, such as coyote and javelina, can adapt and cause human-wildlife conflict, whereas urban avoiders are more sensitive to urbanization. Mammals are important for maintaining community integrity and this group of wildlife is of great interest to the public and policy makers. Although mammals are important to ecosystems and people in the Phoenix Valley, this group is in need of further study to better understand mammal-urban relationships. To evaluate how the wildlife community responds to varying levels of urbanization, we will collaborate across researchers in the CAP community and with private and public partners at city, county, state, and federal levels. Using data from wildlife cameras set up in natural and semi-natural areas throughout the Phoenix Valley, we will evaluate the spatial and temporal patterns of mammals across the gradient of urbanization. This information will be used to create predictive maps of important habitat for wildlife species and potential human-wildlife conflict zones. These results can be used to enhance conservation and reduce conflict across the gradient of urbanization within the CAP LTER. In this poster, we will describe the overall study design for proposed future work, research objectives, and hypotheses. In addition, we

will share some of our previous results working with mammals in other urbanized landscapes and make predictions for what we expect to observe in urban-adapted wildlife communities in Arizona.

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López-Castrillo, I. E., and E. R. Vivoni. *Hydrologic modeling of South Mountain under an extreme event and implications for downstream urban growth and ecological design alternatives.

With a steady population increase predicted for the City of Phoenix, more urban development will be needed to accommodate the growing population. Expanding populations leading to denser urban areas poses a greater risk for more frequent flood events. It's in the less dense, or less developed, urban basins that opportunities for ecological applications for flood mitigation can be introduced. For this investigation, the development of a hydrologic model using the HEC Hydrologic Modeling System has been focused in the South Mountain region in Phoenix. Two distinctive basins, the South Mountain Fan and Pima Canyon Wash, have been modeled for a six-month period between May 1, 2014 and October 31, 2014 during which, significant rainfall events were observed in the region. Using a network of discharge gages and meteorological stations from the Flood Control District of Maricopa County, the model parameters have been adjusted and calibrated to best match the observed discharges. Although canopy, surface, and soil storage constitute a great contribution to the simulated discharge, model calibrations have shown that channels are the leading driver for peak discharges and total discharge volume. This observation might indicate that for flood-mitigating ecological applications to be effective, a greater emphasis should be placed on channels for controlled storm flows. Future work includes the continuation of model validation for different rainfall events and periods, as well as the simulation of these ecological applications through parameter variation.

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Markolf, S. A.^{1,2}, M. Chester¹, D. Eisenberg¹, T. Miller³, R. Zimmerman⁴, C. Davidson⁵, and T. Seager¹. *The role of social-ecological-technological systems (SETS) in the vulnerability and resilience of infrastructure.*

Recent events like hurricanes Harvey, Irma, and Maria have brought new attention to some of the limitations of traditional infrastructure protection and response mechanisms, and highlight the major challenges that extreme

weather events continue to pose to our infrastructure systems – particularly in the context of climate change where many locations are expected to see both gradual changes to average temperature and precipitation values and more intense and frequent extreme events. One of the biggest (and often overlooked) exacerbating factors in the threat that extreme events pose to our infrastructure systems is the role that path dependency and lock-in (i.e., the idea that, once in place, infrastructure systems often follow trajectories that very difficult or costly to change) have in the development of vulnerability) within our infrastructure systems – particularly in the context of environmental change and system complexity. Therefore, we develop a series of case studies, systems-level analysis, and conceptual framing in order to better understand lock-in and path dependency and enhance the long term resilience of our infrastructure systems. In doing so, we reach the following preliminary conclusions: 1) in order to better recognize maladaptive lock-in, infrastructure should be characterized as Socio-Ecological-Technological Systems (SETS) rather than just purely technical systems; 2) a SETS perspective helps provide a more comprehensive understanding of the major challenges facing our infrastructure systems; and 3) lack of a SETS perspective may limit our ability to fully comprehend the evolution of vulnerabilities within our infrastructure systems and fully develop the solution space related to these vulnerabilities.

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McPhillips, L. E.¹, S. M. Newell², and N. B. Grimm³. *Stormwater infiltration patterns in vacant lots in the Phoenix metropolitan area.*

Vacant land in Phoenix comprises 6.5% of the total city area. This land could be a potential asset or a vulnerability, depending on the state of these vacant properties. We focused here on soil properties, with the goal of understanding how these vacant lot soils might play a role in stormwater retention and prevent local flooding. We selected 20 vacant lots which were all located in CAP PASS (Phoenix Area Social Survey) neighborhoods distributed throughout the Phoenix metropolitan area. At each lot, we quantified infiltration under saturated and unsaturated conditions and also took samples to assess soil texture, bulk density, and organic matter. Measured infiltration rates varied across sites by several times, ranging from 0.4-8.1 cm/hr under unsaturated conditions and 2.1-22.3 cm/hr under

saturated conditions. Measured infiltration rates generally exceeded those predicted by the NRCS SSURGO national soils geodatabase, and overall trends between measured and database values were similar for unsaturated infiltration but more variable for saturated rates. Discrepancies may be linked to disturbance from demolition or manipulation of soils in preparation for development. Some of the lowest infiltration rates were measured in the PASS SevenEleven neighborhood in South Phoenix, which is concerning because there is also a lack of engineered stormwater drainage infrastructure in this neighborhood. We hope to use this insight on infiltration patterns to inform modeling of stormwater retention in vacant lots around Phoenix, which will help target areas of low retention for potential engineering interventions to enhance stormwater retention and other ecosystem services.

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***Moen, C. E., J. Hackney, and J. C. Johnson. *The urban heat island's impact on ecdysone levels during development of western black widows, *Latrodectus hesperus**.**

The steroid hormone 20-hydroxyecdysone (20E) controls molting in insects and other arthropods. The timing of 20E production and subsequent developmental transitions is regulated by a variety of factors including nutrition, photoperiod, and temperature. Rapid urbanization has led to an increasing prevalence of urban heat islands. Some arthropods, such as the western black widow, appear to thrive under UHI conditions but the physiological mechanism underlying their success as urban exploiters has not been explored. In addition, developmental regulation by 20E in arachnids in general is inadequately characterized, with studies primarily focusing on showing their capability to synthesize the hormone at all. Recent field studies show average summer temperatures in urban Phoenix to be elevated by 6°C compared to average desert temperatures. The western black widow thrives in the urban habitat; yet, our work shows that extreme urban temperatures slow development, reduce body mass, and increase mortality. Here we look at the relationship between 20E levels and development in spiderlings reared under desert (27°C), intermediate (30°C), and urban (33°C) temperatures. Developmental progression and hemolymph 20E titers were recorded for six families of spiders collected from urban Phoenix, focusing on the second developmental instar. We found that 33°C, but not 30°C, led to 1) significantly higher production of 20E throughout development, 2) additional peaks of 20E, 3) delayed developmental

progression, and 4) significant familial variation in 20E concentrations suggesting that urban temperatures have surpassed the threshold for being able to regulate 20E levels for optimal development progression.

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Nguyen, T. and P. Westerhoff. *Upstream wastewater discharges impact two –thirds of surface water treatment plants in Texas, USA.

De facto potable reuse occurs when treated wastewater is discharged into the upstream of drinking water treatment plants (DWTPs). Due to concern about impacts of contaminants of emerging concerns (CECs) at downstream DWTPs, a recent study on de facto reuse occurrence have been assessed at national scale, but it is limited to the DWTPs serving greater than 10,000 people. This study will look at all DWTPs in Texas for potential impacts of upstream treated wastewater discharging to surface waters by using "De Facto Reuse in our Nations Consumable Supply (DRINCS)" model. The goals of the study are to: (i) quantify the percent of treated wastewater present at a particular DWTP's intake; (ii) analyze the spatial distribution and magnitude of the de facto reuse under variable flow conditions; (iii) evaluate the proximity analysis of wastewater treatment plants upstream (WWTPs) to a single DWTP; (iv) investigate the ability of removing CECs by the installed unit processes at these impacted DWTPs. Overall, two thirds of all surface water intakes in Texas (i.e., 420 out of 593) were impacted by at least one upstream wastewater discharge. Higher de facto reuse at DWTPs were identified in the southwest of Texas with an estimate of more than 20%. Under low flow conditions, 16 of 25 sites potentially contained greater than 90% treated wastewater. Among the ten DWTPs studied, the estimated number of WWTPs, which are at the upstream of each DWTP ranged between 2 and 22 within <100 miles. This range shifted to 21 and 151 as the distance increased to <1000 miles. Some DWTPs installed processes of granular activated carbon (GAC), ozone which is capable of removing or transforming CECs, but these tend to be located in larger cities. This study investigates the de facto potable reuse of municipal wastewater and supports monitoring efforts by identifying highly impacted areas.

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Paine¹, G.; V. Berisha², H. Rowe³, K. Hofer¹, A. P. Singh², S. Puranam², S. Feisst⁴, and S. J. Hall⁵. *EcoSonics - Psychoacoustic diversity modeling for environmental management.

Can psychoacoustic measures be used to predict impact of environmental change on species diversity? We hypothesize that modeling correlation between ecosystem psychoacoustic properties and local weather data can expedite prediction of ecosystems impact from climate and land use change and strengthen management outcomes. EcoSonic models the correlation between the entropy of the Mel-frequency cepstral coefficients (MFCC) and weather data, to characterize the relationship between changes in weather and the acoustic fingerprint of the ecosystem. Environmental sound qualities change with weather variation and climate patterns. Hard surfaces, such as rocks, increase reverberation, amplifying animal calls, while vegetation mass dampens sound propagation. These environmental variables also change frequency response of ecosystems. We ask if MFCC's are a robust measure of climate impact on acoustic properties of ecosystems (Acoustic Diversity Measure, ADM). The method includes taking historical sound data to create mathematical models which are applied in an attempt to predict the data for a future date, or for a set of inputs for which the input is unknown. In this context, we try to create a model that learns the acoustic diversity of a location over time and can predict the same for different sets of future dates.

The ADM is applied in developing a robust approach to road noise mitigation and wildlife crossing design by considering how sound quality varies relative to road distance, elevation and patterns of vegetation in addition to variation of these patterns relative to weather conditions. This helps future proof solutions whilst optimizing site-specific solutions.

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Pandorf, M., and P. Westerhoff. *Addition of graphite nanoparticles to enhance growth and reduce nutrient leaching in lettuce cultivation.

Agriculture has become dependent on the addition of chemical fertilizers, which have inefficient plant nutrient uptake and cause nutrient leaching into water bodies. Nanoparticles (NPs) in agriculture have been proving to have many benefits including increased yield, improved germination rates, and enhanced nutrient delivery. This research is focused on using graphite

nanoparticles to efficiently deliver plant nutrients to lettuce; therefore, enhancing its overall growth and reducing nutrient leaching. The goal of the research is to compare lettuce cultivation between bulk fertilizer and nanoparticles combined with bulk fertilizer at varying nutrient rates. The objectives were: (i) compare nutrient leaching between treatments, (ii) assess nanoparticle effectiveness through yield, and (iii) conduct a nutrient balance between plant tissue, soil, and leachate. Lettuce was grown in a seven-week greenhouse pot study with leachate collection bi-weekly or as needed. Based on results to date, no significant improvements of yield, leaching, or nutrient uptake have been seen between the bulk NPK fertilizer and the bulk NPK fertilizer combined with carbon nanoparticles. For the summer growth period, there was no statistical difference between the fertilized treatments indicating the nanoparticles did not have a negative impact on growth. Currently a second trial is being conducted comparing bulk and nano treatments at nutrient rates of 100%, 70%, 50%, and 30% of the recommended nutrient dose for lettuce. Nanoparticles can have a positive impact if less nutrients are applied to grow a comparable yield to the full nutrient dose considering less nutrients means less leaching.

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Perez-Ruiz, Eli R.^{1,3}, E. R. Vivoni^{1,2}, and N. P. Templeton². *Urban land cover type influences CO₂ fluxes within Phoenix, Arizona.

Urbanization represents a drastic modification of land surface characteristics that impact local energy, water and carbon cycles. Cities represent approximately a 3% of land surface; however, they are responsible for more than 70% of the global anthropogenic CO₂ emissions. The knowledge of dynamics of urban carbon fluxes or net ecosystem exchange (NEE) is scarce, particularly over the great variability of land cover types present within cities. In this study, we present a comparison of NEE measurements in four typical urban landscapes in the Phoenix metropolitan area. A mobile eddy covariance (EC) tower was deployed at a xeric landscaping (XL), a parking lot (PL) and a mesic landscaping (ML) during consecutive, short-term (~40 days) sampling periods and compared to a reference site (REF) in a suburban neighborhood over a longer deployment period (~9 months). We analyzed the diurnal cycle and the daily and seasonal variations of NEE in the context of the measured meteorological conditions. EC observations were then related to vegetation conditions through a satellite-based Normalized Difference Vegetation Index (NDVI) and incoming radiation variations, and to anthropogenic activities through local traffic counts and comparisons between workdays and weekends. All sites showed important differences in NEE with respect to the REF site due to

the influence of the urban patch area sampled within the EC footprint. Daily NEE values at all sites exhibited differences among days of the week that were linked to traffic conditions, with higher values during weekdays and lower values during weekends. The diurnal behavior of NEE showed different trends depending on the vegetation fraction within each site and the proximity to nearby roads. Minimum midday (around noon) values of NEE were found in XL, ML and REF sites coinciding with the maximum rate of urban plants absorbing CO₂, while maximum peaks of NEE occurred during rush hours (around 8 am and 6 pm) in PL, ML, and REF sites, where the traffic influence was high. Overall, three of the four sites with low to moderate vegetation acted as a net source of CO₂ during the respective deployments, while one site with a well-irrigated mesic landscaping acted as a net sink of CO₂ during the summer. Urban metabolism (traffic) and vegetation activity are the main forces controlling the urban NEE, thus, the characteristics and function of urban patches should have a strong control on the CO₂ fluxes within cities, which can be reliably measured using the EC method.

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Reichman, A., P. Prosser, and E. Rugland. *ASU Project Cities*.

ASU Project Cities is a university-community program connecting Arizona State University students and faculty in select academic courses with projects and sustainability needs and/or challenges of a local community partner. Over the course of a 12-24 month program cycle, students from multiple disciplines and courses research difficult problems selected by the city. At the end of each semester, students present innovative solutions, designs, recommendations, and/or strategies to city staff, which are then used by the community to make more informed decisions to move projects, planning and community sustainability efforts forward.

Project Cities involves a broad range of ASU academic disciplines and departments including, but not limited to, sustainability, public policy, tourism, urban planning, design, landscape architecture, engineering, business, journalism, and environmental management. Through this applied “real-world” experiential-style program, students have the opportunity to influence a local community’s decision making and planning capacity; thus, having a lasting impact on the community’s economic, social and

environmental future. This poster is an overview of the ASU Project Cities program.

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Ribeiro, C.¹, M. M. Wheeler², L. Steger², and S. J. Hall². *Shrubs alter patterns of inorganic soil nitrogen availability in native desert parks across metropolitan Phoenix.

Atmospheric nitrogen deposition from urban activities has increased the availability of nitrogen to primary producers in ecosystems worldwide. In deserts, water and nitrogen availability limit productivity. However, shrubs can increase resource availability for other plants, and the interaction between urban nitrogen deposition and shrub concentration of nutrients is not well understood. We ask, how do shrubs affect patterns of soil inorganic nitrogen across a precipitation and urbanization gradient? We predict that soil nitrogen availability will be higher in desert parks within the urban core than desert lands outside the city, will increase with precipitation, and will be higher under shrubs than between them. Ion-exchange membranes were placed in surface soil between and under a dominant Sonoran Desert shrub, *Larrea tridentata*, at sites in the Phoenix metropolitan area over multiple years to measure plant-available nitrogen. Using mixed modeling, we found that soil inorganic nitrogen availability was higher in urban desert parks compared to the west valley ($p=0.007$), but did not differ from soil nitrogen in east valley parks. Nitrogen increased with precipitation ($p<0.001$), but the effect of precipitation was small in the wetter east valley ($p=0.003$). Nitrogen availability was higher under shrubs than between shrubs ($p=0.01$). This effect was larger in desert parks in the west than in the east or urban core ($p=0.003$). This work suggests that the relationship between soil nitrogen availability and shrubs is affected by both precipitation and location relative to the city, showing how small-scale landscape heterogeneity and urban influences may change nitrogen availability to plants.

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Russell, J. B.¹, and S. Neuer². *Utilizing remotely sensed data to monitor algal blooms and water quality in Arizona reservoirs.

In the face of a fast-growing population and limited reservoir capacity, closely monitoring algal blooms, especially noxious ones, which can impact water quality in the reservoirs that supply water to the Phoenix metropolitan

area will only become more essential. Furthermore, with changing climate conditions, understanding long-term trends and predicting future scenarios will also become increasingly important. The proposed research will utilize historical and newly generated in situ data on water properties and algal populations in three terminal reservoirs, Saguaro Lake, Bartlett Lake, and Lake Pleasant, to gain a fuller understanding of any existing trends in reservoir water quality and to make reasonable predictions about future scenarios. In addition, remotely sensed reflectance data have the potential to allow for monitoring of algal populations on a greater spatial and temporal scale at a lower cost, and without the need for direct lake sampling. In the proposed research, I will use the collected in situ lake water properties and data on algal populations to ground truth remotely sensed data from Landsat 8's Operational Land Imager and to select and refine a variety of bio-optical algorithms. These refined algorithms will allow me to create future water quality monitoring protocols and will also fill in historical gaps in knowledge of water quality when no field data are available.

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***Sanchez, C. A.¹, P. Coseo², and C. Cheng². Understanding co-production in urban ecological design: Design processes to support "Designed Experiments".**

We present survey results from a series of pilot co-production design processes held in Fall 2017 for *Designed Experiments* associated with three landscape architecture design studios. *Designed Experiments* are urban design projects as ecological tests to improve our understanding of how urban ecological infrastructure (UEI) performs (Felson and Pickett 2005). This co-production process links urban ecologists, practitioners, stakeholders, and students to collaboratively generate designs, maintenance, and monitoring for designed experiments. However, how this process unfolds specifically in UEI-based projects has not been studied in the Phoenix metro area. We aim to understand how co-production processes in CAP LTER *Designed Experiments* unfold, and how they can support equitable, sustainable, and resilient UEI design outcomes. We surveyed students, researchers, and practitioners working in three different UEI-based designed experiment projects in Phoenix, Tempe, and Buckeye, Arizona. These projects are associated with undergraduate and graduate landscape architecture studio courses that utilized a research-service-learning structure in which researchers and practitioners paralleled the course. The surveys allow us to understand how existing knowledge produced by CAP LTER is being integrated into landscape architecture design content. Initial findings

reveal opportunities and challenges to this co-produced design approach. The findings provide direction for how urban ecological design co-production processes can better contribute to project efficacy for more equitable, sustainable, and resilient outcomes. Going forward, we will conduct semi-structured follow-up interviews to further investigate co-production dynamics and processes. We hope to refine our survey instrument to function as a reflexive feedback mechanism for future CAP LTER *Designed Experiment* projects.

Reference

Felson, A., and S. Pickett. 2005. Designed experiments: New approaches to studying urban ecosystems. *Frontiers in Ecology and the Environment* 4(3): 549-556.

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Stuhlmacher, M. F.¹, R. Goldblatt², M. Georgescu¹, N. Clinton³, B. Tellman¹, G. Hanson², and A. K. Khandelwal⁴. *30-meter resolution urban classification in Google Earth Engine.

Global representations of modern day urban land use and land cover (LULC) extent are becoming increasingly prevalent, yet considerable uncertainties in the representation of built environment extent (i.e., global classifications generated from 250-m resolution MODIS imagery or the United States' National Land Cover Database) remain because of the lack of a systematic, globally consistent methodological approach. We aim to increase resolution, accuracy, and improve upon past efforts by establishing a data-driven definition of the urban landscape, based on Landsat 5, 7 & 8 imagery and ancillary data sets. Continuous and discrete machine learning classification algorithms have been developed in Google Earth Engine (GEE), a powerful online cloud-based geospatial storage and parallel-computing platform. Additionally, thousands of ground truth points have been selected from high resolution imagery to fill in the previous lack of accurate data to be used for training and validation. We will present our 2013 classification in comparison to the existing urban area classifications (i.e., MODIS MCD12Q1, NLCD, DMSP-OLS). Our more accurate, high resolution approach has direct implications for development of projected urban growth that is grounded on realistic identification of urbanizing hot-spots, with consequences for local to regional scale climate change, energy demand, water stress, human health, urban-ecological interactions, and efforts used to prioritize adaptation and mitigation strategies to offset large-scale climate change. Future work to apply the built-up detection algorithm globally and yearly is underway in a

partnership between Google, Columbia University, the University of California in San Diego, and Arizona State University.

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Votaw, A. *Providing tools for increased participation and improved sustainable practices to the Phoenix metropolitan community through environmental education.

As the impact of human behavior on the planet's ecosystems becomes increasingly clear, significantly more focus is being devoted to the field of sustainability. Key to this field is the understanding of how people interact with their local environments and how those interactions can be adapted to reduce human impacts regionally, continentally, and even globally. A society lacking in a basic understanding of how the environment works is unlikely to meaningfully change its behavior in response to sustainability recommendations. With funding from CAP LTER, Ecology Explorers aims to educate the Phoenix community about the ecology of a desert city and the real world issues a city in the desert must face. Through afterschool curricula, outreach activities at community events, and hosting field trips for local schools, Ecology Explorers is an educational tool for the Phoenix community starting at a young age and continuing into late adulthood. Aside from in-person learning, Ecology Explorers also provides an extensive lesson plan database and other online resources to help assist educators in classrooms across the country. Ecology Explorers has reached thousands of people through its educational resources with hopes of creating a better informed and more environmentally active generation of citizens.

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Wang, C.¹, C. Wang², S. W. Myint², and Z-H. Wang¹. *Spatial and temporal variability of satellite-based aerosol optical depth in the dynamic urban environment.

Elevated concentration of atmospheric aerosols during severe urban air pollution episodes necessitates a deep understanding of the underlying determinants for a sustainable urban environment. The 15-year (2001–2015) Moderate Resolution Imaging Spectroradiometer (MODIS) aerosol optical depth (AOD) data for the Phoenix and Los Angeles metropolitan areas were applied to examine the spatio-temporal patterns and dynamics of

urban aerosols. The strongly correlated temporal trends of AOD were observed due to the similar seasonal pattern of aerosol emissions and potential synoptic connections between two areas. Relatively higher mean value and lower decreasing trend of AOD were found in the Phoenix Metropolitan Area (PMA). Correlations reveal that topography is the predominant factor affecting the spatial pattern of AOD, as compared to the urban land use and vegetation. The effect of urbanization on air pollution varies with preexisting landscape, which apparently alleviates aerosol concentration in the PMA. Vegetation mitigates air pollution despite its emission of fine mode aerosols. As a cross-validation, the ground-measured concentrations of particulate matters (PM_{2.5} and PM₁₀) were compared against AOD. The abnormal weak positive or strong negative AOD–PM_{2.5} associations result from the relatively small portion of anthropogenic aerosols and the changing atmospheric boundary layer height.

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Wheeler, M. M.¹, S. L. Collins², N. B. Grimm¹, C. Clark³, R. A. Sponseller⁴, and S. J. Hall¹. *Nutrient enrichment alters annual plant diversity in the northern Sonoran Desert.

Increased nitrogen (N) deposition threatens global biodiversity, but its effects in arid and urban ecosystems are not well studied. In deserts, annual plant communities make up most of the plant diversity, support wildlife, and are an important part of nutrient cycling and ecosystem functioning. We conducted an eleven-year nitrogen and phosphorus addition experiment in Sonoran Desert preserves around Phoenix, AZ to test how nutrient availability interacts with growing season precipitation to affect annual plant diversity. We hypothesized that higher nutrient availability would affect diversity only in years with high water availability, and that combined nitrogen and phosphorus addition would have the greatest effect. We compared winter annual diversity in nutrient addition treatments over time in desert preserves within and outside the Phoenix metropolitan area. Using a mixed modeling approach, we found that annual species richness significantly decreased with N addition ($p < 0.001$) and increased with water availability ($p = 0.002$). However, water availability did not affect the impact of N addition on annual plant richness. The similar response to N across the precipitation gradient indicates that when there is enough precipitation to stimulate annual germination, N is likely limiting. Annual diversity differed by region, with fewer species in desert preserves within than outside the city. This pattern may be due to high N deposition in the urban core or to other

urban effects. While increased N deposition has been considered of less concern in primarily water-limited ecosystems, these results indicate that desert diversity may be more threatened by N deposition than previously thought.

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Wright, M. K.¹, D. M. Hondula¹, L. Wilson², L. C. Kurtz², L. E. Watkins¹, P. C. Chakalian², K. L. Larson¹, and S. L. Harlan³. *Degrees of desire: Household preferences are key determinants of indoor temperatures in Phoenix.

Exposure to extreme heat is hazardous to human health, particularly during prolonged heat events. Heat mitigation and adaptation strategies are generally focused on outdoor thermal conditions, yet in the developed world, heat-related discomfort, injuries, and death often occur due to indoor heat exposure within private residences. Previous studies characterizing the indoor residential thermal environment mainly examine its relationship to physical factors, such as outdoor temperature, radiation, and building construction (e.g., material, orientation, window placement). Yet little attention has been paid to social and behavioral factors that may account for significant variance in indoor conditions within and between households, including access to and use of cooling resources, constraints on these resources, thermal preference, and demographic variables.

We have undertaken analysis of social and behavioral factors and their influence on indoor thermal conditions as part of the 3HEAT Project. 3HEAT is an NSF-supported interdisciplinary collaboration between researchers at Arizona State University, Georgia Tech, and University of Michigan. In summer 2016, we administered surveys to 163 Phoenix residents asking about their access to and use of cooling resources, constraints on these resources, thermal preference, and demographics. In a subset of 46 households, we continuously monitored indoor temperature and humidity for four weeks. Utilizing a combination of analysis techniques, including clustering analysis, cross tabulation, and bivariate correlation, we identify shared social and behavioral characteristics among households with similar temperature profiles. Deeper understanding of the household-scale circumstances and behaviors clarifies drivers of indoor temperature variability not easily captured by simple demographic indicators.

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Zhang, Y.¹, A. Middel^{2,3}, and B. L. Turner II^{1,3}. *Evaluating the effects of vertical urban forms on land surface temperature using Google Street View images.

The impact of vertical urban forms on land surface temperature has not been sufficiently addressed due to a lack of high-resolution urban form data. Incorporating the 3D environment in surface temperature assessments is important, because shading effects are only implicitly captured in bird's eye view remote sensing data. Google provides an immense collection of Street View images, enabling city-wide fine-scale urban form measurements to address vertical urban form dimensions where Lidar data are lacking or insufficient.

This study employs a novel 3D urban form metric derived from segmented 360° Google Street View imagery to examine the impact of vertical urban structures, i.e. buildings and trees, on surface temperature variations. In contrast to traditional bird's eye view remote sensing data, the 3D metric represents a human-centric view within street canyons, corresponding to how pedestrians experience cities, which is critical for health impact assessments and street-level landscape design. We first compare the 3D urban form metric to traditional 2D land cover fractions derived from classified National Agriculture Imagery Program (NAIP) data, discussing differences and similarities at the local scale. We then examine their combined effects on land surface temperature variations. Findings will facilitate optimal designs of urban landscape with regard to configuration and composition of vertical urban features to reduce the UHI effect and increase summertime outdoor thermal comfort in cities worldwide.

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Zhao, Q., D. J. Sailor, and E. A. Wentz. *Impact of tree locations and arrangements on outdoor microclimates and human thermal comfort in an urban residential environment.

Trees serve as a valuable asset in the urban built environment. In the arid city like Phoenix, trees are one of the primary urban green infrastructures to ameliorate extreme heat stress. Because of the cost of water and space in the desert residential environment, designing the optimal tree arrangement to

maximize the overall thermal benefits for the residential neighborhood, is significant and necessary. In this research, we first simulated a real neighborhood with current tree arrangement in ENVI-met, and validated the reliability of ENVI-met models by comparing the simulated results with the car-based air temperature transects. Further, we evaluated and compared the differences of outdoor microclimates and human thermal comfort by simulating different tree layouts (cluster, equal interval, or disperse) in the same neighborhood. Tree benefits at individual building scale and neighborhood scale are also compared and discussed. The simulation results showed that an equal interval two trees arrangement provides the most microclimate and human thermal comfort benefits in the neighborhood due to the importance of shading in the hot arid desert environment, following by cluster tree arrangement without canopy overlap. These findings will help policy makers and urban planners offer better guidelines for planting and establishing residential trees to mitigate extreme heat in the hot arid residential environment.

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