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Editorial: Urban water management, planning, and design: Links, opportunities, and challenges

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Editorial on the Research Topic
Urban water management, planning, and design: Links, opportunities, and challenges

Introduction

Urban water systems are critical infrastructure that support many aspects of everyday life in cities. Urban water systems include not only constructed devices and infrastructure, but also institutions, landscapes, buildings, and the habits of residents, which together shape how water is used and managed in cities. Understanding the complexity of urban water systems therefore requires research at the intersection of urban water management, urban planning, and environmental design, answering questions such as: How do cities integrate centralized and engineered infrastructure solutions with decentralized and nature-based solutions? How can policies and governance structures be integrated? How can decision-making processes become more inclusive and collaborative across sectors and communities to achieve urban water sustainability? How can urban and landscape design support the goals of promoting adaptive water management strategies and coping with climate change impacts? How can design contribute to improved performance and sustainability of urban water systems? How are the decisions made in the process of planning, designing, and managing urban water systems and who benefits and who is left out to avoid perpetuating system injustice and inequitable outcomes?

With these questions in mind, we sought to develop a Research Topic for Frontiers in Water that offered a space for interdisciplinary research that addressed how management, planning, and design issues overlap within and through urban water systems. We solicited papers under the subject title "Urban Water Management, Planning, and Design: Links, Opportunities, and Challenges," noting our specific interest in papers that tackled the intersection of these topics. Our intent was to highlight integrative papers that cross disciplines. Sustainable urban water systems are complex and no single discipline can provide comprehensive and sustainable solutions. Urban flooding resilience to climate change, for example, lies in the intersection of social, ecological, and technological systems; it requires policy support and investment in green infrastructure design for managing urban hydrological impacts from climate change-induced flooding (Cheng et al., 2017; Chang et al., 2021). Across sectors, we must pursue more integrative thinking and approaches if we are to foster future urban spaces that mesh the achievements of industrialization with the stark needs for sustainable, resilient, regenerative, and equitable forms of urbanism (Hughes and Hoffmann, 2020).

The collection that follows contains seven original articles that span disciplines and bring novel insights into the creation and maintenance of sustainable urban water systems (Table 1). The articles demonstrate collaborative approaches and address cross-cutting topics in urban water management. Each of the contributions approached the questions posed for this Research Topic with a unique multi-disciplinary or interdisciplinary perspective. Some authors used modeling to forecast water planning needs given engineering constraints, social trends, and climate change. Others used mapping to link historical development patterns with culture and industrialization. Still others focused especially on culture and institutions as drivers of current and future trends. We thank all of the authors for their thoughtfulness in responding to the need for integrative work in this area.

Interdisciplinary perspectives for urban water management, governance, and design

The papers in this collection challenge many contemporary notions of urban development, including water infrastructure planning, which often focus on technology adoption and economic growth as benchmarks for progress. By contrast, innovation and site-specific solutions and are pervasive themes in the study and practice of sustainable urban water systems. Nature-based solutions are employed as "green" technologies that supplant former "gray" hard infrastructure and seek to reintroduce natural resource flows and balances to modern urban systems (Wild et al., 2017). These strategies have been studied extensively in recent decades to understand co-benefits of improving water management and multiple ecosystem services in cities as remedies to industrialized urbanism.

Understanding urban development trends beyond the most recent industrial period provides more perspective. Modern urban development in industrial cities often paved over older urban forms that connected residents with important natural resources or amenities (Khirfan et al.). Many urban water systems were hidden during the nineteenth and twentieth Centuries and emphasized linear designs rather than nutrient cycling and resource reuse (Odum, 1971; Tarr et al., 1984). The institutionalization of economic systems and industrial development in cities has created path dependence, which makes cities less adaptable to the kinds of rapid changes we currently experience in a globalized and warming world (Tellman et al., 2018). More thoughtful, community-oriented approaches to design can help re-connect residents with both the networks of infrastructure that provide water services and the networks of neighbors that form strong communities (Muller). In addition, uncovering urban water systems can expose the vital role this infrastructure plays in modern cities. In building more visible urban water systems, governance and design are just as (if not more) important than engineering and technology (Muller et al., 2022).

Despite the importance of culture and history in shaping infrastructure, engineering models used for contemporary water planning do not incorporate these factors when examining pathways of change and adaptation. For instance, in using stakeholder-driven scenario planning to understand how green infrastructure can promote climate change adaptation for stormwater management, landscape designs or socioeconomic perspectives are not necessarily integrated into assessments that use industry-standard planning tools such as the Stormwater Management Model (SWMM) (Tchintcharauli-Harrison et al.) or the Soil and Water Assessment Tool (SWAT) (Guswa et al., 2020). Other sectors of urban water management (e.g., drinking water, wastewater) have similar engineering design tools with limited capacity for broadly incorporating innovative designs or social considerations (Novotny, 2007; Novotny et al., 2010; Daigger, 2011).

Management, governance, and design processes must all be sufficiently adaptive and inclusive to keep up with the pace of change in complex modern cities. Yet the intellectual, technological, and managerial developments that underlie the development of industrial cities have likely instigated path dependencies, which reduce our ability to adapt to change in ways we do not yet fully understand. For water management, many of the world's largest cities import a significant percentage of water supply from outside their borders (MacDonald and Shemie, 2014). Large centralized infrastructural facilities such as underground sewer and wastewater treatment systems require a large amount of investment and thus are often difficult to change once established. This has led to artificially high rates of water use, facilitated by infrastructure to convey and treat potable

TABLE 1 Summary of contributions to the Research Topic on *Urban Water Management, Planning and Design*.

Title and authors	Key themes	Region	Contribution
Effects of urban development patterns on municipal water shortage. Heidari et al.	Urban water planning Climate change Development and water Water demand. Smart growth, density	Colorado, USA, North American Mountain West	Denser development patterns can help improve climate change adaptation. Areas with urban sprawl are more likely to experience water shortages with climate change
Resilience and Adaptive Capacity of the Swan Coastal Plain Wetlands Nanda et al.	Social-ecological systems Institutions and policy Transformative action Adaptation and resilience	Western Australia	Broader planning approaches that incorporate social-ecological systems and resilience theory can identify inadequacies of current policies and pathways in ecosystem management
Reading an Urban Palimpsest: How the Gradual Loss of an Urban Stream Impacts Urban Form's Connections and Ecosystem Functions Khirfan et al.	Spatial analysis Historical pathways Water and design Restoration Ecosystems and cultural services	Amman Jordan	Daylighting streams can reconnect cities with their natural waterscapes through multi-scale connectivity, which can also enhance cultural needs
Ablutionary Urbanisms: Water Infrastructures, Cultural Production and Charitable Dispensation Muller	Local water infrastructure Water and culture Integrative design	Cairo, Egypt	Urban water systems can be designed to be prominent components for civic engagement, but examples are few, especially from non-Western cultures
Hybrid and Multi-Level Adaptive Governance for Sustainable Urban Transformations in the Global South: A Secondary City Case Study Yasmin et al.	Adaptive governance Hybrid infrastructure Social networks Institutions Sustainability transitions Power and decisions	Mymensingh City, Bangladesh	Decision-making for urban water management can strengthen planning outcomes by recognizing and incorporating voices from both formal and informal institutions that comprise planning networks
Role of neighborhood design in reducing impacts of development and climate change, West Sherwood, OR Tchintcharauli-Harrison et al.	Stormwater Climate change Green infrastructure Engineering analysis Development and planning Scenarios, LID, design	Oregon, USA, North American Pacific Northwest	Scenario planning can be a powerful tool to evaluate climate change adaptation, but current models and tools may not be well-suited to include landscape design or socioeconomic perspectives
Integrating urban planning and water management through green infrastructure in the United States-Mexico border Lara-Valencia et al.	Green infrastructure Development Trans-boundary planning Engagement Ecosystem restoration Governance Urbanization dynamics	U.S.-Mexico Border, Nogales Arizona-Mexico	Urban design and green infrastructure can bring together landscapes and peoples that are artificially divided by politics. Multicriteria analysis can incorporate planning goals across disciplines

water, and collect and dispose of wastewater that is not reused or recovered. Urban sprawl can build in path dependencies that continue high rates of water use. In the absence of adaptive actions, residents' responses to climate change based on status quo expectations and assumptions of per capita resources use will likely outstrip existing natural resources; for water, this is especially acute for urban areas located in arid and semi-arid regions (Heidari et al.). This is an example of how modern urban life is highly resource and energy-intensive (Kennedy et al., 2015; Goldstein et al., 2020). Better designs, which connect people with resources and the local environments around them and consider interconnectedness in social-ecological-technological systems, can help mitigate path dependencies and, over the course of the twenty-first Century, promote adaptation for climate change (Markolf et al., 2018; UNEP, 2021). Urban water system designs must incorporate both social and technological considerations to be sustainable. In the industrial era, large water systems have disconnected people from the (often) distant locations and expensive facilities needed that facilitate readily available water from the average household tap (Thayer, 1994; Strang, 1996).

If urban water systems are solely designed by experts and do not consider communities and users, they will likely result in inadequate and inequitable systems. In some cases, the natural landscapes that comprise an urban watershed or water system span geographic and political boundaries. Rivers cross between states, territories, and countries. Runoff flows from one jurisdiction to another. Without joint management and shared recognition of needs, overuse by one group can induce scarcity for another, while dumping wastes creates downstream water quality challenges for residents elsewhere in the watershed. As demonstrated in the case study in Western Australia, integrated approaches can address the inadequacies of current policies and pathways by building a broader planning approach that includes social-ecological systems and resilience theory (Nanda et al.). In Bangladesh, Yasmin et al. demonstrate the significance of governance across scales and networks and the recognition of both informal and formal institutions in addressing water development needs. The U.S.-Mexico border has been an acute example of both cooperation and competition for decades, from the 1944 Treaty of Hidalgo that allocated water resources for the Rio Grande/Rio Bravo, to contemporary understanding of how border walls segment shared ecosystems, watersheds, and culture (Sandoval-Solis and McKinney, 2012; Porse et al., 2015). Green infrastructure planning that spans political boundaries can help alleviate artificial segmentation, helping redraw water systems to even erase, if in mind, some artificial political lines (Lara-Valencia et al.). Even small interventions can have noticeable beneficial impacts, but failing to think about water planning in long-term and holistic ways likely leads to inadequate designs that perpetuate problems of the status quo (Heidari et al.; Lara-Valencia et al.).

Equity as a focus of research

We published this call during a time of extreme disruption from a global pandemic and awakening to systemic injustice in society. The groundswell of support for the Black Lives Matter movement after the murder of George Floyd in the U.S. raised awareness of persistent injustice in our social, political, and economic systems. The global response to the pandemic associated with the novel Coronavirus disease of 2019 (COVID-19) and its subsequent variants was affecting all facets of society. In North America, the pandemic response revealed yet again the severe and systemic inequities present in U.S. cities (Benjamin, 2022). The pandemic response highlighted how, without concerted action, future global disruptions in the twenty-first century are likely to continue to disproportionately affect those most in need. The research community is responding to this call with greater focus on issues of racial and socioeconomic diversity and equity. However, this collection does not explicitly include articles with equity as the main focus. Reincorporating equity and the value of public institutions into the management, planning, and design of all aspects of cities, including urban water systems, is a central challenge for both scholars and practitioners.

If history is a guide, interdisciplinary research must not recede from tackling issues of environmental justice at the intersection of management, planning, and design of urban water systems. Infrastructure development in many places had marginalizing effects due to underlying racist and exclusionary policies. Uneven distributions of power determine who has access to decision-making venues and resources for adaptation. Environmental justice research in the U.S. has documented that toxic and hazardous facilities are disproportionately located in close proximity to African American and Hispanic neighborhoods (Mohai and Bryant, 2019). In the meantime, minority neighborhoods have less access to quality parks and recreation, urban trees, and ecosystem services in many American cities, which results in inequitable exposure to hazards such as extreme heat (Boone, 2002; Trounstine, 2018). Yasmin et al. highlight opportunities for, and barriers to, reorganizing these distributions in their case study of Mymensingh in Bangladesh in this Research Topic.

Renewed focus on urban inequality is critical, and can build on the insights of the past. As an example, in the nineteenth century, Friedrich Engels observed the conditions that some urban residents endured:

> *"The view from this bridge, mercifully concealed from mortals of small stature by a parapet as high as a man, is characteristic for the whole district. At the bottom flows, or rather stagnates, the Irk, a narrow, coal-black, foul-smelling stream, full of debris and refuse, which it deposits on the shallower right bank… Below the bridge you look upon the piles of debris, the refuse, filth, and offal from the courts on the steep left bank; here each house is packed close behind its neighbor and a piece of each is visible, all black, smoky, crumbling, ancient, with broken panes and window- frames. The background is furnished by old barrack-factory buildings. On the lower right bank stands a long row of houses and mills; the second house stand so low that the lowest floor is uninhabitable, and therefore without windows or doors"* (Engels, 1887).

In Europe and North America, the onset of the sanitarian movement in the late nineteenth century began to address the systemic inequities observed by Engels. An historical perspective leads us to questions for today: what equivalent movements will become institutionalized to deal with persistent inequality in modern cities and promote equitable adaptation in twenty-first century urban water management?

Concluding thoughts: Future interdisciplinary research for sustainable urban water systems

The submissions to this Research Topic highlighted the need for publication outlets that value diverse methodological approaches and are not beholden to disciplinary fields. Compiling these contributions under the umbrella of a Research Topic may instigate reading across disciplines of engineering, design, anthropology, and social-ecological systems analysis. In our experience, undertaking such research presents many challenges. For instance, doing truly interdisciplinary work requires teams with capacity to translate information across methodological traditions and language barriers. Also, research funding agencies are often driven toward reductionist studies focused on generating new knowledge within a particular discipline or set of closely related disciplines, rather than work that broadly spans disciplines. Finally, the applied questions that often arise at the intersection of fields and modes of practice may be particularly difficult to address with sufficient certainty that meets common standards of research outcomes.

More incentives are needed for interdisciplinary and transdisciplinary research in sustainable urban transitions, and particularly research that integrates urban design. Urban residents' perceptions of water systems relate closely to how they value water as a scarce resource (Kearns, 2017). Many see water as passively delivered to taps for consumption, even as it originates from the environmental systems where we recreate and grow food. The field and practice of urban design can help city residents to become more connected with surrounding environmental systems, both physically and mentally. Moreover, reimagining urban water systems as hybridized amalgamations of existing centralized and new distributed devices requires significant innovations in management and design (Muller et al., 2022). Limited research has tackled these challenges. They are not simply technological; they are multifaceted. Our most significant challenges for managing urban resources are often institutional. Such integrated work for resilient and regenerative infrastructure systems is difficult within management siloes that date back over a century (Pincetl, 1999). Further incentives and opportunities for researchers to work across boundaries and work with industry and practitioners is essential for a future where urban infrastructure systems such as water are meaningfully contributing to broad goals for justice and sustainability.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

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References

Benjamin, G. (2022). Why African Americans are dying at higher rates from COVID-19 in the USA. *The Monitor*. Available online at: https://www.monitor.co.ug/News/National/Why-African-Americans-are-dying-at-higher-rates-from-COVID-19/688334-5517924-x8qdogz/index.html (accessed August 17, 2022).

Boone, C. G. (2002). An assessment and explanation of environmental inequity in Baltimore. *Urban Geogr.* 23, 581–595. doi: 10.2747/0272-3638.23.6.581

Chang, H., Pallathadka, A., Sauer, J., Grimm, N. B., Zimmerman, R., Cheng, C., et al. (2021). Assessment of urban flood vulnerability using the social-ecological-technological systems framework in six US cities. *Sustain. Cities Soc.* 68, 102786. doi: 10.1016/j.scs.2021.102786

Cheng, C., Yang, Y. C. E., Ryan, R., Yu, Q., and Brabec, E. (2017). Assessing climate change-induced flooding mitigation for adaptation in Boston's Charles River watershed, USA. *Landsc. Urban Plan.* 167, 25–36. doi: 10.1016/j.landurbplan.2017.05.019

Daigger, G. (2011). Sustainable urban water and resource management. *The Bridge* 41, 13–18.

Engels, F. (1887). *The Condition of the Working Class in England (Die Lage der arbeitenden Klasse in England)*. Leipzig, Germany: Otto Wigand.

Goldstein, B., Gounaridis, D., and Newell, J. P. (2020). The carbon footprint of household energy use in the United States. *Proc. Natl. Acad. Sci. USA*. 117, 19122–19130. doi: 10.1073/pnas.1922205117

Guswa, A. J., Hall, B., Cheng, C., and Thompson, J. R. (2020). Co-designed land-use scenarios and their implications for storm runoff and streamflow in New England. *Environ. Manag.* 66, 785–800. doi: 10.1007/s00267-020-01342-0

Hughes, S., and Hoffmann, M. (2020). Just urban transitions: toward a research agenda. *WIREs Clim. Change* 11. doi: 10.1002/wcc.640

Kearns, F. (2017). *Making the Invisible Visible: Connecting Home Water Use and City Infrastructure Using Participatory Design.* The Confluence: California Institute for Water Resources. Available online at: https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=24061 (accessed July 15, 2022).

Kennedy, C. A., Stewart, I., Facchini, A., Cersosimo, I., Mele, R., Chen, B., et al. (2015). Energy and material flows of megacities. *Proc. Natl. Acad. Sci. USA* 112, 5985–5990. doi: 10.1073/pnas.1504315112

MacDonald, R. I., and Shemie, D. (2014). *Urban Water Blueprint.* Arlington, VA: The Nature Conservancy Available online at: https://water.nature.org/waterblueprint/#/intro=true (accessed August 17, 2022).

Markolf, S. A., Chester, M. V., Eisenberg, D. A., Iwaniec, D. M., Davidson, C. I., Zimmerman, R., et al. (2018). Interdependent infrastructure as linked social, ecological, and technological systems (SETSs) to address lock-in and enhance resilience. *Earth's Future* 6, 1638–1659. doi: 10.1029/2018EF000926

Mohai, P., and Bryant, B. (2019). *Race and the Incidence of Environmental Hazards: A Time for Discourse.* Abingdon, Oxon: Routledge. Available online at: https://search.ebscohost.com/login.aspx?direct=trueandscope=siteanddb=nlebkanddb=nlabkandAN=2177312 (accessed July 29, 2022).

Muller, B., Amon, A., Cerra, J., Cheng, C., Feldman, D., Lau, T., et al. (2022). "Redrawing our urban waters: Merging design, law, and policy in advancing distributed water systems," in *The Routledge handbook of sustainable cities and landscapes in the Pacific Rim Routledge international handbooks*, eds. Y. Yang and A. Taufen (Abingdon, Oxon; New York, NY: Routledge).

Novotny, V. (2007). "Cities of the future : towards integrated sustainable water and landscape management," in *Proceedings of an international workshop held July 12–14, 2006 in Wingspread Conference Center, Racine, WI*. London: IWA Publishing.

Novotny, V., Ahern, J., and Brown, P. (2010). *Water Centric Sustainable Communities : Planning, Retrofitting, and Building the Next Urban Environment.* Hoboken, NJ: Wiley.

Odum, H. T. (1971). *Environment, Power, and Society*. New York: Wiley-Interscience.

Pincetl, S. (1999). *Transforming California, a Political History of Land Use in the State*. Baltimore, MD: Johns Hopkins University Press.

Porse, E., Sandoval-Solis, S., and Lane, B. A. (2015). Integrating environmental flows into multi-objective reservoir management for a transboundary, water-scarce river basin: Rio Grande/Bravo. *Water Resour. Manag.* 29, 2471–2484. doi: 10.1007/s11269-015-0952-8

Sandoval-Solis, S., and McKinney, D. C. (2012). Integrated water management for environmental flows in the Rio Grande. *J. Water Resour. Plan. Manag.* 2012:121107213312003. doi: 10.1061/(ASCE)WR.1943-5452.0000331

Strang, G. (1996). Infrastructure as landscape. *Places* 10, 8–15.

Tarr, J., McCurley, J., McMichael, F., and Yosie, T. (1984). Water and wastes: a retrospective assessment of wastewater technology in the U.S., 1800–1932. *Technology and Culture* 25, 226–263.

Tellman, B., Bausch, J. C., Eakin, H., Anderies, J. M., Mazari-Hiriart, M., Manuel-Navarrete, D., et al. (2018). Adaptive pathways and coupled infrastructure: seven centuries of adaptation to water risk and the production of vulnerability in Mexico City. *EandS* 23, art1. doi: 10.5751/ES-09712-230101

Thayer, R. L. (1994). *Gray World, Green Heart: Technology, Nature, and Sustainable Landscape*. New York: Wiley.

Trounstine, J. (2018). *Segregation by Design: Local Politics and Inequality in American Cities*. New York: Cambridge University Press.

UNEP (2021). *Global Environmental Outlook for Cities*. Nairobi, Kenya: United Nations Environment Program. Available online at: https://www.unep.org/resources/report/geo-cities-towards-green-and-just-cities (accessed August 17, 2022).

Wild, T. C., Henneberry, J., and Gill, L. (2017). Comprehending the multiple 'values' of green infrastructure—valuing nature-based solutions for urban water management from multiple perspectives. *Environ. Res.* 158, 179–187. doi: 10.1016/j.envres.2017.05.043