Table 1

Bibliographic Reference	Abstract	Key Contributions	Review Comments
Abraham, S. et al. 2020. Sustainable Landscapes in California: A Guidebook for Commercial and Industrial Site Managers. Pacific Institute, Oakland, CA.	The guidebook is intended for site managers of commercial and industrial properties interested in adopting sustainable landscape practices. This includes those involved with the day- to-day operations of the site, such as a facility manager, or those involved in operations or sustainability at the corporate level.	Targeted guidebook for on-the-ground professionals.	
Alliance for Water Efficiency. 2013. Conservation Limits Rate Increases for a Colorado Utility. allianceforwaterefficiency.org	The City of Westminster, CO, story of greatly reduced costs due to the embrace of water efficiency.	Reduced water use in Westminster since 1980 has resulted significant savings in both water resource and infrastructure costs, saving residents and businesses 80% in tap fees, and 91% in rates compared to what they would have been without conservation. The cheapest water (by far) is the water we already have and the best way to keep rates and tap fees low is to conserve the water we already have.	Case study on the opportunities available through efficiency, and the importance of looking at the full urban water system.
Alliance for Water Efficiency. 2015. Water Offset Policies for Water-Neutral Community Growth. allianceforwaterefficiency.org	Water demand offset policies require action on the part of developers to ensure that construction of new developments does not result in an increase in overall water demands.	Walks through the elements of water offsets: determining water demand of new development; method for estimating savings from new efficiencies to be installed; water demand offset ratio (how much new efficiency will offset potential new demand. ration usually greater than 1:1 for some measure of safety).	A literature review and case study compilation on the use of offset methodologies for community growth and conservation.
Alliance for Water Efficiency. 2015. A review, analysis, and synthesis of published and pending research on outdoor water use and water savings. AWE, Chicago, IL.	This report summarizes the work of the AWE Outdoor Water Savings Research Initiative. Phase 1 is a review, analysis, and synthesis of published research on outdoor water use and water savings. In particular, studies that documented water savings were sought.	.Outdoor water savings are achievable and can be significant. .Quantifying water savings from outdoor programs and measures is challenging. .Reporting of outdoor water savings in research varies and there is a lack of geographic and climate variability in the research. .Cost savings are rarely documented. .Standardized approaches and methods for measuring and evaluating outdoor water efficiency programs are needed.	Comprehensive look at water and landscape research to date.
Alliance for Water Efficiency. 2018. Market Analysis and Recommendations: Landscape Transformation. allianceforwaterefficiency.org	What are customers landscape preferences and what drives customers to change their landscape?	This report provides analysis and insight regarding the barriers to landscape transformation in the single-family market.* Key customer survey takeaways. * Key program takeaways.	Clearly presented information on landscape programs, with details from cities around the country.
Alliance for Water Efficiency. 2019. Sustainable Landscapes: A Utility Program Guide. allianceforwaterefficiency.org	This guide leverages these specific insights, lessons, and considerations gathered in AWE’s Landscape Transformation Study to provide actionable information for utilities beginning or enhancing outdoor water efficiency programs.	1. First, general considerations for outdoor landscape programs are outlined. …broadly applicable to an array of programs. 2. Second, considerations for specific types of outdoor landscape programs are discussed. They include turf removal, rebates and incentives, free materials, and customer education. Specific advice and examples are provided for each program category. * Case Studies.	Clearly presented information on landscape programs, with details from cities around the country.
Alliance for Water Efficiency. 2022. Increasing the Value of Water Efficiency with Stacked Incentive Programs. allianceforwaterefficiency.org	Reviewing cases where stacked incentives have worked to broaden participation and increase program effectiveness.	Measured performance of combined water quantity and water quality programs in San Diego, CA and Austin, TX	Important foundational work in a growing field.
American Planning Association. 2022. Planning for Urban Heat Resilience, PAS Report 600. APA, Chicago, IL.	As the effects of climate change are already being felt, we must urgently plan our cities to better support equitable human thermal comfort in communities today and in the future. This critical text shows us how.	The report lays out the complexity of heat, outlines the role of planners in equitably addressing heat, and presents a framework for how planners can mitigate and manage heat across a variety of plans, policies, and actions.	

Andrade, R. et al. 2021. Landscaping preferences influence neighborhood satisfaction and yard management decisions. Urban Forestry & Urban Greening 59, April 2021.	Here, we test the social-ecological dynamics of landscape preferences, satisfaction with trees and desert plants, and management intensity in residential yards and neighborhoods throughout the desert city of Phoenix, Arizona, USA.	Neighborhood satisfaction increased with xeric landscaping and proximity to the desert. * The effects of desert landscapes are positive irrespective of landscaping preference. * Satisfaction was positively associated with yard management intensity for people with mesic landscaping preferences. * People living in neighborhoods with the highest levels of satisfaction also intensively managed their yards.	Understanding demographics in the urban landscape ecosystem in Phoenix, AZ.
Atwater, P. et al. 2016. Transforming how water is managed in the West. Bloomberg Data for Good Exchange Conference. 25-Sep-2016, New York City, NY, USA.	The California Data Collaborative is a coalition of municipal water utilities serving ten percent of California's population who are delivering on that promise by centralizing customer water use data in a recently completed pilot project.	This project overview describes tools that have shown promising early results in improving water efficiency programs and optimizing system operations. Longer term, these tools will help navigate future uncertainty and support water managers in ensuring water reliability no matter what the future holds.	Foundational work in the new era of big data, as applied to urban water systems, and water efficency.
Baerenklau, K.A. et al. 2013. Do Increasing Block Rate Water Budgets Reduce Residential Water Demand? A Case Study in Southern California. Water Science and Policy Center, Working Paper 01-0913,University of California, Riverside.	This study investigates the effect of introducing a fiscally neutral increasing block-rate water budget price structure on residential water demand.	We estimate demand was reduced by at least 18 per cent, although the reduction was achieved gradually, over 3 years. * Additional information: how different subpopulations responded; compare alternative rate structures efficacy vs the water budget approach.	An important contribution to the literature on the use of water budgets by urban water providers.
Baldi, D. S. et al. 2022. Native plant gardens support more microbial diversity and higher relative abundance of potentially beneficial taxa compared to adjacent turf grass lawns. Urban Ecosystems 2023.	Native plant communities within urban ecosystems increase abundance and diversity of insects and insectivo- rous birds, but less is known about how native gardens could impact underlying soil bacterial communities. In this study, we identified 13 sites in the Omaha/Lincoln, Nebraska, USA area with native plant gardens that were converted from turf grass.	We found several potentially beneficial bacterial taxa to be more abundant in native garden soil than in adjacent turf. These findings suggest that conversion of turf grass to native gardens could improve ecosystem services associated with soil bacterial diversity such as increased carbon sequestration, phosphate dissolution, and soil reduction of nitrous oxide.	Research on the soil-water-landscape relationship in urban settings.
Barnes, M. R. et al. 2018. Public land managers and sustainable urban vegetation: The case of low-input turfgrasses, Urban Forestry & Urban Greening 29, 284-292.	Little is known about urban public land managers' perceptions and beliefs about low-input turfgrass (e.g. fine fescue species) and their willingness to encourage such environmentally sustainable practices for public lands or support low-input vegetation conversion programs for private re- sidential yards in their cities.	Overall managers showed favorable views towards low-input turfgrasses suggesting an interest in conversion to more sustainable management. Also, they demonstrated significant support of municipal programs to convert both public and private lands to low- input turfgrasses.	Research on understanding and support of public land managers.
BBC Research & Consulting. 2023. Exploratory Analysis of Potential Water Savings, Costs and Benefits of Turf Replacement in Colorado. BBC Research & Consulting, Denver, CO.	● How much non-functional turf exists in Colorado?● What is the realistic water savings potential for Colorado? ● What are the realistic costs associated with turf removal in Colorado? ● What are the tools that should be employed to maximize outdoor water savings? ● What other elements must be considered when planning a turf replacement program? ● What are the data gaps and potential to refine data for future analyses?	Irrigated turf in Colorado is estimated here to be approximately 100,000 acres but could be less or more - better data is needed * Non functional turf removal has the potential to save approximately 10,000 - 20,000 acre feet a year… * water budget rates could save 5 times more water at a cost 20 times lower per acre foot than turf replacement rebates.	A state-supported study of the turf removal opportunities in Colorado/
Belanger, Andrew. 2022. Southern Nevada Eliminating Nonfunctional Grass. Journal of the American Water Works Association, October 2022.	A federal water shortage declaration prompted the Southern Nevada Water Authority (SNWA) to work with state legislators to pass a bill prohibiting irrigation of "nonfunctional turf" in the Las Vegas Valley by the end of 2026 (AB356). SNWA formed an advisory panel of community stakeholders to formally define functional and nonfunctional turf and make recommendations for implementing the new law.	The advisory panel submitted a set of recommendations that was unanimously approved by SNWA's board of directors in January 2022, including detailed definitions of both Non-Functional Turf, and Functional Turf.	Short review of one jurisdictions approach to managing the water and landscape issue.
Berger, L., Henry, A.D, and Gary Pivo. 2020. Integrated water management recommendations in practice: coexistence of old and new ways in Arizona. Water Policy 22, 501-518.	Integrated water management (IWM) is widely regarded as a key strategy in achieving a variety of urban sus- tainability goals. Despite the promise of this strategy, however, uptake of IWM practices has generally been slow. A central reason for this lies in the divergence of action recommendations in the literature and actual water management praxis. In this paper, we explore how action taken by governments relate (or not) to IWM dimensions found in the literature.	We find that governments in the state systematically use IWM strategies to complement or enhance traditional water management approaches. Uptake differs across management spheres in terms of magnitude and form and is informed by contextual characteristics. Overall, our study indicates that transition may be guided by bottom-up experimentation, context-sensitive selection, and incremental change. This is in contrast to how IWM is often understood in the literature – as sharp shift and break with old traditions.	Important review of the differences in theoretical water management and that of practice.

Blount, K. et al. 2021. Satellites to Sprinklers: Assessing the Role of Climate and Land Cover Change on Patterns of Urban Outdoor Water Use. Water Resources Research 57.	The current work adapts a remote sensing-based methodology to estimate growing season irrigation rates at the census block group scale in Denver, Colorado.	Results show that city-wide outdoor water use does not change significantly from 1995 to 2018, while per capita water use and total water use significantly decrease from 2000 to 2018. Because total water use, but not outdoor use, is decreasing, the percent of water used outdoors significantly increases across the city from 2000 to 2018. Climate variables account for one-quarter of interannual variation in mean irrigation rates due primarily to changes in temperature, not precipitation.	Remote sensing opportunities to measure and manage. The increasing proportion of water used for irrigation highlights the importance of outdoor demand management for urban water systems as indoor efficiencies improve.
Brelsford, C. and J. K. Abbott. 2021. How smart are 'Water Smart Landscapes'? Journal of Environmental Economics and Management 106.	Understanding the effectiveness of alternative approaches to water conservation is impera- tive for ensuring the security and reliability of water services for urban residents. We analyze data from one of the longest-running "cash for grass" policies – the Southern Nevada Water Authority's Water Smart Landscapes program – where homeowners are paid to replace grass with desert landscaping. We use a sixteen year long panel dataset of monthly water consumption records for 300,000 homes in Las Vegas, Nevada.	We estimate the average water savings per square meter of turf removed with an event study and a panel difference-in-differences approach. We find that participation in this program reduced the average treated home's consumption by 20 percent. We find no evidence that water savings degrade as the landscape ages. Depending on the assumed time horizon of benefits from turf removal, we find that the Water Smart Landscapes program cost the water authority about $1.88 per thousand gallons of water saved, which compares favorably to alternative means of water conservation or supply augmentation.	Robust economic evaluation of the longest-running 'cash for grass' program.
Brooks, Andrew and Robert A. Francis. 2019. Artificial lawn people. ENE: Nature and Space Vol. 2 (3) 548-564.	We investigate how the cultural use of domestic lawns has extended into the creation of non-living artificial lawns and how the environmental values of these new landscapes are debated. (through online discourse).	We identify three topics: (i) emotional responses: artificial grass is polarising, and its social value contested; (ii) bio-physical affects: plastic fibres impact human and non-human life and (iii) environmental values: turfgrass replacement influences local and global political ecologies.	Interesting look at the demographic dynamics of urban landscapes, with a focus on artificial turf.
California Water Efficiency Partnership. 2018. Watershed Approach to Landscape Design. CALWEP, Sacramento, CA; Association of Professional Landscape Designers, CA Chapter; Surfrider Foundation, CA.	If we want California landscapes that are truly resilient to changes in climate and ecosystems, we need to go beyond sustainable and water wise principles to begin managing each property as though it were a mini-watershed. By paying attention to the design of the garden, building soil and keeping rain on our properties, selecting climate-appropriate plants and managing supplemental irrigation, we transform our landscapes into abundant watershed wise enhancements to our properties and neighborhoods.	Clear description of the physical elements to engage in creating climate-friendly landscapes in CA. Written by the Green Gardens Group, CA.	
California Water Efficiency Partnership. 2020. The Multiple Benefits of Water Conservation: Defining the environmental and social benefits of landscape transformation programs. CWEP/AWE, Sacramento, CA.	a literature review on the various social and environmental benefits attributed to urban water conservation. In particular, CalWEP sought information on benefits attributed to a specific water management strategy: turf replacement programs (also known as landscape transformation programs).	Develop an appreciation for the breadth of multi- benefits, both environmental and social, associated with landscape transformations; Integrate benefits into water management multi-benefit decision making frameworks; Improve landscape transformation program pitches to increase uptake by hard-to-reach customers, including the CII sector;	Good information for program planners looking at increasing the participation in, and effectiveness of, landscape transformation efforts.
Campbell, P. et al. 2020. 2020 Report: Research and Strategies for Landscape-Based Climate Change Resilience in Boulder, CO. MENV Capstone Project, Department of Environmental Studies, University of Colorado-Boulder.	City of Boulder's planners and policy makers recognize that urban ecosystems are a resource for climate mitigation and an asset for enhanced community resilience against threats such as increased high heat days, intensified drought and flood, or growing wildfire risk. Understanding how landscape management can be leveraged for environmental and human well being is a key piece to Boulder's climate action.	The major aspects of our project were to (1) understand the value and potential of changing landscapes to address socio-ecological issues (2) analyze the levers and opportunities the City of Boulder may use to achieve more widespread change in landscaping practices, and (3) assess the opportunities and challenges of supporting a sustainable landscape economy to implement these programs.	

Center for Regenerative Solutions. 2021. Introduction to Ecosystem-based Carbon Management Opportunities in Urban Landscapes. Urban Sustainability Directors Network. https://naturebasedclimate.solutions/resource-database/intro-ecosystem-based-carbon-mgmt	Assessing carbon management opportunities is a process intended to complement a city's Climate Action Plan by focusing on its urban ecosystems and the opportunities they provide for sequestering carbon and utilizing the captured carbon to enhance critical ecosystem services they provide--enhanced shade, stormwater management, prevention of soil erosion, reduced pollution, biodiversity, food production, among many others.	There is growing recognition that ecosystems are one of our most valuable tools for massively scaling up rates of carbon sequestration across the globe. 1) To identify opportunities for carbon sequestration in urban landscape elements across the city; 2) Describe other ecosystem services that may be delivered by advancing these ecosystem-based carbon sequestration strategies; 3) Outline current methods and data requirements for quantifying these benefits; and 4) Discuss possible next steps for developing priority carbon sequestration projects.	A guide to urban landscape challenges and opportunities.
Chang, B. et al. 2021. Effects of urban residential landscape composition on surface runoff generation. Science of the Total Environment 783.	a 2-year continuous research project was conducted at the Urban Landscape Runoff Research Facility at Texas A&M University to evaluate rainfall capture and runoff volumes associated with several commonly used residential landscape types (including, St. Augustine grass Lawn, Xeriscaping, Mulch, Artificial Turf, and Sand-capped Lawn) and to characterize the flow dynamics of surface runoff in relation to rainfall intensity for each landscape.	Following the initial months of establishment, the effects of landscape type on runoff volumes were significant, with Artificial Turf and Xeriscaping generating greater runoff volumes than Mulch and St. Augustine grass Lawns for most runoff events, which is partially due to the low infltration rate of such landscapes. Overall, Artificial Turf and Xeriscaping showed the greatest cumulative runoff volumes (>400 L/m), whereas Water Efficient- Mulch, Sand-capped Lawn and St. Augustine grass Lawn had a significantly lower cumulative runoff volumes, ranging from 180 to 290 L,m.	Foundational information on urban landscape surface dynamics, vegetation, and water runoff.
Chang, B. et al. 2022. Short-term impacts of urban landscape conversion on surface runoff quality. Urban Ecosystems 2022, 25:1561-1576.	The objective of this 13-month study was to com- pare differences in stormwater runoff quality attributes among five commonly used urban residential mesocosms including established St. Augustinegrass lawn and four alternative residential mesocosms including xeriscaping, mulch, artificial turf, and sand-capped lawn.	Results demonstrated that export of nutrients via runoff, specifically N and P, were influenced by mesocosm type, at least during the initial year following renovation. Collectively, the findings of this study demonstrate that there is no one specific landscape that is best suited for mitigating runoff quality, but rather, alternative mesocosms should be selected based on local climate and environmental concerns.	Foundational information on urban landscape surface dynamics, vegetation, and water runoff.
Colorado Water Conservation Board. 2022. The Colorado Landscape Summit: Transformative Change for a Resilient Future. CWCB, Denver, CO.	Presentations from CO and around the west.	* Less turf in Colorado is generally better than more turf. * We need to develop more definitive data. * The most cost-effective way to reduce turf is to look to the future.	Great baseline information for the state of Colorado 2022.
Colorado WaterWise. 2022. The State of Water Conservation in Colorado: A review of public water systems. Denver, Colorado:. https://coloradowaterwise.org/The-State-of-Water-Conservation-in-Colorado.	This project brings together public water system data available from the State and newly collected survey data from 94 water providers. Through these data we explore how frequently conservation programs are implemented; which programs are believed to be the most successful; the most pressing needs of the water conservation community; and how conservation program effectiveness is being measured.	The findings and recommendations are intended to benefit water providers, the State, local governments, and water conservation organizations.	A review of the state of water conservation programs in one western state.
Denver Parks & Recreation. 2019. Landscape Typology Manual. Denver, CO. denvergov.org	Landscape Typology will help guide a new park and greenway aesthetic, along with a maintenance approach to move Denver toward data-driven decision making and the establishment of high functioning, low maintenance ecosystems.	Landscape Typology supports Denver's progress on goals established under the guiding principles laid out in Denver's Game Plan, including: * Making the parks system more resilient; * Managing resources to ensure long-term health of Denver's parks; and * Providing parks that reflect Denver's community and cultural identity.	Guidance for large landscape systems and the public realm.
Denver Parks & Recreation. 2022. Denver Parks & Recreation Water Management Plan. Denver, CO. denvergov.org	The Water Management Plan is designed to improve the resiliency of DPR's parks system… Safeguarding our investment in the physical resource base is a main priority. We must balance our love for these places with the new paradigm for our parks, continuing to value the heritage of our parks system while accepting the realities of Colorado's semi-arid climate and available water resources.	* A Strategic Water Shortage Response Plan * Parks Irrigation Technology * Parks Irrigation Management Operations * Parks Design Guidelines and Standards * Parks Horticulture Renovation Program * Alternative Water Sources and Water Rights Portfolio. * DPR Facilities Operations	A look at one cities integration of water and landscape resources.

Donovan, G. H. et al. 2022. The association between tree planting and mortality: A natural experiment and cost-benefit analysis. Environment International 170.	Several recent longitudinal studies have found that exposure to the natural environment is associated with lower non-accidental (human)mortality. …we used a natural experiment to assess the impact of 30 years of tree planting by the nonprofit Friends of Trees on non-accidental, cardiovascular, lower-respiratory, and accidental mortality in Portland, Oregon (mortality data were provided by the Oregon Health Authority).	Each tree planted in the preceding 1–5 years was associated with a reduction in mortality rate of −0.154 (95 % CI: −0.323, 0.0146), whereas each tree planted in the last 6–10 and 11–15 years was associated with a reduction in mortality rate of −0.262 (95 % CI: −0.413, −0.110) and −0.306 (95 % CI: −0.527, −0.0841) respectively. Using US EPA estimates of a value of a statistical life, we estimated that planting a tree in each of Portland's 140 Census tracts would generate $14.2 million in annual benefits (95 % CI: $8.0 million to $20.4 million). In contrast, the annual cost of maintaining 140 trees would be $2,716–$13,720.	Value of trees in promoting and maintaining urban health.
Environmental Protection Agency. 2014. WaterSense Water Budget Approach, Version 1.02 2014. EPA, Washington, D.C.	Guide for meeting the Landscape Design Criteria of the WaterSense New Home Specification.	A tool outlining the specific elements of a water-wise landscape.	A reference work for many applications.
Francoeur, X. et al. 2021. Complexifying the urban lawn improves heat mitigation and arthropod biodiversity. Urban Forestry and Urban Greening 60.	The objective of this paper is to compare the performance of lawns to three more complex types of recently established common low-height urban green infrastructures (LHGI) in relation to two ecosystem services: heat mitigation and habitat for biodiversity.	There were major differences in both surface temperature and arthropod morphospecies richness between lawns and the other three LHGI. Results showed that plant structure and diversity improved LHGI performance. This study shows that increasing plant structural complexity and/or diversity increases heat mitigation and habitat for arthropod biodiversity of LHGI. Given its extent in North America, complexifying the omnipresent urban lawns holds considerable potential for GI improvement.	Valuable contribution to the ecological understanding of urban landscapes and the Heat Issue.
Frietz, V. D. et al. 2018. Contrasting Urban Landscapes and Reduced Irrigation Engender Water Conservation in a Desert Environment. Sustainability 2018, 10, 624.	But even with a desert landscape, home owners often overwater, thereby reducing any water conservation possibility. This experiment was designed to demonstrate that plants can retain physiological health even when on reduced irrigation. Three 26.8-m2 plots each of two contrasting landscapes, designated as either traditional or desert, were installed in a desert environment using a pot-in-pot in-ground system. Plots were irrigated at 100% or 50% of evapotranspiration (ET) with either sprinklers (turf) or drip emitters (trees and shrubs) using a modified crossover design.	Midday stem water potentials (Ymd) for Arizona ash, Indian hawthorn and Cleveland sage exhibited seasonal differences. In Chinese pistache, Ymd remained stable when irrigation treatments were lowered from late spring/early summer to late summer. The plants used in this study recovered after two weeks of full (100% ET) irrigation suggesting that landscape managers could irrigate at 50% ET for a limited period (approx. four weeks) as a way to conserve water.	
Gillman, L. et al. 2023. Calling Time on the Imperial Lawn and the Imperative for Greenhouse Gas Mitigation. Global Sustainability 6, e3.	Mown grass or lawn is a ubiquitous form of vegetation in human-dominated landscapes and it is often claimed to perform an ecosystem service by sequestering soil carbon. If lawn maintenance is included, however, we show that lawns become net carbon emitters. We estimate that globally, if one-third of mown grass in cities was returned to treescapes, 310–1630 million tonnes of carbon could be absorbed from the atmosphere, and up to 43 tonnes of carbon equivalent per hectare of emissions could be avoided over a two-decade time span. We therefore propose that local and central governments introduce policies to incentivise and/or regulate the conversion of underutilised grass into treescapes.	If one-third of the lawn in urban areas could be converted to tree cover, we estimate that 0.31–1.63 Gt of carbon could be sequestered over two decades. The estimate might be ambitious, but even one-tenth of these figures would be substantial.	Large-scale review of the impact of lawns and possible mitigation.

Gober, P. et al. 2009. Using Watered Landscapes to Manipulate Urban Heat Island Effects: How Much Water Will It Take to Cool Phoenix?, Journal of the American Planning Association, 76:1, 109-121	The prospect that urban heat island (UHI) effects and climate change may increase urban temperatures is a problem for cities that actively promote urban redevelopment and higher densities. One possible UHI mitigation strategy is to plant more trees and other irrigated vegetation to prevent daytime heat storage and facilitate nighttime cooling, but this requires water resources that are limited in a desert city like Phoenix.	We found that increasing irrigated landscaping lowers nighttime temperatures, but this relationship is not linear; the greatest reductions occur in the least vegetated neighborhoods. A ratio of the change in water use to temperature impact reached a threshold beyond which increased outdoor water use did little to ameliorate UHI effects. .Takeaway for practice: There is no one design and landscape plan capable of addressing increasing UHI and climate effects everywhere. Any one strategy will have inconsistent results if applied across all urban landscape features and may lead to an inefficient allocation of scarce water resources.	Important to addressing the Heat Issue within the water and landscape field.
Green Business Certification, Inc. 2014. SITES v2 Rating System. Green Building Council, Washington, D.C.	A growing body of research suggests that natural elements within cities and other areas generate ecosystem services that can substantially protect and improve a community's resiliency and quality of life in a variety of ways and in a range of contexts.	The SITES v2 Rating System, and specifically its site-specific performance benchmarks, is based on the concept of ecosystem services; an understanding of natural processes; best practices in landscape architecture, ecological restoration, and related fields; and knowledge gained through peer-reviewed literature, case-study precedents, and SITES pilot projects.	Foundational rating system for healthy ecosystems.
Halper, E. et al. 2015. Effects of irrigated parks on outdoor residential water use in a semi-arid city. Landscape and Urban Planning,134, 210-220.	We investigate whether public park amenities act as a substitute for outdoor water use by single-family residential (SFR) households in semi-arid Tucson, AZ, USA. Specifically we account for the effects of a park's proximity, size, and greenness (measured by NDVI), as well as the presence of a public swimming pool. SFR households with and without home pools are analyzed separately.	• Outdoor water use is influenced by park conditions within 8 km (5 miles). • Park proximity, greenness (NDVI) and public pools affect residential outdoor water use. • Responses varied between households with and without home pools.	Important community aspects to the water and landscape management field. . NDVI = normalized difference vegetation index (USGS) for understanding vegetation density and plant health
Hartin, J. et al. 2022. Lawn Removal Motivation, Satisfaction, and Landscape Maintenance Practices of Southern Californians. HortTechnology 32 (1).	We conducted a web-based study of 1153 southern Californians who removed all or a portion of their lawns over the past 10 years to identify their motivation, satisfaction, landscape water use, and related maintenance practices.	Results indicate that rebates were less important for most respondents than the desire to conserve water, improve landscape appearance, and reduce costs. There was a high correlation between the overall satisfaction with the lawn replacement process and the appearance of transformed landscapes, supporting earlier fndings regarding the importance consumers place on landscape appearance. A need for continuing landscape education by water providers and Extension services was also mentioned.	Important information on social preferences, specifically related to the turf removal programs of the Metropolitan Water District of Southern California of 2014-2016.
Hayden, L. et al. 2015. Residential landscape aesthetics and water conservation best management practices: Homeowner perceptions and preferences. Landscape and Urban Planning 144, 1-9.	With increasing water scarcity, changing the landscape preferences and choices of individual homeowners provides a crucial opportunity for water conservation. Using three demonstration landscapes varying in water conserva- tion best management practices (BMPs), we surveyed attendees of a University of California Cooperative Extension educational event to determine preferences for the demonstration landscapes according to aesthetics as well as other preference criteria. The survey examined aesthetic preferences for BMPs at both the whole landscape level and the landscape component (turf, paving, non-turf vegetation) level whereas other preference criteria were examined only at the whole landscape level.	Preference for the landscape with an intermediate amount of BMPs was the highest at the whole landscape level for nearly all criteria. Surprisingly, at the component level, homeowners exhibited preference for the more water conserving components. This indicates that BMPs are aesthetically appealing individually but when BMPs exist for every component in the landscape, the landscape is less preferred.	Important information on social preferences.
Heavenrich, H. and S.J. Hall. 2016. Elevated soil nitrogen pools after conversion of turfgrass to water- efficient residential landscapes. Environmental Research Letters 11.	However, little is known about the long- term biogeochemical consequences of this increasingly common land cover change (conversion from turf to climate-adapted landscapes) across diverse homeowner management practices.	Our findings show that transitioning from turfgrass to water-efficient residential landscaping can lead to an accumulation of NO3-–N that may be lost from the plant rooting zone over time following irrigation or rainfall. These results have implications for best management practices to optimize the benefits of water-conserving landscapes while protecting water quality.	Important work on the larger ecosystem changes resulting from urban landscape conversions.

Hess, David J. et al. 2017. Measuring Urban Water Conservation Policies: Toward a Comprehensive Index. Journal of the American Water Resources Association, Vol. 53, No 2.	Existing approaches to measuring urban Water Conservation Policies (WCP) in U.S. cities are limited because they consider only a portion of WCPs or they are restricted geographically. The Vanderbilt Water Conservation Index (VWCI) consists of a more comprehensive set of 79 observations classified as residential, commercial/industrial, billing structure, drought plan, or general.	* Detailed list of 79 measures for comprehensive water conservation program. *…we argue the measurement of WCPs is still in its infancy, and our approach suggests strategies for improving existing methods.	Rare analysis of water conservation policies in the U.S.
Howard, M. et al. 2022. Quantifying urban tree canopy interception in the southeastern United States. Urban Forestry and Urban Greening 77.	An often overlooked, yet integral, component of green infrastructure (GI) is urban tree canopy, which functions as GI through the process of rainfall interception. Nine trees from three native species commonly found in urban areas in the southeastern United States were studied in three parks in Knoxville, TN, USA to quantify interception.	Annually, red maples, white pines, and willow oaks intercepted 24.4%, 52.4%, and 33.2% of gross throughfall, respectively. Seasonally, white pines performed the most consistently with interception varying only from 49.2% to 57.0% between seasons compared to an interception range of 13.2–39.7% and 17.5–54.2% for red maples and willow oaks, respectively.	Addition to the literature on the important role of urban trees in stormwater management.
Ignatieva, M. et al. 2020. (Opinion) Lawns in Cities: From a Globalised Urban Green Space Phenomenon to Sustainable Nature-Based Solutions. Land 2020, 9, 73.	One of the core objectives of this paper is to share a paradigm of nature-based solutions in the context of lawns, which can be an important step towards finding resilient sustainable alternatives for urban green spaces in the time of growing urbanisation, increased urban land use competition, various user demands and related societal challenges of the urban environment.	We hypothesise that these solutions may be found in urban ecosystems and various local native plant communities that are rich in species and able to withstand harsh conditions such as heavy trampling and droughts.	High level view, with a good bibliography.
Johnson, Dane. 2017. Multiplier Effect Study for Turf Removal-2016 Update. Irvine Ranch Water District, CA. CA-NV AWWA Spring 2017 Conference.	Looking closely at the multiplier effect in one agencies turf removal program, using data analysis, surveys, and Google street view.	Multiplier of 1.14: every 7 rebate participants = 8 non-rebate participants.	More information for consideration with ‘cash for grass’ programs.
Khachatryan, H. et al. 2020. Landscape Aesthetics and Maintenance Perceptions: Assessing the Relationship between Homeowners’ Visual Attention and Landscape Care Knowledge. Land Use Policy 95.	Understanding how consumers view low input landscapes is an important component when developing policies to encourage installation of more environmentally friendly options. The purpose of this study was to quantify homeowners’ perceptions of and visual attention to different landscape designs.	Overall, visual appeal was highest for hetero- geneous landscapes (i.e. incorporating both turfgrass and plants) and lowest for homogenous landscapes (i.e. primarily composed of turfgrass or plants). Homeowners with more knowledge about landscape care viewed the landscapes as more visually appealing and requiring less maintenance than participants with less knowledge. Greater visual attention was positively correlated with increased visual appeal and maintenance ratings. Overall, results imply that landscape ordinances that allow #exibility in incorporation of both turfgrass and ornamental plants optimizes visual appeal of landscape options and attract homeowners. Furthermore, emphasizing the reduced maintenance requirements of low input landscapes could encourage homeowner adoption.	Important information on social preferences.
Kiers, A.H. et al. 2022. Different Jargon, Same Goals: Collaborations between Landscape Architects and Ecologists to Maximize Biodiversity in Urban Lawn Conversions. Land 2022, 11, 1665.	Landscape architects and ecologists alike are embracing the opportunities urban areas present for restoring biodiversity. Despite sharing this goal, their efforts are rarely coordinated. For landscape architects, aesthetics and programming are at the forefront of design and must be given substantial attention, while ecologists look to scientific research to guide their decision-making.	We discuss specific situations in which design priorities can be aligned with ecological function and propose that more attention should be placed on traditional principles of garden design, including perception, complexity and repetition, rhythm and order, proportion and scale, and form and structure. Finally, we argue that each new urban lawn conversion presents an opportunity to test ecological theory at the site-scale, conduct much-needed research on the impacts of design principles on habitat potential, and promote a collaborative urban ecological design aesthetic.	Overview of the intersection of professionals working on urban ecosystems.

Kindler, M. et al. 2022. Water conservation potential of modified turf grass irrigation in urban parks of Phoenix, Arizona. Ecohydrology 15, 3.	In this study, we conducted an ecohydrological monitoring and modelling effort for a compost experiment in two urban parks with either flood or sprinkler irrigation. Soil moisture, evapotranspiration and turf greenness data along with a soil water balance model were used to determine if compost treated plots were different from control plots in each park.	Multiple lines of evidence indicated that green waste compost applications did not appreciably change soil moisture or vegetation conditions in either urban park. Major differences, however, were noted between the two irrigation practices in terms of the seasonality of the soil water balance, plant water stress and the sensitivity to interannual fluctuations in precipitation. Model scenarios showed that significant irrigation reductions from 15% to 30% could be achieved, in particular with small changes in watering depths.	Research on modeled savings from various. irrigation methods
Kroeger, T. et al. 2018. Where the people are: Current trends and future potential targeted investments in urban trees for PM10 and temperature mitigation in 27 U.S. Cities. Landscape and Urban Planning 177, 227-240.	Urban trees reduce respirable particulate matter (PM10) concentrations and maximum daytime summer temperatures. We map potential tree planting sites in the 27 cities and use our local-level PM10 and heat mitigation methods to assess the population-weighted return on investment (ROI) of each site for PM10 and heat abatement for nearby populations.	Consequently, all the studied cities offer opportunities for tree cover increases with a high ROI for PM10 and heat abatement. These are generally sites in more densely populated areas where more people would benefit from the increased ecosystem service provision.	Important research on the positive effect of urban trees on both the Heat Issue, and air quality.
Lachapelle, J. et al. 2023. Maximizing the pedestrian radiative cooling benefit per street tree. Landscape and Urban Planning 230.	Radiation loading, as quantified by mean radiant temperature (TMRT), is a key factor driving poor thermal comfort. Street trees provide shade and consequently reduce pedestrian TMRT. However, placement of trees to optimize the cooling they provide is not yet well understood. We apply the newly-developed TUF-Pedestrian model to quantify the impacts of sidewalk tree coverage on pedestrian TMRT during summer for a lowrise neighbourhood in a midlatitude city.	Importantly, planting a shade tree on a street where none currently exist provides approximately 1.5–2 times as much radiative cooling to pedestrians as planting the same tree on a street where most of the sidewalk already benefits from tree shade. Thus, a relatively equal distribution of trees among sun-exposed pedestrian routes and sidewalks within a block or neighbourhood avoids mutual shading and therefore optimizes outdoor radiative heat reduction per tree during warm conditions.	Modeling to optimize street tree benefits in addressing Heat Issues.
Larson, K. L. et al. 2017. Legacy effects and landscape choices in a desert city. Landscape and Urban Planning 165, 22-29.	Focusing on the semi-arid metropolis of Phoenix, Arizona, this paper examines residents' actual and preferred landscapes for both front and back yards; . This paper provides an original analysis of how legacies in the Phoenix region—including local landscape traditions and development history—affect yard choices.	Long-term residents, not commonly blamed newcomers, more often chose grassy landscapes. Residents of older neighborhoods also choose grassier landscaping compared to residents in newer areas.	Research into the many demographic variations affecting landscape transformation in urban areas in the West.
Larson, K. L. et al. 2020. Municipal regulation of residential landscapes across US cities: Patterns and implications for landscape sustainability. Journal of Environmental Management 275.	Across six U.S. cities, we analyzed 156 municipal ordinances to examine regional patterns in local landscape regulations and their implications for sustainability. Specifically, we conducted content analysis to capture regulations aimed at: 1) goals pertaining to conservation and environmental management, aesthetics and nuisance avoidance, and health and wellbeing, and 2) management actions including vegetation maintenance, water and waste man- agement, food production, and chemical inputs.	While regulatory goals stress stormwater management and nuisance avoidance, relatively few municipalities explicitly regulate residential yards to maintain property values, mitigate heat, or avoid allergens. Meanwhile, biological conservation and water quality protection are common goals, yet regulations on yard management practices (e.g., non-native plants or chemical inputs) sometimes contradict these purposes. As a whole, landscaping ordinances largely ignore tradeoffs between interacting goals and outcomes, thereby limiting their potential to support landscape sustainability. Recommendations therefore include coordinated, multi-objective planning through partnerships among planners, developers, researchers, and non-government entities at multiple scales.	Status of landscape ordinances in the U.S., with attention to attributes promoting sustainability.
Lee, Jeff. 2019. Landscape Water Budget Program 2.0. WaterSmartInnovations.com	Review of HOA and commercial landscape program evolution.	Significant savings with optimal customer contact on a limited budget.	
Lincoln Institute of Land Policy. 2020. Working Paper WP20RQ1. Current Issues and Perspectives in Urban Water Demand Management: A Report on the 5th Urban Water Demand Roundtable April 8–9, 2019, Tempe, Arizona. Lincoln Institute of Land Policy, Cambridge, MA.	The Urban Water Demand Roundtable (UWDR) is a convening of practitioners, consultants, and academics engaged in water demand research. The UWDR was initially organized in 2012 by a group of water professionals and academics to fill a need for a forum with a higher level of dialogue about the ongoing and unexplored changes in urban water demand than could be found at existing national conferences and professional association events. This report was written to capture, organize, and communicate important and interesting insights, questions, and opinions expressed by participants in the 5th UWDR held April 8–9, 2019.	Key Themes: Economics and Sociology of Demand; Challenges to Estimating and Forecasting Demand; Balancing Community Values and Institutional Priorities. * Cross-cutting Themes: The Importance of Multiple Kinds of Scale; The Behavior and Values—Sociology and Psychology—of Urban Water Users; Integrating Land Use and Water Planning	A brief look at the state of water demand research themes.

Lincoln Institute of Land Policy. 2021. Working Paper WP21MD1. Examining the Water and Land Use Connection in Water Utility Planning Requirements: An Inventory of the Laws of all 50 States. Lincoln Institute of Land Policy, Cambridge, MA.	This project examined and evaluated the legal requirements for water utility plans in each of the 50 states, with a particular emphasis on how those plans intersect with land use policy and planning. The Alliance for Water Efficiency (AWE), together with the Environmental Law Institute (ELI), surveyed the statutes and regulations of each state and extracted the relevant sections for review and evaluation.	The information gleaned from this review was validated and deepened through case study interviews within six states, chosen based on their rigorous water utility planning requirements, history of working on land use and water integration, and geographic diversity. States of particular focus: California, Colorado, Connecticut, Florida, Minnesota, Washington. This research demonstrates that legal policies in all 50 states could be strengthened to require more coordination between water utility planning and local land use planning.	More detailed information on the growing connections between land-use and water-use planning in the U.S.
Lincoln Institute of Land Policy. 2021. Working Paper WP21CP1. Examining State Planning Enabling Laws Regarding Water Planning Requirements. Lincoln Institute of Land Policy, Cambridge, MA.	This report summarizes the methodology, findings, and implications of examining and evaluating the legal requirements for water provisions within comprehensive plans in each of the 50 states. Focus was given to planning requirements in statutory law, how these laws are implemented by local governments, and whether the statutes are compulsory or voluntary.	Six states were chosen for further analysis. The data collected from the six states was verified by conducting key-informant interviews with practicing planners working at the intersection of land use and water in those states. These interviews provided additional insights on land use-water integration, the challenges and drivers of land use-water integration and provided examples of communities that have successfully integrated land use and water. These states were chosen for their land use planning requirements, geographic diversity, whether the aggregate population lived within an urban or rural environment, and what the requirements were for water within comprehensive planning.	Detailed information on the state of land use and water use planning in the U.S. With more descriptive information on the states of Florida, Hawaii, Maryland, Pennsylvania, Utah, and Wisconsin.
Lincoln Institute of Land Policy. 2022. Working Paper WP22LG1. Urban Growth Boundaries for Watershed Health: Managing the Impacts of Peripheral Land Uses on Water Quantity and Quality. Lincoln Institute of Land Policy, Cambridge, MA.	This working paper considers how the common land use planning tool of establishing Urban Growth Boundaries (UGBs) can better integrate water management. Three case studies and mixed methods research serve an assessment of limitations and possibilities in this regard. UGB setting and water management practices are compared among the cities of Flagstaff, AZ, Fort Collins, CO, and Eugene, OR. By comparing cases, this working paper advances a novel inquiry into potential integration across planning tools. Current integration of water management and UGBs is mostly limited to mechanisms for reducing water demand. UGBs are more concerned with limiting sprawl, while water management tends to address specific threats by other means.	opportunities exist to incorporate assessments of the ecosystem services provided by rural land uses and their urban alternatives when deciding where urbanization should proceed. A context-specific index could be the basis of such an approach. The most promising way to improve long-term water supply may be quite like the mechanisms used to limit long-term water demand. Namely, an index or rating system should be operationalized for land use decision making. The UGB setting process is best suited to integrate information that can be easily compared across alternatives. This makes an index of watershed service value highly attractive for those who would like to see the UGB tool incorporate water management more effectively.	A review of a common land use tool applied to watershed health and long-term water quality and quantity.
Litvak, E. 2014. Adding trees to irrigated turfgrass lawns may be a water-saving measure in semi-arid environments. Ecohydrology 7, 1314-1330.	A detailed understanding of plot-scale ET and its sensitivity to plant species composition is necessary to improve estimates of urban water vapour fluxes and water balance. We used portable enclosed chambers and empirical equations to quantify ET from (1) unshaded urban lawns covered exclusively by turfgrass and (2) urban lawns comprised of open-grown trees and turfgrass groundcover in the Los Angeles Metropolitan area. Turfgrass at all locations had a non-limiting supply of soil water because of regular sprinkler irrigation.	ET of irrigated turfgrass reached a maximum of 10. 4 ± 1·3 mm/d and was always higher than plot- scale tree transpiration, which did not exceed 1 mm/d. Turfgrass ET was highly sensitive to solar radiation, and the ratio of ET of lawns with trees to ET of lawns without trees decreased with tree canopy cover. Hence, reductions in turfgrass ET caused by shading effects of open-grown trees were more important in influencing total landscape ET than the addition of tree transpiration. This suggests that low-density planting of trees that partially shade irrigated urban lawns may be a water-saving measure in semi-arid irrigated environments.	Fundamental research on the role of evaporation, shade, and vegetation palettes in semi-arid environments like LA.

Litvak, E. et al. 2017. Evapotranspiration of urban landscapes in Los Angeles, California at the municipal scale. Water Resources Research 53, 4236-4252.	We estimated ET of irrigated landscapes in Los Angeles by combining empirical models of turfgrass ET and tree transpiration derived from in situ measurements with previously developed remotely sensed estimates of vegetation cover and ground-based vegetation surveys. We modeled irrigated landscapes as a two-component system comprised of trees and turfgrass to assess annual and spatial patterns of ET.	Annual ET from vegetated landscapes (ETveg) was 1110 6 53 mm/yr and ET from the whole city (vegetated and nonvegetated areas, ETland) was three times smaller, reflecting the fractional vegetation cover. * Turfgrass was responsible for ~70% of ETveg. * ETland was linearly correlated with median household income across the city, confirming the importance of social factors in determining spatial distribution of urban vegetation.	Important physical measurement of landscape and water interactions in LA.
Local Government Commission. 2019. Bringing Water and Land Use Together. LGC, Smart Growth California, Funders' Network, S.D. Bechtel, Jr. Foundation.	Disregard for interconnected systems has led to segregation of land-use planning agencies and water management agencies statewide. Yet, there is a growing awareness and interest in alternative approaches, such as smart growth, integrated regional water management, green infrastructure and "multisolving."	The negative impacts of segregated and misaligned planning are not distributed evenly across California's communities. Integrating water management and land-use planning is critically important to the resilience of our state, but must be achieved through actions that enhance equity.	Sprawling scope of work, with some good analysis of the state of water and land integration across 5 California regions.
Mayer, P. et al. 2008. Water budgets and rate structures: Innovative management tools. Journal AWWA 100:5, May 2008. AWWA, Denver, CO.	A Growing number of utility managers are finding that water budgets offer potential benefits to water utilities and their customers in coping with increasing water scarcity and rising costs.	Different approaches to water budgets, benefits and challenges of each. * Potential use during drought. * Important steps in the implementation process.	Baseline report on the emerge, and status, of water budgets in the early 2000s.
Mayer, P. and R. Smith. 2017. Peak Day Water Demand Management Study. Alliance for Water Efficiency, Chicago, IL.	The objectives of the study were to: determine the viability of using remotely-controlled irrigation systems to reduce peak water demands and thus delay or avoid costly infrastructure, to test implementation methods, and to discover potential barriers for water providers who want to use the technology.	Irrigation programs were successfully interrupted and resumed normal operation the following day, demonstrating the ability to precisely target specific sites and dates to shave peak demands. Based on historic water use records of the participants, an estimated total of 84 kgal of peak demand reduction occurred on each day of interruption. The results of the analysis suggest that 1 MGD of irrigation reduction can be achieved with approximately 500 to 1,700 participants	Managing peak outdoor water demand at the neighborhood and community level.
Medina, E. et al. 2015. Water Conservation Efforts: An Evaluation of the "Cash for Grass" Turf Replacement Rebate Program in Los Angeles City Council District 3. Masters Thesis, UCLA Luskin Center for Innovation.	While there have been many reports analyzing the potential water savings that households could experience by converting their lawns to drought-friendly plants, few reports have analyzed the financial aspects of participating in this action.	For the average participant in CD3, the net out-of-pocket costs of participating in the turf replacement program is $2106 at the current $3.75 rebate level, which resulted in an average 73 percent net reduction in their outdoor watering consumption, saving an average of $627 annually, for a 3+ year payback.	A look at the costs and experiences of one subarea of Los Angeles participating in a 'cash for grass' program.
Meilinger, V. and J. Monstadt. 2019. Infrastructuring Gardens: The Material Politics of Outdoor Water Conservation in Los Angeles Annals of the American Association of Geographers, 113 (1) 206-224.	Water agencies started to subsidize the replacement of lushly irrigated lawns with CaliforniaFriendly landscapes, thereby endorsinga technology-centered "infrastructuring" of gardens to increase water conservation. This approach contrasts with California native plant gardening promoted by nature conservationists, which uses vernacular horticultural techniques to restore native plant biodiversity and reduce irrigation.	The article shows that each approach has important political implications for urban space and water use, the value accorded to nature and gardening work, and relations between citizens and experts. Analyzing the differences between these approaches, we critically interrogate Los Angeles's modern infrastructure regime that shapes water conservation policy.	Political ecology view of water systems, urban landscape, and society.
Metropolitan Water District of Southern California. 2015. Water Savings from Turf Removal. Michael Hollis. MET of Southern.. California, Los Angeles, CA.	… Metropolitan created the Turf Removal Program in January 2014. The program ended in November 2015. During its 23-month life, the program invested $315 million for financial incentives for about 63,500 replacement projects. The primary objective of this paper is to estimate the amount of water saved by the Turf Removal Program.	Subject to the qualifications discussed in the paper, the program is estimated to have saved an average 36.3 gallons per year per square- foot for residential properties, and an average 32.5 gallons per year per square- foot for non-single-family residential properties. Overall savings amounted to 34.4 gallons per year per square-foot.	Detailed analysis of very large turf replacement program, covering 4 distinct property types: single-family residential; duplexes, triplexes, and four-plexes; multi-family and common areas of HOAs; and, mobile home parks.
Metropolitan Water District of Southern California. 2020. The Waterwise Garden: Designed by Nature. Green Gardens Group, Metropolitan Water District of Southern California, Los Angeles, CA.	Landscape design, planning, and maintenance manual for the LA basin.		

Metropolitan Water District of Southern California.. 2022. One Water Committee, Conservation Program Update, Item 6a, June 28, 2022.	Program expenditures, activity, multiplier effect.	Update on these large scale LA-area programs. * For every 100 turf rebate participants, and additional 132 parcels converted their turf because of the program. * Less than 4% of sites reverted to turf after 5-8 years.	
Miller, D. et al. 2022. Vegetation cover change during a multi-year drought in Los Angeles. Urban Climate 43.	Here, we tracked changes in vegetation cover in Los Angeles, California using airborne hyperspectral imagery acquired annually from 2013 to 2018 and coinciding with the exceptional 2012–2016 California drought. Subpixel fractions for trees, turfgrass, non-photosynthetic vegetation (NPV; e. g., senesced plant material), and non-vegetated urban surfaces were mapped at 18 m spatial resolution using Multiple Endmember Spectral Mixture Analysis.	From 2013 to 2018, overall turfgrass cover decreased (−17%) and NPV cover increased (+22%). Tree cover was more stable but decreased in 2018 (−6%). The inland valleys consistently lost more turfgrass than coastal areas. Higher income and water use areas had larger absolute changes in vegetation cover, likely due to their higher baseline of vegetation cover.	Monitoring vegetation change due to droughts in LA.
Miller, D. et al. 2022. Seasonal and interannual drought responses of vegetation in a California urbanized area measured using complementary remote sensing indices. ISPRS Journal of Photogrammetry and Remote Sensing 183, 178-195.	While many studies have evaluated interannual vegetation drought responses, these responses to drought can be expressed diversely across seasons, especially in cities that regularly experi- ence seasonal drought (e.g., in Mediterranean climates). Here, we evaluated seasonal and interannual drought responses across the dominant types of urban trees and grasses in the Santa Barbara, California…	Our results provide insights into the sensitivity of major urban vegetation types to drought at a range of temporal scales and demon- strate how the complementary use of different remote sensing variables (NDVI, ΔLST, EWT) can improve the assessment of drought-induced changes in vegetation canopies. As cities undergo changing climate conditions, annual maps at a single time of year are unlikely to be suf- ficient to evaluate the breadth of potential impacts to ecosystem services from urban vegetation.	Fundamental research into urban vegetation and water dynamics.
Monteiro, R. et al. 2020. Green Infrastructure Planning Principles: An Integrated Literature Review. Land 2020, 9, 525.	an integrative literature review was conducted to identify which green infrastructure planning principles should be acknowledged in spatial planning practices to promote sustainability and resilience.	the most common eight green infrastructure planning principles were selected—connectivity, multifunctionality, applicability, integration, diversity, multiscale, governance, and continuity.	Definitions from a review of literature to serve a more consistent framework and vocabulary in urban ecosystem planning.
Morera, M. C. et al. 2019. Determinants of Landscape Irrigation Water Use in Florida-Friendly Yards. Environmental Management 65:19-31.	Efforts to mitigate outdoor water use in Florida's urban landscapes…require an understanding of mechanisms underpinning low irrigation use in single-family homes with Florida-Friendly Landscaping (FFL).	Aesthetic considerations, horticultural knowledge, and membership in a homeowner's association (HOA) with rules regarding yard care were key variables underlying landscape characteristics and maintenance, while property values, water conservation attitudes, lawn grass, and in-ground irrigation system use significantly predicted irrigation practices.	Important look at behaviors in landscape maintenance, and the factors underlying them.
Municipal Water District of Orange County. 2020. 2008 Urban Drought Assistance Grant: Water Budget Evaluation Study. MWDOC, Fountain Valley, CA.	Develop a methodology for evaluating the impacts of budget based tiered rates (BBTR). Estimate the savings in water consumption over a 5-year period. Identify avenues for further research.	Our analysis indicates a modest savings in household water consumption attributable to BBTR (3-9%). Savings appear generally higher for medium and high-water volume users.	Analysis of water budgets in 3 California agencies.
Myjer, Serena. 2022. Drought Tolerant Landscaping Trends in Claremont, California. CMC Senior Theses. 3048. Claremont Colleges, CA.	This project is the first analysis of landscaping patterns, trends, and changes in Claremont, California using Google Earth imagery.	Among the houses surveyed, we found that 46.75% had changes in landscaping and 53.25% did not change landscaping. Using estimates of water savings from literature, we predicted how much water has been saved by landscape conversion in Claremont. For the median area of turf grass removed, 55.07 m2, we find that a household is saving around 14,581 gallons per year.	Student thesis on landscape change in one California community.
Nabors, A. et al. 2022. California Native Perennials Attract Greater Native Pollinator Abundance and Diversity Than Nonnative, Commercially Available Ornamentals in Southern California. Environmental Entomology, 51 (4), 836-847.	In Southern California, a highly fragmented and urbanized landscape with a rich yet threatened native pollinator fauna, the availability of food resources for native pollinators hinges largely upon the selection of ornamental plants grown in the urban landscape. 3-year study.	Our results suggest that including a data-driven selection of both native and non-native ornamental perennials in the urban landscape can diversify the assemblage of native pollinators, provide critical floral resources throughout the year, and reduce the impact of honey bee landscape foraging dominance by providing plants highly attractive to native pollinators and less so to honey bees.	

Nan, X. et al. 2022. Assessing the thermal environments of parking lots in relation to their shade design characteristics. Sustainable Cities and Society 83.	In this study, we compared the differences in the thermal environments of eight common urban parking lots in Hangzhou, China, and analyzed their main influencing characteristics.	Among the factors, shade had an important effect on the thermal environment of the parking lot. We found that the cooling effect of trees was stronger than that of shading devices for the same shaded area. In addition, the combination of trees and mesh enhanced thermal benefits and has great application prospects, especially for the low coverage trees.	Fundamental research into Heat Issues, parking, trees, and urban surfaces.
Napieralksi, J. et al. 2022. Mapping the link between outdoor water footprint and social vulnerability in Metro Phoenix, AZ (USA). Landscape and Urban Planning 226.	Outdoor surface water inequities are the disproportionate distribution of outdoor water for the management of blue and green space, including residential swimming pools and irrigated gardens, and contribute to thermal inequities that are particularly pervasive in arid climates. The purpose of this study was to map and assess social vulnerability to green space and blue space within two transects in metro Phoenix, Arizona	Communities that are socially vulnerable exhibit less blueness and greenness. Outdoor surface water footprint decreases as vulnerability increases. Historically redlined neighborhoods show fewer pools, surface water, and greenness. Socially vulnerable communities have higher severity of urban heat island effect.	Important to addressing the social aspects of the Heat Issue within the water and landscape field.
Ossola, A. et al. 2021. Small vegetated patches greatly reduce urban surface temperature during a summer heatwave in Adelaide, Australia. Landscape and Urban Planning 209.	As the global climate warms, cities worldwide face more frequent and extreme heatwaves. These events can affect human health and decrease liveability. While the mitigating effects of vegetation on land surface temperature (LST) are well characterised at large spatial scales and during typical weather conditions, the cooling benefits that urban greening can provide at local scales, particularly during summer heatwaves, are poorly quantified.	• Cooling benefits by urban vegetation are greater at land unit than the suburb scale. • Vegetation provides greater cooling benefits to suburbs further from the coast.• Private green spaces are disproportionally important for urban heat mitigation. • Yards and trees are an overlooked asset for localised climate change adaptation. • People can adapt to heat when and where needed the most; during heatwaves and near home.	Important to addressing the Heat Issue within the water and landscape field.
Ouyang, Y. et al. 2014. A Multi-scale analysis of single-family residential water use in the Phoenix Metropolitan Area. Journal of the American Water Resources Association. Vol. 50, No. 2.	Using linear mixed-effects mod- els, we compare the results for the relationship of single-family water use with its determinants using data from the household and census tract scales in the city of Phoenix.	In this study, we find that the census tract scale data produce similar results compared to the house- hold-scale data when we use the econometric models to study the relationship of single-family residential water use and its determinants in Phoenix, Arizona. * The negative relationship between single-family house density and residential water use suggests that residential water consumption could be reduced through coordination of land use planning and water demand management.	
Pacific Institute. 2021. Stacked Incentives: Co-Funding Water Customer Incentive Programs. Pacific Institute, Oakland, CA.	Stacked incentives are customer incentive programs that are co-funded by two or more separate entities to motivate voluntary action on public or private property. This report defines stacked incentives, highlights successful examples throughout the United States, and identifies best practices for water utilities and other organizations to collaborate on these programs.	As a result of developing stacked incentives, water utilities have an opportunity to increase funding for customer incentive programs through collaborative partnerships, improve marketing and engagement with customers, increase access to incentives for low- income households, and more.	A guidebook on expanding resources for community landscape and water use change.
Pacific Institute. 2022. The Untapped Potential of California's Urban Water Supply: Water Efficiency, Water Reuse, and Stormwater Capture. Pacific Institute, Oakland, CA.	…we quantify the potential for a range of water strategies in urbanized parts of California to both reduce inefficient and wasteful water uses and expand local water supplies.	Urban water efficiency could reduce use by 2-3.1 MAF/Yr; Reuse potential is 1.8-2.1 MAF/Yr; Stormwater capture potential is 580,000 AF/yr (dry) to 3 M AF/yr (wet year).	Close look at the supply options needed for the 21st century.
Paschalis, A. et al. 2021. Urban Forests as Main Regulator of the Evaporative Cooling Effect in Cities. AGU Advances 2, 2.	Green spaces are promoted worldwide as local and city-scale cooling strategies but the amount, type, and functioning of vegetation in cities lack quantification and their interaction with urban climate in different settings remains a matter of debate. Here we use state-of-the-art remote sensing data from 145 city clusters to disentangle the drivers of surface urban heat islands (SUHI) intensity and quantify urban-rural differences in vegetation cover, species composition, and evaporative cooling.	Urban vegetation explains the largest fraction of the surface urban heat island (UHI) variability. Urban vegetation type explains the dependence of surface UHI intensity to background climate. Maintaining natural reserves in cities effectively mitigates UHIs.	Community vegetation management to address Heat Issues.

City of Phoenix. 2021. Cool Pavement Pilot Program. Urban Climate Research Center, Arizona State University, Phoenix, AZ.	The City of Phoenix recently initiated the Cool Pavement (CP) Pilot Program in which the City applied the product CoolSeal by GuardTop® to 36 miles of residential neighborhood roads and one public parking lot. This effort resulted in the most miles of road surface coverage with a reflective coating of any municipality globally.	Surface temperatures of the CP were systematically lower than non-treated asphalt concrete across all times of day. Air temperature at 6 feet height was lower above the CP than the non-treated surface in the evening by approximately 0.5°F. Mean radiant temperature, representing a human's total radiant heat exposure walking on the surfaces, was increased at noon and afternoon hours by approximately 5.5°F, on average (ranging from 2.6 to 9.2°F higher), due to higher surface reflectivity. Sub-surface temperatures beneath the CP were lower (4.8°F on average) than beneath the untreated asphalt concrete surfaces.	Important work on Heat Issues and 'cool pavement', in Phoenix, AZ.
Pincetl, S. et al. 2019. Evaluating the effects of turf-replacement programs in Los Angeles. Landscape and Urban Planning 185, 210-221.	Metropolitan Water District of Southern California devoted $350 million to the 2014 program, resulting in more than 46,000 rebate payments (25,000 in Los Angeles County) to remove 15.3 million square meters of turf. We analyzed socioeconomic and spatial trends of program participants and assessed landscape changes from turf replacement using a random sample of properties (4% of LA County participants in 2014–16).	Specifically, we used a novel and cost-effective approach Google Earth Street View to characterize landscapes in front yards and created a typology of land cover types. Results showed:residents made significant reductions in space dedicated to lawns. Analysis also indicated some evidence of "neighborhood adoption" effects.	Looks at impacts beyond simply water savings. Nice graphic details.
Pincetl, S. et al. 2019. Adapting Urban Water Systems to Manage Scarcity in the 21st Century: The Case of Los Angeles. Environmental Management 69:293-308.	We show how the embedded preferences for distant sources, and their local manifestations, have created and/or exacerbated fluctuations in local water availability and suboptimal management. As a socio technical system, water management in the Los Angeles has been dominated by scarcity.	We come to this through a decade of coupled research examining landscapes and water use, the development of the complex institutional water management infrastructure, hydrology and a systems network model. Such integrated research is a model for other regions to unpack and understand the actual water resources of a metropolitan region, how it is managed and potential ability to become more water self reliant if the institutions collaborate and manage the resource both parsimoniously, but also in an integrated and conjunctive manner. The Los Angeles County metropolitan region, we find, could transition to a nearly water self sufficient system.	Review and analysis of the LA water ecosystem.
Pivo, G. et al. 2022. Organizational networks and sustainable urban water practices in US local governments. Water Policy 24, No2., 382.	Organizational networks are regarded as key in policy innovation for sustainable development. This empirical study explores how networks affect the implementation of Sustainable Urban Water Management Practices (SUWM) at the local level. Using data from 110 local governments in five US regions, we examine the relationship between social interaction and the implementation of SUWM, and how this relationship depends on the types of interaction partners.	Our findings show that local governments with larger organizational networks implement more SUWM practices. Collaboration with non-governmental organizations, particularly water sector associations, is strongly associated with an increase in use of SUWM practices.	Descriptions of the opportunities for developing social capital for community sustainability.
Productivity Commission 2020, Integrated Urban Water Management — Why a good idea seems hard to implement, Commission Research Paper, Canberra, Australia.	Integrated water management represents real opportunity for the future, through a whole-of-a-system approach, and regular collaboration. It cannot be delivered by the water sector alone.	The paper sets out an expanded definition of, and approach to, integrated water cycle management, as well as a policy development framework that is used to identify ten key impediments to adopting an integrated approach to urban water management. These ten key impediments point to where action is needed to progress IWCM towards becoming the new business-as-usual way of planning and managing urban water resources.	While based on Australia, this work speaks to the larger context of urban water management.

Quesnel, K. et al. 2019. Shifting landscapes: decoupled urban irrigation and greenness patterns during severe drought. Environmental Research Letters 14.	Urban outdoor water conservation and efficiency offer high potential for demand-side management, but irrigation, greenness, and climate interlinks must be better understood to design optimal policies. To identify paired transitions during drought, we matched parcel-level water use data from smart, dedicated irrigation meters with high-spatial resolution, multispectral aerial imagery. We examined changes across 72 non-residential parcels using potable or recycled water for large landscape irrigation over four biennial summers (2010, 2012, 2014, and 2016) that encompassed a historic drought in California.	We found that despite little change in irrigation levels during the first few years of the drought, parcel greenness deteriorated. Between summers 2010 and 2014, average parcel greenness decreased −61% for potable water irrigators and −56% for recycled water irrigators, providing evidence that vegetation could not reach its vigor from wetter, cooler years as the drought intensified with abnormally high temperatures. Between summers 2014–2016 as drought severity lessened, irrigation rates decreased significantly in line with high drought saliency, but greenness rebounded ubiquitously, on average +110% for potable water irrigators and +62% for recycled water irrigators, demonstrating climate-driven vegetation recovery as evaporation and plant evapotranspiration rates decreased.	Important contribution to the discussion of tradeoffs between urban water and landscape systems.
Rasmussen, S. et al. 2021. When Small Is Not Beautiful: The Unexpected Impacts of Trees and Parcel Size on Metered Water-Use in a Semi-Arid City. Remote Sensing 2021, 13, 998.	This research explores the drivers of outdoor water consumption in a semi-arid, medium-sized Colorado city that is projected to undergo significant population growth. We used a combination of correlation and linear regression analyses to identify the key descriptive variables that predict greater water consumption at the household scale.	Some results were specific to the development patterns of this medium-sized city, where outdoor water use increased 7% for each additional mile (1.6 km) a household was located from the historic urban center. Similarly, more expensive homes used more water as well. Surprisingly, households with a higher ratio of vegetation cover to parcel size tended toward less water consumption, possibly from tree shade canopy.	Understanding the variables directing outdoor water use in semi-arid cities.
Reyes, B. et al. 2018. Urban Irrigation Suppresses Land Surface Temperature and Changes the Hydrologic Regime in Semi-Arid Regions. WATER 2018, 10, 1563.	This study analyzes the impact of irrigation on land surface temperatures and the hydrologic regime of a large, semi-arid urban metropolis. Using remotely sensed products, municipal water use data, and simulations with a coupled land surface-hydrologic model we find significant impacts on both land surface temperatures and the hydrologic dynamics of the study domain, Los Angeles, CA.	The analysis of remotely sensed land surface temperature finds a decrease of up to 3.2 ± 0.02 K between low and high irrigation areas of similar land cover. … relatively low irrigation volumes push the semi-arid urban environment into a sub-humid regime.	Analysis of water and landscape dynamics as they affect Temperature and hydrology, in LA basin.
Richards, Daniel R. and B. S. Thompson. 2019. Urban ecosystems: A new frontier for payments for ecosystem services. People and Nature, 2019: 1:249-261.	Urban ecosystems provide many benefits to people, including regulation of environmental conditions, recreational opportunities, and positive health impacts. However, many urban ecosystems are under pressure from increasing urbanisation, because the economic benefits they provide are rarely captured by the people who own and manage them. Such ecosystems are seldom economically competitive compared to more profitable residential, commercial, and industrial land uses.	Here, we explain how payments for urban ecosystem services (PUES) could help protect, restore, and man- age urban ecosystems.	Provide Rationales for PUES based on beneficiary-provider arrangements. Discuss the growing awareness of urban ecosystems and the need for better management arrangements.
Rocky Mountain Institute. 2022. Growing to Its Potential: The Value of Urban Nature for Communities, Investors, and the Climate. RMI Innovation Center, Basalt, CO.	Our analysis of the global costs and benefits of urban nature focused on seven common forms: green roofs, coastal wetlands, other bodies of water (including those outside cities that supply water to cities), mangroves, street trees, urban forests, and grassy parks and other open green spaces. Urban nature provides tangible energy, carbon, and cost savings that also make the case for increased investment at the city scale. However, there is little quantified data on these savings…	To help fill this gap, this report shares novel quantified estimates of urban nature's energy, carbon, and cost savings potential for buildings, stormwater management, and transportation in six cities around the world: Abidjan, Côte d'Ivoire; Ahmedabad, India; Austin, Texas, USA; Curitiba, Brazil; Houston, Texas, USA; and Sacramento, California, USA (Exhibit ES 2). * In most cases, the financial savings generated by urban nature — including reduced energy consumption, avoided power generation buildout, lower initial infrastructure costs, and avoided transportation fuel or power expenditures — outweighed its costs.	A valuable contribution to the literature on quantified environmental services from nature based systems.

Rosser, Teresa A. 2020. Front yards as green infrastructure: Fragmented yard ecosystems across single-family neighborhoods in Los Angeles. MURP Thesis. UCLA Luskin Center for Innovation.	This thesis explores how land tenure impacts front yard management practices and contributes to patterns of fragmentation and connectivity across residential landscapes in the city of Los Angeles. It assesses the relationships between land tenure and patterns of green infrastructure across neighborhood landscapes through the geospatial analysis of 120 yard surveys and a series of semi-structured resident interviews.	…owner occupancy is positively correlated with front yards that are rich in green infrastructure, and identifies patterns of structural fragmentation and spatial mimicry across neighboring properties. * the type of front yard changes made in both neighborhoods, alongside responses from interviews with residents, suggest a shift in normative landscaping trends that is encouraging the addition and maintenance of green infrastructure. However, spatial clusters of neighbor mimicry along with insights from residential interviews suggest that social norms and neighboring yard cover can foster collective landscaping change in a way that builds greater connectivity across urban landscapes.	Student research on the changing urban landscapes in LA. Good street side photos of front yards.
Saher, R. et al. Assessing the Microclimate Effects and Irrigation Water Requirements of Mesic, Oasis, and Xeric Landscapes. Hydrology 2022, 9, 104.	This study investigated the microclimate effects and irrigation water requirements of three landscape types in an arid region of Phoenix, AZ. The microclimate effect encompassed surface temperature, air temperature, and wind speed. The simulations of the three landscapes were conducted using ENVI-met software for the hottest day of the year (23 June 2011). The simulated model was validated using ground data.	Results show that the mesic landscape induced cooling effects, both in the daytime and nighttime, by reducing surface and air temperatures. However, the mesic landscape showed high-water consumption because of a high leaf area density. The oasis landscape showed 2 C more daytime cooling than the mesic landscape, but the nighttime warming (surface temperature) was comparable to the xeric landscape.	Study of the water and landscape dynamics with respect to irrigation and the Heat Issue, in AZ.
Saher, R.; Stephen, H.; Ahmad, S. 2023. Role of Urban Landscapes in Changing the Irrigation Water Requirements in Arid Climate. Geosciences 2023,13,14.	In this paper, we investigate the role of the urban landscape on the irrigation water requirements in arid cities. The role of the landscape in determining the irrigation water requirements is examined through the changes in surface-heat energy exchanges. The effects of landscapes are examined through land use change, buildings' geometry and orientation, and vegetation types. The irrigation water requirement is assessed as the function of urban evapotranspiration and irrigation efficiency.	The study focuses on understanding the heat exchanges and their effects on irrigation water requirements in arid climates. Two major cities were studied: Las Vegas Valley and Phoenix metropolitan. The study concludes that the development of hardscapes, including commercial and road infrastructures, increases the overall surface temperature by 2 C per unit change in albedo, thereby increasing evapotranspiration and urban irrigation water requirement.	Important to understanding the effects of land use decisions on water use and Heat Issues.
Shashua-Bar, L. et al. 2009. The cooling efficiency of urban landscape strategies in a hot dry climate. Landscape and Urban Planning 92, 179-186.	This paper describes a climatic analysis of landscape strategies for outdoor cooling in a hot-arid region, considering the efficiency of water use. Six landscape strategies were studied, using different combina- tions of trees, lawn, and an overhead shade mesh. The effects of these treatments were tested during the summer season in two semi-enclosed courtyards located at an urban settlement in the arid Negev Highlands of southern Israel.	Compared to a non-vegetated exposed courtyard, which on average reached a maximum air temperature of 34 ◦ C in mid-afternoon, a similar courtyard treated with shade trees and grass yielded a daytime temperature depression of up to 2.5 K Combinations of grass and trees, or shade mesh and grass, offered greater cooling, and less water use.	Experiments in addressing the Heat Issue, shade, trees, water, and grass. Pictures included.
Shurtz, K.M. et al. 2022. Insights into Efficient Irrigation of Urban Landscapes: Analysis Using Remote Sensing, Parcel Data, Water Use, and Tiered Rates. Sustainability 2022, 14, 1427.	To understand how landscape irrigation can be better managed, we selected two urban irrigation systems in northern Utah, USA, and performed a statistical analysis of relationships among water use, irrigated area, plant health (based on the Normalized Difference Vegetation Index), and water rate structures across thousands of parcels. Our approach combined remote sensing with 4-band imagery and on-site measurements from water meters. We present five key findings that can lead to more efficient irrigation practices.	First, tiered water rates result in less water use when compared to flat water rates for comparable plant health. Second, plant health does not strictly increase with water application but has an optimum point beyond which further watering is not beneficial. Third, many water users irrigate beyond this optimum point, suggesting that there is water conservation potential without loss of aesthetics. Fourth, irrigation is not the only contributor to plant health, and other factors need more attention in research and in water conservation programs. Fifth, smaller irrigated areas correlate with higher water application rates, an observation that may inform future land use decisions.	Study of water use patterns, vegetation, and management in semi-arid region.
Simpson, T. J. and Robert A. Francis. 2021. Artificial lawns exhibit increased runoff and decreased water retention compared to living lawns following controlled rainfall experiments. Urban Forestry & Urban Greening 63	Two varieties of artificial grass with varying pile height (short vs long) were compared with a living grass control. Infiltration was measured as drainage (total, initial and delayed) and retention.	Significant differences in runoff were observed across all treatments, demonstrating that both types of artificial grass displayed greater volumes and proportion of runoff than living grass, and that long artificial grass had significantly greater runoff than short artificial grass.	Research on possible effects of artificial turf on water runofff.

Sokolow, S. et al. 2016. Impacts of Urban Water Conservation Strategies on Energy, Greenhouse Gas Emissions, and Health: Southern California as a Case Study. American Journal of Public Health 106, No. 5.	Objectives. To determine how urban water conservation strategies in California cities can affect water and energy conservation efforts, reduce greenhouse gas emissions, and bene!t public health. Methods. We expanded upon our 2014 health impact assessment of California's urban water conservation strategies by comparing the status quo to 2 options with the greatest potential impact on the interrelated issues of water and energy in California: (1) banning landscape irrigation and (2) expanding alternative water sources (e.g. desalination, recycled water).	Among the water conservation strategies evaluated, expanded use of recycled water stood out as the water conservation strategy with potential to reduce water use, energy use, and greenhouse gas emissions, with relatively small negative impacts for the public's health.	Public health perspective on the urban water and landscape field.
Spahr, K. et al. 2020. Greening up stormwater infrastructure: Measuring vegetation to establish context and promote cobenefits in a diverse set of US cities. Urban Forestry and Urban Greening 48.	Co-benefits are difficult to quantify because they span a diverse set of categories and cannot be easily measured using any single metric. Drawing from existing techniques in the field of ecosystem services, this study uses the normalized difference vegetation index (NDVI) to establish trends in ecosystem services in ten US cities with Green Infrastructure Programs (GSI) programs and to evaluate the impacts of GSI interventions on urban greenness.	Results show that only two of the ten study cities (Seattle, WA and Milwaukee, WI) are getting greener, likely due to maturing vegetation. A case study for one of the 10 cities, Philadelphia, utilizes a stormwater control measure (SCM) inventory of GSI installations, and shows decreasing greenness at the city-wide scale. This case study demonstrates that 62% of GSI project area is composed of non-vegetated SCMs. Moving forward, decision makers are encouraged to incorporate NDVI into their planning processes to move beyond water quality and quantity control measures and directly incorporate and incentivize co-benefits into GSI goals.	Remote sensing to monitor and manage green infrastructure in US cities, and to assess potential impacts.
Spang, E. et. 2018. The estimated impact of California's urban water conservation mandate on electricity consumption and greenhouse gas emissions. Environmental Research Letters 13	This paper uses the reported data (from CA Water Res Ctl Bd) to assess how the water utilities have responded to this mandate and to estimate the electricity savings and greenhouse gas (GHG) emissions reductions associated with reduced operation of urban water infrastructure systems.	The results show that California succeeded in saving 524 000 million gallons (MG) of water (a 24.5% decrease relative to the 2013 baseline) over the mandate period, which translates into 1830 GWh total electricity savings, and a GHG emissions reduction of 521 000 metric tonnes of carbon dioxide equivalents (MT CO2e). For comparison, the total electricity savings linked to water conservation are approximately 11% greater than the savings achieved by the investor-owned electricity utilities' efficiency programs for roughly the same time period, and the GHG savings represent the equivalent of taking about 111 000 cars off the road for a year.	Important to understanding the direct relationship between urban water and energy systems.
Turner, V.K. et al. 2022. How are cities planning for heat? Analysis of United States municipal plans. Environmental Research Letters 17.	Heat has become a central concern for cities everywhere, but heat governance has historically lagged behind other climate change hazards. This study examines 175 municipal plans from the 50 most populous cities in the United States to understand which aspects of urban heat are included or not in city plans and what factors explain inclusion.	We find that a majority of plans mention heat, but few include strategies to address it and even fewer cite sources of information. Findings point to the emergence of two independent heat governance systems, EHE and UHI, and several gaps in heat planning: integration, specificity, solutions, disparity, economy, and thermal comfort.	Update on status of Heat Issue recognition and planning in the U.S. EHE = extreme heat event UHI= urban heat island
UCLA Luskin Center for Innovation. 2016. Turf Replacement Program Impacts on Households and Ratepayers: An Analysis for the City of Los Angeles. Board of Regents, University of California Los Angeles. https://innovation.luskin.ucla.edu/	In order to encourage turf replacement, the city launched a turf replacement program in 2009. Commercial and residential customers can receive a rebate from the utility when they replace their lawns with less water intensive landscaping. Currently, the city is offering a rebate of $1.75 per sq. ft. up to 1,500 sq. ft. This report seeks to answer two questions regarding the turf replacement program. First, under what conditions does participation in the turf replacement program provide financial benefits to households? Second, is the turf replacement program a reasonably cost effective investment for utilities and ratepayers?	We found that when the utility offers a rebate of $1.75 per sq. ft. of turf replaced, typical households make back their initial investment in the program and start saving money in less than 10 years, a timeframe considered to be the policy status quo and comparable to other investments such as solar panels. Our analysis suggests that the current level of lawn replacement rebates is also cost effective from the ratepayer and utility perspective. When the utility offers a rebate of $1.00 per sq. ft., ratepayers see savings start to accrue after approximately 10 years. When the rebate increases to $1.75 per sq. ft. of turf replaced, the typical ratepayer does not see savings for 14-20 years depending on the rate at which MWD increases the cost of water.	Economic evaluation of the turf replacement programs in the City of Los Angeles from 2009 to 2015, on over 15 million square feet of turf.

UCLA Luskin Center for Innovation. 2022. Equity in Stormwater Investments: Measuring Community Engagement and Disadvantaged Community Benefits for Equitable Impact in the Safe Clean Water Program. Board of Regents, University of California Los Angeles. https://innovation.luskin.ucla.edu/	The Safe, Clean Water Program (SCWP) reflects the will of the voters of Los Angeles County, who approved Measure W in 2018 by close to 70%. In an ordinance implementing the Safe Clean Water Program, the county Board of Supervisors included provisions to prioritize equity in implementation and armed an intention to address inequity in infrastructure in August 2021	Members of a disadvantaged community must agree that they will benefit from a project for project proponents to claim a Disadvantaged Community Benefit. Project proponents in disadvantaged communities should be required, and be provided guidance, technical assistance, and financial assistance, to conduct robust community engagement throughout the Safe, Clean Water Program and especially when claiming a Disadvantaged Community Benefit.	Planning and managing water-based programs for equitable outcomes.
U.S. Water Alliance. 2016. One Water Roadmap: The Sustainable Management of Life's Most Essential Resource. uswateralliance.org	Presents the view that all water has value and should be managed in a sustainable, inclusive, integrated way.	Framework for moving forward with the entire community.	Foundational work on a new vision for water management, inclusive and holistic.
Vahmani, P. and G. Ban-Weiss. 2016. Climatic consequences of adopting drought-tolerant vegetation over Los Angeles as a response to California drought. Geophysical Research Letters 43, 8240-8249.	One measure pursued was replacing lawns with landscapes that minimize water consumption, such as drought-tolerant vegetation. If implemented at broad scale, this strategy would result in reductions in irrigation and changes in land surface characteristics. In this study, we employ a modified regional climate model to assess the climatic consequences of adopting drought-tolerant vegetation over the Los Angeles metropolitan area.	Transforming lawns to drought-tolerant vegetation resulted in daytime warming of up to 1.9°C, largely due to decreases in irrigation that shifted surface energy partitioning toward higher sensible and lower latent heat flux. During nighttime, however, adopting drought-tolerant vegetation caused mean cooling of 3.2°C, due to changes in soil thermodynamic properties and heat exchange dynamics between the surface and subsurface. Our results show that nocturnal cooling effects, which are larger in magnitude and of great importance for public health during heat events, could counterbalance the daytime warming attributed to the studied water conservation strategy.	Modeling of potential impacts of large-scale landscape change the Los Angeles region.
Warner, L. et al. 2018. Informing Urban Landscape Water Conservation Extension Programs using Behavioral Research. Journal of Agricultural Education. Vol. 59, Issue 2.	In this study, we explored whether urban Extension audiences in Florida had unique characteristics that could be used to design tailored programs. We used electronic surveys to collect water conservation and landscape management behaviors along with demographic information.	Urban landscape water conservation programming should be designed to build a connection between residents and their local water bodies, and should engage the many partners present in urban systems.	Studying the different 'publics' to whom programs are directed.
Water Research Foundation. 2018. Joining-Up Urban Water Management with Urban Design and Planning. Project SIWM5R13/4853. The Water Research Foundation, Denver, CO and Alexandria, VA.	This project investigates the key inhibiting and enabling factors in coordinating efforts across the urban planning, design, and water management sectors. The research team conducted a literature review, administered a national survey, interviewed experts, and more.	* Developed a self-assessment tool: the Bridges-to-Barriers Matrix. * Explores 5 case studies.	
Water Research Foundation. 2021. Economic Framework and Tools for Quantifying and Monetizing the Triple Bottom Line Benefits of Green Stormwater Infrastructure. Profect No. 4852/SIWM4T17, Water Research Foundation, Denver, CO and Alexandria, VA.	Provides stormwater practitioners with a systematic approach for quantifying and monetizing the financial, social, and environmental benefits of GSI at the community, watershed, or neighborhood scale.	Provide a foundation for developing a systematic approach for evaluating the costs and benefits of	Needed tools for an increasing interest, and investment, in urban environmental services.
Wei, D. et al. 2022. High resolution modeling of vegetation reveals large summertime biogenic CO2 fluxes in New York City. Environmental Research Letters 17.	We set up a biosphere model to estimate the regional biogenic CO2 fluxes in New York City (NYC) and assess the importance of vegetation within developed land covers. The model incorporates a high-resolution (30 m) land cover map which identifies the mixture of impervious surfaces and vegetation that is ubiquitous across developed land covers. We designed three model scenarios to evaluate the role of developed land covers in regional biogenic CO2 fluxes by assuming (a) there is no vegetation versus scenarios where all remotely sensed vegetation in developed land covers is either (b) grassland or (c) deciduous forest.	Despite relatively low tree canopy cover in NYC, the regional biogenic CO2 fluxes are surprisingly large when vegetation within the developed land covers is included. * Using a Lagrangian atmospheric transport model, we find that the regional biogenic CO2 uptake offsets up to 40% of atmospheric CO2 enhancements attributed to anthropogenic emissions in summer afternoons and completely balances on-road traffic in one of the most congested cities in the United States	Modeling the sequestration value of urban trees, with data from NYC.

Wentz, E.A. et al. 2016. Impact of Homeowner Association (HOA) landscaping guidelines on residential water usek. Water Resources Research 52, 3373–3386.	Appropriate regulatory measures addressing residential landscaping, such as those applied by Homeowner Associations (HOAs), may serve to reduce municipal water use, joining other water-use reducing measures under consideration by arid cities. This research assesses quantitatively the role that Covenants, Conditions, and Restrictions (CCRs) applied to landscaping by HOAs play on water consumption	Statistical comparisons and models of Goodyear, Arizona, USA, reveal that: HOA yards have less vegetation cover and those households use less peak-season water (July) than those households in non-HOA neighborhoods. * Results of the study suggest that HOA landscaping regulations have the potential to reduce peak-season water use by up to 24% if CCRs were to set maximum vegetation regulations rather than minimum and if compliance were enforced.	Rare look at Home Owners Associations, landscape, and water.
Western Resource Advocates. 2010. Arizona Water Meter: A comparison of water conservation programs in 15 Arizona communities. WRA, Boulder, CO. https://westernresourceadvocates.org/	This report highlights the water conservation programs of 15 Arizona communities and evaluates their programs by seven important water conservation criteria. The communities are Buckeye, Casa Grande, Chandler, Clarkdale, Lake Havasu City, Mesa, Payson, Peoria, Phoenix, Prescott, Safford, Scottsdale, Sierra Vista, Tucson, and Yuma.	gray and green infrastructure options for stormwater management.	A baseline assessment of conservation in Arizona, providing important measure for analysis.
Western Resource Advocates. 2022. Financing the Future: How to Pay for Turf Replacement in Colorado. WRA, Waternow Alliance, Boulder, CO. https://westernresourceadvocates.org/	To achieve turf replacements at larger scale, Colorado cities and utilities will need to be positioned to make significant investments in these programs, as they would for other water supply projects. Some of these investment opportunities can be found on property a city or water utility owns. However, the most substantial opportunities to replace non-essential turf are on private properties, or public property outside of utility ownership such as parks and median strips.	The research on current turf change-out programs leads to two major conclusions. First, these programs are showing meaningful success in terms of water savings. Second, with a few notable exceptions, current programs are fairly small-scale, and thus not realizing most of the water supply and cost saving benefits achievable.	Helping water providers explore options for financing future initiatives.
Western Resource Advocates. 2023. Exploring Policy Options for Expanding Landscape & Irrigation Professional Certification in Colorado. WRA, Boulder, CO. https://westernresourceadvocates.org/	Pathways to increase water conservation in M&I Outdoor Irrigation.	4 Options: * Status Quo * Public Education * State-sponsored voluntary licensure * State-required landscape professional certification.	A review of options for helping the green industry adapt to rapidly-changing conditions in the world of urban landscapes.
Wheeler, M.M. et al. 2020. Attitudinal and structural drivers of preferred versus actual residential landscapes in a desert city. Urban Ecosystems 23: 659-673.	In this study, we conducted a resident survey to consider the relationship between preferred and actual yard grassiness in the desert city of Phoenix, AZ, where outdoor water use makes up over two-thirds of residential water consumption.	We found that nearly half of surveyed residents had less grass than they would prefer, and that existing yard grassiness is best explained by structural characteristics out of the variables we considered.	Solid survey work identifying the importance of structural systems (Frame).
Wilson, S. et al. 2022. Urbanization of grasslands in the Denver area affects streamflow responses to rainfall events. Hydrological Processes 36, No. 10.	A thorough understanding of how urbanization affects stream hydrology is crucial for effective and sustainable water management, particularly in rapidly urbanizing regions. This study presents a comprehensive analysis of changes in streamflow response to rainfall events across a rural to urban gradient in the semi-arid area of Denver, Colorado. We used 8 years of April to October instantaneous streamflow data in 21 watersheds ranging in size from 0.8 to 90 km2 and with impervious areas ranging from 1% to 47%.	Watersheds with >10% impervious cover had a precipitation threshold of 1–2 mm/hr needed to produce a streamflow response, compared to thresholds of 4–36 mm/hr for watersheds with less than 10% impervious surface cover. This lower precipitation threshold in more impervious watersheds led to more frequent streamflow responses. On average, streamflow responses had shorter duration and higher peak flows in watersheds with more impervious surface cover.	Hydrologic impacts of land use planning.
Wittern, Matt, and Sanjay Gaur. 2022. Protecting Against Water Rate Challenges With the Equivalent of Bear Spray. Journal of the American Water Works Association, March 2022.	With the landmark 2015 court case Capistrano Taxpayers Association v. City of San Juan Capistrano, some in the water industry were unsure of the effect the ruling would have on budget-based water rates. How would it affect these and other increasingly prevalent tiered-rate pricing and other market-based restric- tions that had proved effective in managing water demand? Add to that the seeming constitutional con- tradictions between tax and water provisions, and it was easy for anxiety to creep in.	A California water utility was sued over its water-budget based rate structure designed to help customers conserve the state's most precious resource. The utility successfully defended itself and shares lessons learned for other water agencies facing rate challenges.	Important update on the use of water-budget based billing to monitor and manage water use.
Woodard, Jessica A. 2019. Mainstreaming Sustainable Landscapes in the East Bay Municipal Utility District. San Francisco State University, San Francisco, CA.	Underlying the design of and heavy investment in lawn conversion programs is an ambitious end-goal: to transform the landscaping market away from lawns, and mainstream sustainable landscapes. Using a market transformation framework, this study investigates the geographic variation of reported attitudes (aesthetic preference and willingness to replace lawn) and lawn conversion rates, as indicators of landscape transformation, across the East Bay Municipal Utility District (EBMUD).	We confirm the important relationship between lawn conversion rates and aesthetic appreciation of water-conserving landscapes but found a weaker relationship with reported willingness to convert lawn. Drought years had an overall positive effect. Below-average rebate participation correlates with below-average aesthetic ratings.	Thesis work looking at landscape transformation in the East Bay of CA, with details on willingness-to-convert, and the importance of aesthetics.

You, J. 2022. Connecting Land and Water Planning in Colorado. Journal of Planning Education and Research 1-18.	Water scarcity is a significant threat to urban and regional planning. Water scarcity has challenged planners to respond to the problem in an important but previously overlooked way. Although the connection between land and water planning has not been adequately recognized in planning education and research, some governments have begun to manage the two natural resources together.	Drawing upon the literature on integrated policy approach and policy implementation, this article presents a summary of policy actions in the past decade aimed at better integrating land use and water resource planning in Colorado. * This article delineates the importance of the comprehensive plan as the main vehicle in encouraging local governments to connect land and water.	Update on land and water planning in Colorado.
Zhang, X. and H. Khachatryan. 2020. Investigating Monetary Incentives for Environmentally Friendly Residential Landscapes. Water 2020, 12, 3023.	This study investigates the effects of households' monetary incentive requirement on households' preferences and willingness to pay for low-input landscapes. The discrete choice experiment method was used to analyze responses from households categorized into low, medium, and high incentive requirement groups.	The results show that rebate incentives may have significant positive effects on individuals' intentions to adopt low-input landscapes. Florida.	Study to remind program managers that there are usually many sub-groups of customers and they respond to a variety of incentives.
Ziter, C.D. et al. 2019.Scale-dependent interactions between tree canopy cover and impervious surfaces reduce daytime urban heat during summer. PNAS 116, no. 15, 7575-7580.	We asked how tree canopy cover and impervious surface cover interact to influence daytime and nighttime summer air temperature, and how effects vary with the spatial scale at which land-cover data are analyzed (10-, 30-, 60-, and 90-m radii). A bicycle-mounted measurement system was used to sample air temperature every 5 m along 10 transects (~7 km length, sampled 3–12 times each) spanning a range of impervious and tree canopy cover (0–100%, each) in a midsized city in the Upper Midwest United States.	Daytime air temperature was substantially reduced with greater canopy cover (≥40%) at the scale of a typical city block (60–90 m), especially on the hottest days. However, reducing impervious surfaces remained important for lowering nighttime temperatures.	Looking at Heat Issues, impervious surfaces, trees, and urban surface management.
Regulations, Guidelines, and Laws(All accessed January-April 2023)			
Aspen, CO. Water efficient landscaping standards. October 6, 2021.	* Maximum applied water budget, at 7.5 gallons/sqft/season. * Water efficient landscape worksheet required. * % org matter in top 6 inches, and soil analysis required. * Special features (like Eco zones, green infrastructure) provide increased budget to 8 gal/sq ft/season.	* some areas require FireWise landscape techniques. * Smart irrigation systems required. *Certified Irrigation audit required.	Water wise standards for high-altitude locations.
City of Aurora, CO. 2022. Aurora City Code, Chapter 138 Utilities, Sec. 138-191. Use of turf and ornamental water features.	* Prohibits cool season turf: when used primarily as aesthetic element; in front or side yards of SF; larger than 500 sq ft total in SF; medians or curbsides; Golf courses; Observed water waste has large fines.	Will do an economic study after 3 years.	Most restrictive rules in CO to date.
Avon, CO. Ordinance 23-01, to amend Avon Mun Code Section 7.28.050.	Updates and amendments to city landscape code. reflecting water efficiency and wildlife concerns.	* Implement Water Budgeting practices, using a general allocation of 7.5 gallons/sq ft/season. * Produce 'Mountainscape' designs that conserve water and mitigate fire. * Utilize Hydrozones, and incentivize Green Infrastructure. * Landscape professional required for design. * Smart irrigation controllers, and irrigation Audit prior to C.O. required on Non-Residential properties.	Good ordinance details for high-altitude (>6500') communities in the West. Landscape guide has pictures.
State of California. 2015. Model Water Efficient Landscape Ordinance.	All local agencies must adopt, implement, and enforce the MWELO or a local Water Efficient Landscape Ordinance (WELO) that is at least as effective as the MWELO. Agencies to report on utilization annually. Update to the 1993 original ordinance.	Utilizes Water Budgets, and WUCOLS: Water Use Classification of Landscape Species. Irrigation Audit, by Certified Professional, required. Green infrastructure techniques encouraged.	https://govt.westlaw.com/calregs/Browse/Home/California/CaliforniaCodeofRegulations?guid=IBBB0A9505B6E11EC9451000D3A7C4BC3&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default)
State of California. March 2022. Governor's Executive Order N-7-22, directing the California State Water Resources Control Board to evaluate standards, while specifically targeting all non-functional turf.	Greatly restricted water use, especially by turf. As of April 4, 2023, Level 2 demand restrictions lifted but still bans watering of non-functional turf in most all non-residential settings.		
State of Colorado. 2022. House Bill 22-1151. Approved June 8, 2022.	Concerning measures to incentivize water-wise landscapes, and, in connection therewith, creating a statewide program to finance the voluntary replacement of irrigated turf….	State of Colorado Water Conservation Board to develop program to distribute finds starting in July 2023, with an initial state appropriation of $2 million dollars.	
Castle Rock, CO. Town of Castle Rock Landscape and Irrigation Criteria Manual. April 1, 2021.	Conservation-oriented regulation, including: *Composite Landscape Water Use Rating Chart *QWEL certification and registration with town is required. *LArch license for non-residential design. * Utilize ColoradoScape design principles. * 15"/growing season plant water limit. (~9 gal/sq ft) 19" for SF	* Water shall not be applied to impervious surfaces. * Apply LID stormwater techniques. * Soil evaluation and 4 yds3/1000 sq ft. * Drip or subsurface only if >4' but <10' * Min 75% plant coverage at maturity.	Great detail, including key definitions. QWEL= Qualified Water Efficient Landscaper - a training and certification program.

EPA WaterSense New Home Specification. Landscape Design Criteria (Section 4.1.1) and WaterSense® Technical Evaluation Process for Approving Home Certification Methods. 2021. EPA, Washington, D.C.	Based on Water Budget Tool and efficient technologies.	Budget set at 70% of seasonal ET for cool-season grass. * Points for weather or soil-based controllers.	Guidelines for a water-efficient home.
San Antonio, TX Sec. Chapter 34, Sec 271-273. 2006	* No above ground spray irrigation on spaces <5' wide, not including impervious surfaces. * Spray heads must be installed 4" away from hardscape. * 10,000 sq ft max above ground irrigation (2010).	*Large landscape Annual System Analysis. * 4" of soil under turf grass. * Irrigation Audit required.	Great details on water use, efficiency, conservation, and water waste.
Surfrider Ocean Friendly Gardens. San Clemente, CA.	Ocean Friendly Gardens are designed to mimic nature and restore resilient coasts and the natural water cycle by creating native habitat, conserving water, and reducing runoff that causes pollution at the beach and in our local waterways.	* At least 50% native plants, no invasives. * Rain shutoff on sprinklers required. * No landscape fabric or artificial turf. * Pervious pavers suggested. * Bioswales. * Direct roof runoff to swales or rain barrels.	
Texas Administrative Code TITLE 30 PART 1,CHAPTER 344,SUBCHAPTER F, RULE §344.62. 2009, amended 2020.	ENVIRONMENTAL QUALITY. TEXAS COMMISSION ON ENVIRONMENTAL QUALITY. LANDSCAPE IRRIGATION: STANDARDS FOR DESIGNING, INSTALLING, AND MAINTAINING LANDSCAPE IRRIGATION SYSTEMS, Minimum Design and Installation Requirements	* No above ground spray irrigation on spaces <48" wide, not including impervious surfaces. * Spray heads must be installed 4" away from hardscape. * Hydrozones with matched precipitation sprinkler heads. * Rain or moisture shutoff device. * Licensed irrigation professional required.	
City of Tuscon, AZ. 2013. Department of Transportation, Engineering Division, Active Practice Guidelines. August 6, 2013. Green Streets.	The intent of these guidelines is to require the incorporation of green infrastructure features into Tuscon roadways wherever possible.	Performance Goal: Stormwater runoff to be directed to green infrastructure before storm drains or natural drainage ways. * Landscape areas are designed to retain the first 1/2" of rainfall falling on the roadway and public right-of-way…	Performance measures for roadways. This begins to address their contribution to stormwater and other urban ecology issues in communities.
State of Utah. 2022. House Bill 121.	Directs water conservation on the grounds of most state-owned properties (exceptions for golf courses, athletic fields, parks, sod farms), allowing only 20% turf area in any new construction. Incentives for private property owners to use drought resistant landscaping.		
City of Westminster, CO. Landscape Regulations 2004.	* 7 Xeriscape principles. * Hydrozones required, water budget of 15 gal/sq ft max/season. * 5 yds3/1000 sq ft, to 8" deep. * Inspection and irrigation audit required before C.O. for non-residential.	2020 Updates: * Established a Zero hydrozone. Max 10% high hydrozone area. Min 10% trees and shrubs Native. * Min. landscaped area reduced. * Public landscape areas min. 50% pollinator species.	