



# Not all risks are equal: a risk governance framework for assessing the water SDG

Johanna Karolina Louise Koehler<sup>1,2</sup> 

Accepted: 22 June 2023 / Published online: 6 July 2023  
© The Author(s) 2023

## Abstract

While it becomes apparent that the sustainable development goal for water will likely not be met by 2030, the first UN Water Conference in almost half a century has produced a large number of non-binding commitments and pledges, thus falling short of closing the global governance gap that is widening through climate change. This article adopts a risk governance perspective and provides reflections and recommendations on the need for coordination, critical evaluation, integration and a deeper understanding of risk perceptions and responses related to the water SDG across public, private and civil society actors. Drawing on van Asselt and Renn, the paper proposes a water risk governance framework applying the principles of communication and inclusion, integration, and reflection, to assessing progress toward the water SDG. Focusing on the transformation of water services, it discusses who is represented, whose risks are perceived and responded to, and who is responsible for providing evidence and scaling innovation. It concludes that for scaling up four elements are necessary, including institutional innovation, financing mechanisms, monitoring, as well as social and policy uptake.

**Keywords** SDG 6 · UN, 2023 Water Conference · Water policy · Risk governance · Transformation · Hybridity

## Abbreviations

SDG Sustainable Development Goal  
UN United Nations

---

✉ Johanna Karolina Louise Koehler  
johanna.koehler@vu.nl

<sup>1</sup> Institute for Environmental Studies, Vrije Universiteit Amsterdam, De Boelelaan 1111, 1081 HV Amsterdam, The Netherlands

<sup>2</sup> School of Geography and the Environment, University of Oxford, South Parks Road, OX1 3QY Oxford, United Kingdom

## 1 The current state of the water SDG

The world faces an imminent risk of a global water crisis according to the United Nations World Water Development Report 2023 (UN, 2023) launched at the second UN Water Conference in almost half a century. Globally, two billion people (26% of the population) do not have access to safe drinking water and 3.6 billion (46%) lack access to safely managed sanitation. As the climate changes, droughts that may have occurred once every ten years now happen approximately every three years (Rodell & Li, 2023). By 2050, droughts are likely to affect over three-quarters of the world's population (UNCCD, 2022).

Breaking down the risks of a global water crisis to make them governable is a complex challenge. The targets of the Sustainable Development Goal for Water (SDG 6) do so by focusing on drinking water, sanitation, water quality risks, questions of water-use efficiency, integrated water resource management as well as the protection and restoration of water-related ecosystems (UN, 2015). Importantly, both expanding international cooperation and strengthening the participation of local communities are highlighted as essential in ensuring the availability and sustainable management of water and sanitation for all (UN, 2015). While the global governance of water concerns all elements of SDG 6 as well as the oceans, seas and marine resources (SDG 14), in this perspective, I focus on the drinking water challenge (SDG 6.1) as a core component of the imminent global water crisis. I argue that for the sustainable transformation of drinking water services, we need to better account for the different risk perceptions and responses of actors from government, market, and civil society across a range of environmental, financial, operational, social, political and institutional risks. As risk perceptions and preferred responses often diverge and clash across these actors, progress toward the water SDG can slow down or be blocked. The water risk governance framework proposed below includes these actors in a 'governance triangle' to assess their role in reflecting on, communicating and integrating core risks into strategies toward achieving the water SDG. This process of negotiation captures indispensable elements for transformative change in general form, so it can be applied to different contexts and serve the analysis of water risks globally in the run-up to the 2023 UN SDG summit.

With the 2030 Sustainable Development Goal Agenda, the UN formally recognized the need to take a critical look at the state of the world's water resources and declared the period between 2018 and 2028 the "International Decade for Action of Water for Sustainable Development" (A/RES/71/222) (UN, 2018). However, recent studies find that none of the SDG 6 targets is likely to be delivered by 2030, and increases in water-use efficiency (SDG target 6.4) alone will neither ensure sustainable water withdrawals nor reduce the number of people suffering from water scarcity, while key data gaps remain (Grafton et al., 2023; Sadoff et al., 2020).

With the goal of averting a global water crisis, the world convened in New York from 22 to 24 March 2023 for the second UN Water Conference 46 years after the first UN Water Conference in Mar del Plata in Argentina to assess the midway point of the Water Action Decade (Grafton et al., 2023). The conference has produced some momentum for advancing the governance priority for water globally, including the agreement to establish a UN Special Envoy for Water, approximately 700 voluntary commitments, and pledges that amount to around USD 300 billion (UN, 2023). There was a discernible change to previous global conferences with increasing discussions on linking the governance of hydrological extreme events and water, sanitation, and hygiene services. However, Biswas and Tortajada

(2023) call for more innovative solutions to meet the increasingly complex task of water management.

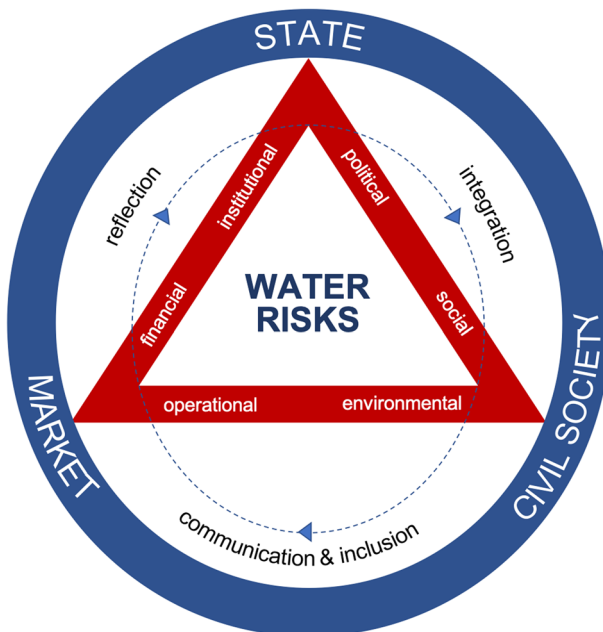
I argue here that the 2023 SDG Summit should follow up on the conference pledges to ensure that innovative governance structures are put in place, on the one hand to follow through with the implementation of these pledges, but on the other hand to critically evaluate how they connect, whether they form a concerted response to the global water challenge, and to determine where efforts counter those of others. To move forward, further dialogue is needed that takes risk perceptions and responses from different perspectives and various contexts into account. As “not all risks are equal” and risk perceptions vary (Health Council of the Netherlands, 1995; van Asselt & Renn, 2011), an overlapping consensus has to be found across public, private and civil society actors, including marginalized voices. Rather than the number of commitments and pledges, it is the depth and foresight of the agreements developed in dialogue between the stakeholders what counts. For the agreements to be sustainable, the integration of relevant knowledge, experience, values and ongoing self-reflection are essential. This is captured in the water risk governance framework below and may be applicable beyond water services.

## 2 A water risk governance perspective

The challenges to transforming conference pledges into sustainable water governance across scales are linked to institutional, infrastructural and behavioral lock-ins (Global Commission on the Economics of Water, 2023). These lock-ins are conditions that resist change through a variety of factors detailed below. Institutional lock-in may result from dominant discourse (for example, prioritizing efficiency over equity), insensitive laws and policies, economic rules, existing property rights through land rights, permits and contracts (Seto et al., 2016), cemented fragmentation of governance, inadequate (de)centralization (for example, through a lack of allocated resources) and limited agency for citizens, women, children, Indigenous Peoples, local communities, and civil society (Global Commission on the Economics of Water, 2023; Grafton et al., 2023). Infrastructural lock-in may occur through underinvestment and non-existent or limited service, particularly in rural areas of low-income countries. Divergently, behavioral lock-in is affected by social structures and norms, as knowledge and value systems may influence risk perceptions and thus investment and planning decisions. This frequently exacerbates the state of drinking water for many poorer and minority communities, who typically live in locations more prone to flooding. Another important challenge is the mismatch between water research priorities and needs in the Global South (Smith et al., 2023). Some of these challenges and lock-ins have been discussed in previous INEA publications (Gupta & Vegelin, 2016). Access to water and sanitation services, promoted by the human right to water and the SDGs, may be strengthened through court cases, for which knowledge on both access and allocation is essential (Hurlbert, 2020). Examining allocation via treaty and policy design, Gerlak et al. (2011) focus on fairness through transparency and data exchange, while Conti and Gupta (2016) emphasize principles of water governance (such as equitable and reasonable utilization, stakeholder participation, and the polluter-pays principle). Across such negotiations over treaties and policy design as well as SDG implementation strategies varying risk perceptions and responses are evident that play an important role in the decision-making processes to overcome existing lock-ins and challenges.

For progress toward the availability and sustainable management of water (SDG 6), it is essential to examine how the attributes of the human system and its dynamics, in particular the governance system, can be changed toward more “effective, feasible, and just solutions,” (IPCC, 2022, p. 111) by investigating state, market and civil society interactions across multiple scales. I argue that progress toward and attainment of the water SDG requires investigation of the core risks as perceived by the actors involved in these transformations, including how the risks shape the institutions around them to increase their risk-managing capability. The term ‘risk governance’ involves the translation of the substance and core principles of governance outlined below into the context of risk-related decision-making (van Asselt & Renn, 2011). Actors, however, respond to risks according to their own risk constructs and notions, yielding multiple meaningful and legitimate interpretations of risk assessment outcomes (Keeney, 2004). As a consequence, whether risks are acceptable or not could be fiercely debated. Van Asselt and Renn (2011) therefore propose three principles for risk governance that are recognized here as critically important for advancing the water SDG globally: (i) communication and inclusion, (ii) integration, and (iii) reflection. The complexity of water-related challenges requires multi-level governance and coordination across different governance levels and sectors (Gupta et al., 2013), whose risk perception and institutional culture may vary significantly.

This paper proposes a water risk governance framework (Fig. 1) which suggests that the perceptions and responses from different state, market and civil society actors to risks that hamper progress toward the water SDG, including operational, financial, social, political, institutional and environmental risks, require communication and inclusion in dialogue, reflection on the complexity of the problem and the way forward, and the integration of relevant knowledge and different values into the policy process. According to van Asselt and



**Fig. 1** Water risk governance framework (source: author)

Renn (2011), these three principles do not constitute separate steps or stages but should be considered at every stage in the risk governance process by all actors. This is indicated through the rotating circle in the framework. The institutional, infrastructural and behavioral lock-ins identified by the Global Commission on the Economics of Water (2023) are related to the risks associated with the management and governance of water quantity and quality challenges. Their occurrence and combination vary across different contexts. The framework is useful for assessing the lock-ins and specifically for which risks the processes of communication and inclusion, integration and reflection are lacking or limited among the different state, market and civil society actors as well as who takes responsibility for managing these risks. Disputes between different societal camps over wicked problems usually require solutions which combine (inter)governmental action, civil society engagement, (social) entrepreneurship, and technological innovation to satisfy different stakeholders with varying motivations and normative perspectives. Referring to such solutions to problems, Rawls (1989) speaks of the domain of “overlapping consensus,” and Shapiro (1988) coined the term “clumsy solutions,” which help maintain the integrity of a set of values over time. The quest to achieve such clumsy solutions in water governance appears critical to enhance sustainability, and the following questions and reflections are proposed to be taken into the SDG Summit and discussions beyond.

### 3 Governing risks for universal water services

It is the objective of the proposed risk governance framework to contribute to bridging the governance gap that prevents water services from achieving SDG 6.1. Its core elements can be operationalized to examine the number, distribution and responsibilities of the actors involved and how they apply van Asselt and Renn’s (2011) three principles to each of the risks for risk mitigation.

When applying the water risk governance framework to water services, it is important to acknowledge that water risks and the risks of managing water service provision vary depending on the perspective of the user, service provider, government or international agency. Water utilities face growing societal and environmental pressure to develop innovative institutions – rules, norms and strategies (Crawford & Ostrom, 1995) – that can address the dilemma of expanding access to services while keeping them affordable and sustainable (Foster, 2013; Hope et al., 2019; Sachs et al., 2019; Tosun & Leininger, 2017; WHO/UNICEF, 2017). As a consequence, hybrid governance arrangements characterized by collaborative forms of governance are emerging globally in addition to community-based organizations, public and private service providers. If adopting innovative approaches, these arrangements may aim to address the *financial risks* around revenue and subsidies to bridge the USD 140 billion capital investment gap in an endeavor to meet the targets of the water SDG (Hutton & Varughese, 2016; Libey et al., 2020), while accommodating for *environmental risks*, for example from contamination or extreme weather-related events affecting the available quantity and quality of water (Horne et al., 2018; Nowicki et al., 2020), *operational risks* around infrastructure and service reliability (Foster et al., 2018; Whaley et al., 2021), and *socio-political risks* around distribution issues, legal provisions and uptake (Koehler, 2018; Rayner, 1993; Sultana & Loftus, 2012; Wilder & Ingram, 2018). *Institutional risks* may be determined by the separation of powers between policy, service delivery, and regulation, and the degree of autonomy in managing service delivery (Bakker, 2003; Hope et al., 2019; Koehler et al., 2022). Addressing the

universal-access-versus-affordability dilemma depends on the utilities' capacity to mitigate these risks. Hybrid arrangements intrinsically provide the opportunity for reflection, integration, communication and inclusion thus accounting for varying risk perceptions. Due to specific expertise of state, market and civil society actors within hybrid service providers, and despite the possibility of conflict between them, there seems to be potential in allocating the risks to where they are most effectively managed while accommodating for environmental impacts around water scarcity and quality.

### 3.1 Who's at the table?

With regard to the principle of *communication and inclusion*, the potential of collaborative forms of governance with public, private and/or civil society representation should be further explored to deal with increasing operational, financial, social, political, institutional and environmental risks to advance more resilient, equitable and sustainable outcomes. Understanding how risks are distributed and managed across state, market and community arrangements is essential for aligning contractual arrangements, the professionalization of water services and how they are regulated. Examining the resulting portfolio of risk mitigation strategies across contexts helps to understand and potentially interfere with the pace, scope and depth of water service transformations. Hybrid forms prevail in contemporary governance and are even purposefully designed (Pahl-Wostl et al., 2020). They may lead to a better distribution of risks to where they are best managed if an overlapping consensus between the different representations is negotiated, so the form of hybridity is adjusted to the context (Brandsen & Karré, 2011; Koehler et al., 2018; Lemos & Agrawal, 2006; Rawls, 1989; Verweij et al., 2006). An example would be blended finance mechanisms (Money, 2018) as part of performance-based contracts for rural water service providers operating in a last-mile context in Africa and Asia (McNicholl et al., 2019, 2020). They can support sustainable service transitions by including several stakeholders thus ensuring that user payments are topped up by private and public sources of funding based on the criteria of equity, use and scale. While it is acknowledged that financial risks have to be included in discussions among stakeholders to have a chance of being mitigated, further reflection is important on the fact that such arrangements can perform the function of non-state quasi-regulators and whether they can indeed overcome the stagnation deployed by the UN Secretary General in the 2021 progress report on SDGs (UN, 2021).

### 3.2 Whose risks?

*Reflection* on inclusion and exclusion must be encouraged to avoid perpetuating injustice in new policies that deal with risks to universal water services. The concept of social construction of risk (Douglas, 1985; Johnson & Swedlow, 2021; Wildavsky, 1987) in policy design raises awareness for specific target populations that have been (dis)advantaged by previous policies (Chard et al., 2019; Ingram & Schneider, 1991; Ingram et al., 2007; Lasswell, 1936). Understanding the risk perceptions and preferred responses by representatives of different groups, including Indigenous People, youth, and other marginalized groups, are essential for inclusive transformations across scales and constitute a significant research and practice gap for advancing SDG 6. If transformations in the water sector occur horizontally between different states or units through policy diffusion and uptake (Gilardi & Wasserfallen, 2019; Gray, 1973; Jordan & Huitema, 2014), thorough analysis is required

to develop optimal adaptation strategies for contextualizing the process and outcome of the transformation. In hierarchical transformations between (inter-)national and sub-national entities, the role of legal and financial mandates has to be considered to ensure inclusivity. Gaining detailed knowledge on the role of policy diffusion and power asymmetries in transformational change is critical.

### 3.3 Whose metrics, who's responsible?

Furthering the *integration* of science and policy is critical to the necessary understanding for addressing complex emergent water challenges (Varady et al., 2023). It is time to think more creatively about shared problem-solving, including inter- and transdisciplinary settings, providing clearer pathways for science to inform critical decisions, for example through supporting the implementation of the Intergovernmental Science-Policy Platform for Water Sustainability (2023). Two important recommendations in the science-policy interface are highlighted here. First, data gaps but also ways of measuring are abundant. Further dialogue on what (and what not) we measure, why, and how is an important element of risk governance, which should be advanced in the communication and translation of water-related hazards into decision-making processes globally to ensure comparability while recognizing the different value systems underlying such processes. Second, the role of governments is critical in scaling up pilots developed through research and innovative practices by local organizations to meet the objectives of the 2030 Agenda for Sustainable Development. For example, this is important in the rural water services sector, particularly in the global South, as these areas are often considered commercially unviable (Koehler et al., 2018). Government is thus critical with regard to facilitating patterns of change, for example integrating emerging governance models in policy design and law, enabling agency of policy entrepreneurs through administrative and financial support, and exercising oversight to legitimize the transformational process (Hood et al., 2001). Scoones et al. point to “state-led transformations” (2015) to re-embed markets in stronger frameworks of social control, and Mazzucato (2013) recognizes the “green entrepreneurial state’s” central role in institutional innovation and financing. These key recommendations should be considered at the 2023 UN SDG Summit if the dramatic acceleration is to be achieved that has been called for by the UN Secretary General both in the progress report on SDGs (UN, 2021) and at the 2023 New York Water Conference.

## 4 Conclusion

Not all water risks are equal. Their construction, perception, communication and mitigation challenge the making of international treaties with regard to water as recent discussions at the UN Water Conference highlighted. They vary across state, market and civil society actors as well as across temporal, spatial and institutional scales (Cash et al., 2006). This paper suggests that for progress toward the water SDG to occur, reflection, communication, inclusion and integration in policies and implementation strategies across a number of water-related risks – be they environmental, financial, operational, social, political or institutional – need to be aligned to allow for transformational change to build momentum. Four elements appear to be necessary, including institutional innovation, adequate financing mechanisms, monitoring and social and policy uptake. If patterns of change (escaping



lock-in mechanisms that prevent transformation), innovations (for example through new governance models) and agency (for example by policy entrepreneurs or effective collaborators) (Brouwer & Huitema, 2018; Huitema & Meijerink, 2009) are well-aligned (Olsson et al., 2014), the depth, scope and pace of transformation may be increased. The water risk governance framework proposed here may help to ask questions that can assist in integrating these elements in the quest to advance clumsy agreements, to assess the achievement of the water SDG, and to examine to what extent the pledges made at the UN Water Conference are being pursued; however, whether innovative arrangements can reach global scale and become binding or persist at local and regional scales remains to be seen.

**Funding** This manuscript was written as part of the Dutch Research Council funded Veni project “Risk-pooling and institutional innovation for sustainable water service transitions (RiskPOOL).”

**Data availability** Not applicable.

## Declarations

**Conflict of interest** The author has no competing interests to declare that are of relevance to the content of this article.

**Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

## References

- Bakker, K. J. (2003). From public to private to ... mutual? Restructuring water supply governance in England and Wales. *Geoforum*, 34(3), 359–374. [https://doi.org/10.1016/S0016-7185\(02\)00092-1](https://doi.org/10.1016/S0016-7185(02)00092-1)
- Biswas, A. K., & Tortajada, C. (2023). United Nations water conferences: Reflections and expectations. *International Journal of Water Resources Development*, 39(2), 177–183. <https://doi.org/10.1080/07900627.2023.2176655>
- Branden, T., & Karré, P. M. (2011). Hybrid organizations: No cause for concern? *International Journal of Public Administration*, 34(13), 827–836. <https://doi.org/10.1080/01900692.2011.605090>
- Brouwer, S., & Huitema, D. (2018). Policy entrepreneurs and strategies for change. *Regional Environmental Change*, 18(5), 1259–1272. <https://doi.org/10.1007/s10113-017-1139-z>
- Cash, D. W., Adger, W. N., Berkes, F., Garden, P., Lebel, L., Olsson, P., Pritchard, L., & Young, O. (2006). Scale and Cross-Scale Dynamics. *Ecology and Society*, 11(2). <http://www.jstor.org/stable/26265993>
- Chard, R., Messel, M., Rogofsky, D., & Scott, K. (2019). *Social construction of target population: A quantitative application of Schneider and Ingram’s Theory* (CESR-Shaaffer Working Paper Series).
- Conti, K. I., & Gupta, J. (2016). Global governance principles for the sustainable development of groundwater resources. *International Environmental Agreements: Politics, Law and Economics*, 16(6), 849–871. <https://doi.org/10.1007/s10784-015-9316-3>
- Crawford, S. E. S., & Ostrom, E. (1995). A grammar of institutions. *The American Political Science Review*, 89(3), 582–600. <https://doi.org/10.2307/2082975>
- Douglas, M. (1985). *Risk acceptability according to the social sciences*. Russel Sage Foundation.
- Foster, T. (2013). Predictors of sustainability for community-managed handpumps in Sub-Saharan Africa: Evidence from Liberia, Sierra Leone, and Uganda. *Environmental Science and Technology*, 47, 12037–12046.



- Foster, T., Willetts, J., Lane, M., Thomson, P., Katuva, J., & Hope, R. (2018). Risk factors associated with rural water supply failure: A 30-year retrospective study of handpumps on the south coast of Kenya. *Science of The Total Environment*, 626, 156–164. <https://doi.org/10.1016/j.scitotenv.2017.12.302>
- Gerlak, A. K., Lautze, J., & Giordano, M. (2011). Water resources data and information exchange in trans-boundary water treaties. *International Environmental Agreements: Politics, Law and Economics*, 11(2), 179–199. <https://doi.org/10.1007/s10784-010-9144-4>
- Gilardi, F., & Wasserfallen, F. (2019). The politics of policy diffusion. *European Journal of Political Research*, 58(4), 1245–1256. <https://doi.org/10.1111/1475-6765.12326>
- Global Commission on the Economics of Water. (2023). *The What, Why and How of the World Water Crisis*. <https://turningthetide.watercommission.org/>
- Grafton, Q. R., Biswas, A. K., Bosch, H., Fanaian, S., Gupta, J., Revi, A., Sami, N., & Tortajada, C. (2023). Goals, progress and priorities from Mar del Plata in 1977 to New York in 2023. *Nature Water*, 1(3), 230–240. <https://doi.org/10.1038/s44221-023-00041-4>
- Gray, V. (1973). Innovation in the states: A diffusion study. *American Political Science Review*, 67(4), 1174–1185. <https://doi.org/10.2307/1956539>
- Gupta, J., Pahl-Wostl, C., & Zondervan, R. (2013). Glocal water governance: A multi-level challenge in the anthropocene. *Current Opinion in Environmental Sustainability*, 5(6), 573–580. <https://doi.org/10.1016/j.cosust.2013.09.003>
- Gupta, J., & Vegelin, C. (2016). Sustainable development goals and inclusive development. *International Environmental Agreements: Politics, Law and Economics*, 16(3), 433–448. <https://doi.org/10.1007/s10784-016-9323-z>
- Health Council of the Netherlands. (1995). *Not all risks are equal: A commentary on "Premises for Risk Management."*
- Hood, C., Rothstein, H., & Baldwin, R. (2001). *The government of risk: Understanding risk regulation regimes*. Oxford University Press.
- Hope, R., Foster, T., Koehler, J., & Thomson, P. (2019). Rural Water Policy in Africa and Asia. In J. Daddon, S.J., Garrick, D.E., Penning-Rowsell, E.C., Hall, J.W., Hope, R. and Hughes (Ed.), *Water Science, Policy and Management: A Global Challenge*. Wiley.
- Horne, J., Tortajada, C., & Harrington, L. (2018). Achieving the sustainable development goals: Improving water services in cities affected by extreme weather events. *International Journal of Water Resources Development*, 34(4), 475–489. <https://doi.org/10.1080/07900627.2018.1464902>
- Huitema, D., & Meijerink, S. (2009). *Water policy entrepreneurs: a research companion to water transitions around the globe*. Edward Elgar Publishing.
- Hurlbert, M. (2020). Access and allocation: Rights to water, sanitation and hygiene. *International Environmental Agreements: Politics, Law and Economics*, 20(2), 339–358. <https://doi.org/10.1007/s10784-020-09484-6>
- Hutton, G., & Varughese, M. (2016). *The costs of meeting the 2030 sustainable development goal targets on drinking water, sanitation, and hygiene*. The World Bank.
- Ingram, H., & Schneider, A. (1991). The choice of target populations. *Administration & Society*, 23(3), 333–356. <https://doi.org/10.1177/009539979102300304>
- Ingram, H., Schneider, A. L., & DeLeon, P. (2007). Social construction and policy design. In P. Sabatier (Ed.), *Theories of the Policy Process* (pp. 93–129). Westview Press.
- Intergovernmental Science-Policy Platform for Water Sustainability. (2023). *Summary: A Game-Changer For UN 2023 Water Conference*. [https://udallcenter.arizona.edu/sites/default/files/2023-04/Game Changer Summary Paper.pdf](https://udallcenter.arizona.edu/sites/default/files/2023-04/Game%20Changer%20Summary%20Paper.pdf)
- IPCC. (2022). *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Lösschke, V. Möller, A. Okem, & B. Rama (eds.)). Cambridge University Press.
- Johnson, B. B., & Swedlow, B. (2021). Cultural theory's contributions to risk analysis: A thematic review with directions and resources for further research. *Risk Analysis*, 41(3), 429–455. <https://doi.org/10.1111/risa.13299>
- Jordan, A., & Huitema, D. (2014). Innovations in climate policy: The politics of invention, diffusion, and evaluation. *Environmental Politics*, 23(5), 715–734. <https://doi.org/10.1080/09644016.2014.923614>
- Keeney, R. L. (2004). Framing public policy decisions. *International Journal of Technology, Policy, and Management*, 4(2), 95–115.
- Koehler, J., Nyaga, C., Hope, R., Kiamba, P., Gladstone, N., Thomas, M., Mumma, A., & Trevett, A. (2022). Water policy, politics, and practice - the case of Kitui County, Kenya. *Frontiers in Water*, 4, 1022730. <https://doi.org/10.3389/frwa.2022.1022730>

- Koehler, J. (2018). Exploring policy perceptions and responsibility of devolved decision-making for water service delivery in Kenya's 47 county governments. *Geoforum*, 92, 68–80. <https://doi.org/10.1016/j.geoforum.2018.02.018>
- Koehler, J., Rayner, S., Katuva, J., Thomson, P., & Hope, R. (2018). A cultural theory of drinking water risks, values and institutional change. *Global Environmental Change*, 50, 268–277. <https://doi.org/10.1016/j.gloenvcha.2018.03.006>
- Lasswell, H. (1936). *Who Gets What, When, and How?* McGraw-Hill.
- Lemos, M. C., & Agrawal, A. (2006). Environmental governance. *Annual Review of Environment and Resources*, 31(1), 297–325. <https://doi.org/10.1146/annurev.energy.31.042605.135621>
- Libey, A., Adank, M., & Thomas, E. (2020). Who pays for water? Comparing life cycle costs of water services among several low, medium and high-income utilities. *World Development*, 136, 105155. <https://doi.org/10.1016/j.worlddev.2020.105155>
- Mazzucato, M. (2013). *The entrepreneurial state: Debunking public vs private sector myths*. Anthem Press.
- McNicholl, D., Hope, R., Money, A., Lane, A., Armstrong, A., van der Wilk, N., Dupuis, M., Harvey, A., Nyaga, C., Womble, S., Favre, D., Allen, J., Katuva, J., Barbotte, T., Buhungiro, E., Thomson, P., & Koehler, J. (2019). *Performance-based funding for reliable rural water services in Africa* (Uptime Consortium, Working Paper 1). <https://static1.squarespace.com/static/5d5fc19961d87c00011689d2/t/5f02887c0e31a70a9c5fc990/1594001552517/Performance-based+funding+for+reliable+rural+water+services.pdf>
- McNicholl, D., Hope, R., Money, A., Lane, A., Armstrong, A., Dupuis, M., Harvey, A., Nyaga, C., Womble, S., Allen, J., Katuva, J., Barbotte, T., Lambert, L., Staub, M., Thomson, P., & Koehler, J. (2020). *Results-based Contracts for Rural Water Services* (Uptime Consortium, Working Paper 2).
- Money, A. (2018). *Hybridity and Blended Finance*. World Water Council.
- Nowicki, S., Koehler, J., & Charles, K. J. (2020). Including water quality monitoring in rural water services: Why safe water requires challenging the quantity versus quality dichotomy. *Npj Clean Water*, 3(1), 14. <https://doi.org/10.1038/s41545-020-0062-x>
- Olsson, P., Galaz, V., & Boonstra, W. J. (2014). Sustainability transformations: a resilience perspective. *Ecology and Society*. <https://doi.org/10.5751/ES-06799-190401>
- Pahl-Wostl, C., Knieper, C., Lukat, E., Meergans, F., Schoderer, M., Schütze, N., Schweigatz, D., Dombrowsky, I., Lenschow, A., Stein, U., Thiel, A., Tröltzsch, J., & Vidaurre, R. (2020). Enhancing the capacity of water governance to deal with complex management challenges: A framework of analysis. *Environmental Science & Policy*, 107, 23–35. <https://doi.org/10.1016/j.envsci.2020.02.011>
- Rawls, J. (1989). The domain of the political and overlapping consensus. *New York University Law Review*, 64(2), 233–255.
- Rayner, S. (1993). Risk perception, technology acceptance, and institutional culture: Case studies of some new definitions. In B. Ruck (Ed.), *Risk is a Construct* (pp. 197–220). Knesebeck.
- Rodell, M., & Li, B. (2023). Changing intensity of hydroclimatic extreme events revealed by GRACE and GRACE-FO. *Nature Water*, 1(3), 241–248. <https://doi.org/10.1038/s44221-023-00040-5>
- Sachs, J. D., Schmidt-Traub, G., Mazzucato, M., Messner, D., Nakicenovic, N., & Rockström, J. (2019). Six transformations to achieve the sustainable development goals. *Nature Sustainability*, 2(9), 805–814. <https://doi.org/10.1038/s41893-019-0352-9>
- Sadoff, C. W., Borgomeo, E., & Uhlenbrook, S. (2020). Rethinking water for SDG 6. *Nature Sustainability*, 3(5), 346–347. <https://doi.org/10.1038/s41893-020-0530-9>
- Scoones, I., Leach, M., & Newell, P. (2015). *The Politics of Green Transformations*. Routledge.
- Seto, K. C., Davis, S. J., Mitchell, R. B., Stokes, E. C., Unruh, G., & Ürge-Vorsatz, D. (2016). Carbon lock-in: types, causes, and policy implications. *Annual Review of Environment and Resources*, 41(1), 425–452. <https://doi.org/10.1146/annurev-environ-110615-085934>
- Shapiro, M. (1988). Introduction: Judicial selection and the design of clumsy institutions. *Southern California Law Review*, 61, 1555–1569.
- Smith, D. M., Gordon, C., Kittikhoun, A., Molwantwa, J., Pacheco Mollinedo, P., Romdhane, A. B., Shrestha, R., Tindimugay, C., & McDonnell, R. (2023). Research and innovation missions to transform future water systems. *Nature Water*, 1(3), 219–222. <https://doi.org/10.1038/s44221-023-00049-w>
- Sultana, F., & Loftus, A. (2012). *The right to water: politics, governance and social struggles*. Earthscan.
- Tosun, J., & Leininger, J. (2017). Governing the interlinkages between the sustainable development goals: Approaches to attain policy integration. *Global Challenges*, 1(9), 1700036. <https://doi.org/10.1002/gch2.201700036>
- UN. (2015). *Sustainable Development Goals: 2030 Agenda for Sustainable Development*. UN. <https://sustainabledevelopment.un.org/?menu=1300>
- UN. (2018). *International Decade for Action on Water for Sustainable Development, 2018–2028*. <https://www.un.org/en/events/waterdecade/>
- UN. (2021). *Progress towards the Sustainable Development Goals - Report of the Secretary-General*.

- UN. (2023). *The United Nations World Water Development Report 2023: Partnerships and Cooperation for Water*. <https://unesdoc.unesco.org/ark:/48223/pf0000384655>
- UN. (2023, March 24). New agenda sets sail with bold action as UN Water Conference closes. *United Nations News*. <https://news.un.org/en/story/2023/03/1135022>
- UNCCD. (2022). *Drought in Numbers 2022*. [https://www.unccd.int/sites/default/files/2022-06/Drought in Numbers %28English%29.pdf](https://www.unccd.int/sites/default/files/2022-06/Drought%20in%20Numbers%20English%29.pdf)
- van Asselt, M. B. A., & Renn, O. (2011). Risk governance. *Journal of Risk Research*, 14(4), 431–449. <https://doi.org/10.1080/13669877.2011.553730>
- Varady, R. G., Smith, G. E., & Gerlak, A. K. (2023, March 31). 2023 UN Water Conference: How can the US capitalize on the momentum? *The Hill*. <https://thehill.com/opinion/energy-environment/3927975-2023-un-water-conference-how-can-the-us-capitalize-on-the-momentum/>
- Verweij, M., Douglas, M., Ellis, R., Engel, C., Hendriks, F., Lohmann, S., Ney, S., Rayner, S., & Thompson, M. (2006). Clumsy solutions for a complex world: The case of climate change. *Public Administration*, 84(4), 817–843.
- Whaley, L., Cleaver, F., & Mwathunga, E. (2021). Flesh and bones: Working with the grain to improve community management of water. *World Development*, 138, 105286. <https://doi.org/10.1016/j.worlddev.2020.105286>
- WHO/UNICEF. (2017). *Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines*. World Health Organization and United Nations Children's Fund.
- Wildavsky, A. (1987). Choosing preferences by constructing institutions: A cultural theory of preference formation. *American Political Science Review*, 81(1), 3–22.
- Wilder, M., & Ingram, H. (2018). Knowing equity when we see it: water equity in contemporary global contexts. In K. Conca & E. Weinthal (Eds.), *The Oxford Handbook of Water Politics and Policy* (pp. 49–75). Oxford University Press.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.