10

DESIGN FOR WATER JUSTICE

Co-Developing Tools for Equitable Cities

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10.1 Introduction: The Observatorio Metropolitano de Agua

In recent years, the idea of major cities in the Global South running out of water due to climate change has received considerable attention, e.g. Cape Town, Mexico City, and Chennai (Harvey, 2023; Masih & Slater, 2019; Sengupta & Cai, 2019). To address this, governments are prioritising data and digital technologies to address the numerous social and environmental concerns associated with water management and service delivery (Daigger et al., 2019). Digital tools such as urban dashboards, digital observatories, and indicator systems are used to integrate multiple data sources and visualisations to assist governments, citizens, and businesses make decisions (Kitchin et al., 2015; Mattern, 2015). These digital technologies serve to inform planning, increase transparency in policy-making, and inspire future scenarios for the city (Valenzuela-Montes & Carvalho-Cortes Silva, 2015). While this topic has gained attention in the academic literature, most scholarly work has focused on the economic or operational value attributed to digital technologies for water management, the risks of datafication for surveillance and privacy concerns, or how digital technologies can change managerial structures in the water distribution system (Amankwaa et al., 2021; Hoefsloot, Richter, et al., 2022). There is a need to analyse the implications of the digital transition in urban water governance from a relational perspective – acknowledging its social and material elements – and explore more just and collaborative pathways for future developments (Luque-Ayala & Marvin, 2015).

Therefore, this research explores how digital information infrastructures can support just urban water governance. Specifically, we analyse this question through the development of a tool that aims to contribute to

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a fairer distribution of water resources among urban residents by exploring the potential of collecting and disseminating data regarding water access in *Observatorio Metropolitano de Agua para Lima-Callao*[1] (Metropolitan Water Observatory for Lima-Callao, referred to as the MWO hereafter).

In essence, the MWO (Figure 10.1) is a collaboratively designed data platform that collects and distributes data regarding water access in urban Lima and Callao from the perspective of its residents. The MWO has two core attributes: a geo-visor depicting the various data layers in space and the form through which urban residents can share information about their water access. Users have the flexibility to expand the map to full-screen width, zoom in/out, toggle data layer visibility and transparency, switch between base maps, and access information by clicking on data points. The map includes a legend, a scale bar, and an information box at the bottom.

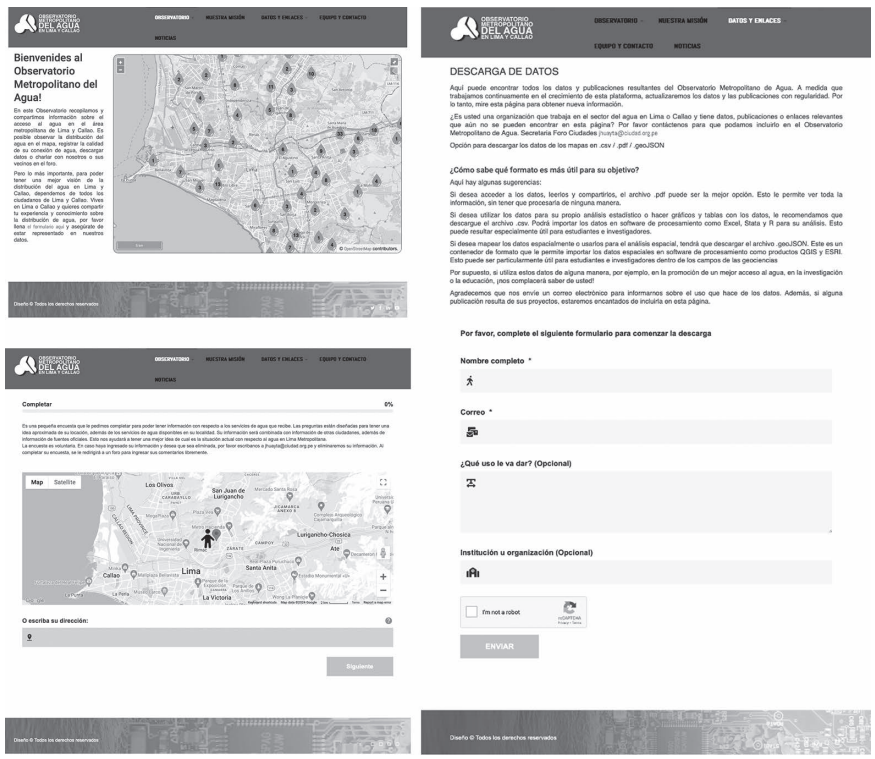

FIGURE 10.1 Screenshot of the MWO prototype. The top left screenshot shows the homepage with the map presenting data in a desktop browser. The bottom left screenshot shows the data input form in a desktop browser. The right screenshot shows the menu and data download page in a mobile phone browser.

The MWO incorporates diverse data-sharing methods, such as the data input form, chat function, photo uploads, and dedicated hashtags on social media. The questionnaire, developed in collaboration with participants, adjusts dynamically based on respondents' water sources and experiences. The data fields and indicators on which data are collected within the MWO represent the main issues within the water sectors from the perspective of Lima's urban residents. Additionally, a chat forum allows residents to share information and experiences in written text. To ensure protection against malware and privacy, registration is required, whereas to reduce participation barriers, it allows the use of pseudonyms and passwords without the need for personal information. Lastly, residents have the right to invisibility by being able to delete their shared data at any time. Users can request the removal or revision of their submitted data, with location privacy ensured.

Initiated by Foro Ciudades para la Vida, a non-governmental organisation working on the development of just and sustainable cities in Peru, the MWO was designed in collaboration with residents from three districts in Lima: academic researchers (the authors of this chapter), civil society organisations, and a web developer. The idea of the MWO was conceived from the frustration of our civil society partners in trying to access information and data about equality in water distribution in the city from the public water company, SEDAPAL. By making inequalities visible through the MWO, the transdisciplinary team collaborating in the MWO's design aimed to create a space to critically engage with the current water data, increase transparency, and influence action for a just water distribution system.

In this chapter particularly, we want to discuss the MWO and its contribution to exploring how we can design digital infrastructures that contribute to just water governance as an ongoing conversation between theory and practice. This is informed by design science approaches in action research and information and communication technologies for development (ICT4D), which emphasise the iterative process of designing information technologies to contribute to the dual goals of knowledge generation and creating a useful technological artefact (Islam & Grönlund, 2012; Sein et al., 2011). Specifically, we reflect on the MWO's development through the lens of design justice and its implications for theory, methods, and ethics. Inspired by bell hooks (1991), this research aimed to contribute to theory as a practice of 'liberatory activism'. This means that theory and methods are used to expand our thinking in support of justice approaches and assist in the struggle to oppose classism, racism, and sexism. This project is directed to assist residents who live in situations of injustice to bring about change.

Continuing this chapter, we will first introduce design justice as a guiding framework for research and praxis, and specifically how a commitment to design justice informs our theoretical, methodological, and ethical approach. Following, we will provide a brief background on the digital

infrastructures developed for water governance in Lima and reflect on how the MWO challenges the modernist approaches to water management embedded in the infrastructure. We end with a reflection on the questions remaining and future steps to be taken to design digital information systems for water justice.

10.2 Design Justice: Theoretical, Methodological, and Ethical Implications

Design justice is an approach to design that is led by marginalised communities and that aims explicitly to challenge, rather than reproduce, structural inequalities. It has emerged from a growing community of designers in various fields who work closely with social movements and community-based organisations around the world (Costanza-Chock, 2020). As Costanza-Chock (2020) wrote, the goal of design justice is to go "beyond the frames of *social impact design* or *design for good*, to challenge designers to think about how good intentions are not necessarily enough to ensure that design processes and practices become tools for liberation, and to develop principles that might help design practitioners avoid the (often unwitting) reproduction of existing inequalities" (p. 6). On a broader scale, design justice decentres the big technological companies in the Global North by shining a light on the many valuable ways innovation happens through social movements, in the Global South, or emergent from marginalised communities (Costanza-Chock, 2020; Jimenez et al., 2022). Hence, design justice serves as a route to counter inequality and intervene in unjust structures. In doing so, design justice builds on a long history of related approaches, such as value-sensitive design, universal design, and inclusive design.

Advocates of design justice argue that this approach helps centre people who are typically marginalised by design and employs collaborative and creative practices to address the most pressing issues confronting them. The Design Justice Network, for instance, promotes ten principles that guide the design process, ranging from the relationship with communities to the role of the designer, the process, and the design outcome. What these principles suggest is that this approach does not begin and end with merely the act of designing something, but it incorporates a broader way of thinking, where justice is about ensuring that the communities affected by the technology are at the core of the design process (Design Justice Network Principles, 2018). This departs from the notion that social global justice, specifically in relation to feminist and decolonial work, is a practice, not only a theory (Khene & Masiero, 2022). The designer then adopts the role of a facilitator whose job is to centre the voices of those impacted by the design process instead of an expert. This implies drawing on what is already working instead of bringing new ideas altogether.

Regarding our work on the MWO, design justice has theoretical, methodological, and ethical implications for research practice. Theoretically, design justice implies an approach that goes beyond the narrow modernist goals of digital development. Instead, it adopts a relational approach that allows a rethinking of digital infrastructure that accounts for its social and political lives. Throughout this chapter, we urge readers to think about water and digital infrastructures beyond their material features and consider people, landscapes, and knowledge as part of the infrastructural systems. Additionally, following Masiero (2022) we embrace multidisciplinary theoretical approaches from fields such as urban geography, critical data studies, ITC4D, and design studies to push the boundaries and bridge the gaps between research and practice. This stems from the commitment to understanding technology, data, knowledge, water, or the everyday city from a relational perspective.

Within our research, this is reflected in our understanding of urban governance as the regimes of decision-making and coordination between state and non-state actors for the planning, development, and management of urban space and life (Gupta et al., 2015), which is increasingly reliant on the production of digital data for decision-making, and the urban society, materiality, and economy are intertwined with coded algorithms (Datta, 2018; Shaw & Graham, 2017). Urban operational processes such as water distribution and traffic control are digitised to make their measurement and monitoring more efficient and equitable (Amankwaa et al., 2021). Specifically, with regard to urban infrastructures, supervisory control and data acquisition (SCADA) systems have been extensively rolled out in cities globally to monitor and control flows in water, traffic, and electricity grids (Kitchin & Dodge, 2017).

Following in the footsteps of 'smart city' developments, which are often informed by technocratic and neoliberal approaches to urban governance (Odendaal, 2023; Verrest & Pfeffer, 2018), 'smart water' is characterised by a belief that more data lead to better control over urban infrastructure (Amankwaa et al., 2021). It is argued that new opportunities for big data and crowdsourced information may create possibilities for more open, complete, and democratic data collection (Elwood, 2008; McFarlane & Söderström, 2017). Moreover, the developments in computing and measurement technologies that have allowed for the generation and analysis of big data have spawned the idea that, with sophisticated and reliable technologies, it would be possible to reduce human idiosyncrasies in the management and governance of urban flows (Taylor & Richter, 2017). Design justice steers away from these modernist understandings of infrastructure and instead promotes embedding community values in design.

Methodologically, a design justice framework means we approach citizens as active agents in the smart city (Calzada, 2018; Vanolo, 2016). Using digital tools for public engagement and accountability holding and their

datafied movement through and consumption of the city, urban residents have become a central part of thinking about and developing the digitalised city. Specifically, in the contemporary city, characterised by complex public-private governance and ownership structures, data can help trace actions and responsibilities and help inform policy decisions. This observation aligns with that of Pfeffer (2018), who states that digital technologies can create opportunities for residents, as knowledge actors, to contribute to understanding urban infrastructure and, untimely, the city at large.

To facilitate a more collective and democratic process of knowledge generation for urban water governance, our methodological approach departed from the idea of *concertación*. As a concept, *concertación* is original to Peruvian governance culture and refers to the cyclical and "highly sensitive and complex process of dialogue– negotiation – *concertación* – conflict management and consensus-building (or not)" among stakeholders (Miranda Sara & Baud, 2014, p. 506). Embracing this complex and deliberative process instead of pursuing more technocratic approaches opens space for dialogue about fundamental conceptualisations of water, knowledge, and good governance. Miranda Sara (2021) applies this in her research to analyse and facilitate the formulation of different scenarios for Lima's water governance in the future, an approach she labels "espacio de concertacion" (space for concertation). We built on this work during the development of the MWO. While Miranda Sara (2021) analysed this process from an institutional perspective, we aimed to create a digital information infrastructure which can serve as an *espacio de concertación* and visibilise and exchange knowledge between stakeholders.

However, the "(or not)" in Miranda Sara and Baud's (2014) definition of *concertación* mentioned above is important and carries much weight. Opting for dissensus rather than consensus by stepping out of the dominant methods, debates, and technologies for inclusive collaboration can be a powerful approach for communities and civil society organisations to break with predefined roles and potentially redistribute power in the negotiation over the smart city (Kaika, 2017).

Finally, ethically design justice entails a strong commitment to justice in both research and practice. By engaging in the design of the MWO, we moved from descriptive and theoretical analysis towards action-oriented and collaborative design approaches aiming at influencing policy and practice. We are not only analysing what was happening but also actively trying to intervene in Lima's water governance and data practices by introducing a new technological artefact and collaborating with fellow scholars, activists, and community members.

The choice to engage in action-oriented design research as part of the MWO project has forced us to position this work within the debates on the varied forms of injustice experienced by residents in Lima and speaks to the ways in which feminist and decolonial researchers relate to and interact

with the multiple forms of resistance against patriarchy, (neo)-colonialism, and capitalism. We hope our research and involvement in the development of the MWO can support these struggles. As Kabeer (1994, p. 80) wrote: "the 'ways of knowing' that have dominated the production of knowledge [. . .] have played an important role in defining and legitimating particular viewpoints and methods. The production of knowledge is, therefore, a logical place to begin the project of reversals".

The first step herein is questioning the dominance of modern sciences, which is often based on a rationalist, secular epistemology that emphasises the relevance of science, economics, and technology (Jimenez et al., 2022). Due to its perceived universality, other forms of knowledge (e.g. local and indigenous) are typically viewed as less relevant and deficient (Escobar, 2016; Mignolo, 2011; Mignolo & Walsh, 2018). Much of this dominant knowledge is characterised by temporal realities, categorising things into binaries and placing the value of Western/scientific thinking above anything else (Hlabangane, 2021). It also means that only the parts of reality which can be captured are considered truth, neglecting the knowledge, experiences, and realities that lay beyond the capture of modernist scientific methods.

Authors suggest that to address the coloniality of knowledge, there needs to be a decentring of the Western geopolitics of knowledge to make space for alternative ways of thinking and being. This involves entering into a dialogue of knowledges, all situated in equal terms (Reiter, 2018). This stems from a recognition that knowledge is not created in a vacuum but shaped as part of a system of knowledge claims, values and standards, structures, and epistemologies (Muñoz-Erickson et al., 2017) and is profoundly emergent from the region (Wijsman & Feagan, 2019). To contribute to the production of knowledge rather than its erasure, we have aimed to stay close to the stories shared with us by many people in Lima and the region and to do justice to their experiences in our analysis of the events through theory and by our effort to understand their struggles through a lens of socio-economic and colonial injustice.

Within this positioning, we understand just water governance as the collective of administrative, material, political, and social systems that work towards the fair allocation of water and the recognition of the social, political, and epistemological dimensions of water (Zwarteveen & Boelens, 2014). Hence, to be able to contribute to water justice, we must acknowledge how our position in the world and past and current experiences have informed the choice of area and study, our experience of fieldwork in Lima as a Latin American city, our initial conceptualisations of water, justice, and the city – all fundamental notions within this work – through modernist and Western lenses. Recognising the limitations of our thinking is a process of learning new theories, approaches, and methods and unlearning colonial and patriarchal thinking and frameworks (Aguilar & Icaza, 2021). We write this in the present tense since this process is by no means near completion.

10.3 Findings: Designing Information Infrastructures for Just Water Governance

There is value in creating and theorising at the same time. As explained by Milan and Treré (2019), the parallel acts of exploring alternative data imaginaries and creating alternative data practices can be valuable exercises for thinking about data justice in design and how we might overcome the injustices in the system. The MWO fits within this tradition. In creating an artefact, we were required to decide who should participate in the design and use, what features should it have, what purpose does it serve, and how will people interact with it. (Young & Kitchin, 2020). This invites us to reflect on how values are inscribed in the technology, forces us to place the developed technological artefact within its sociotechnical assemblage, and gives insights into what theory might mean for society.

In the design and development of the MWO, we approached these questions from both theory and practice, and the process up to now shows how designing according to the principles of data justice has implications for the process and the outcome. Data justice and its commitment to visibility and anti-discrimination requires engaging with plural perspectives and values right from the initiation of the project through to the use of the artefact. This calls attention to the issues of privacy, discrimination, and access, considering the importance of approaching information infrastructures within the social, political, and material context in which they are implemented, and centres the agency and needs of residents in the creation and mobilisation of digital information infrastructures (Hoefsloot, 2022).

In Lima and Callao, SEDAPAL uses various information systems that collect data to govern and manage the water distribution system within the metropolitan area (Jimenez et al., 2024). To manage the operational side of the water distribution system, SEDAPAL has implemented a supervisory control and data acquisition (SCADA) system. Essentially, current SCADA systems entail the implementation of sensors in non-digital technologies, which are connected through software that allows the registration and monitoring of measurements. The sensors applied to the infrastructure measure the volume of the water at any single time and at multiple locations within the system. Together, these single measurements produce large data sets that record the water volume in the complete system in near real-time. Like other 'smart city' technologies, these SCADA systems have become increasingly autonomous in that they currently allow for automated interventions to change settings in the system. To understand the implications of these changes for the city and the just distribution of urban resources, we must look at the transformation of the infrastructure through the introduction of digital elements.

The SCADA system and the commercial, informal system are the two primary sources of structured data. Yet, there are also a variety of information

systems which directly or indirectly generate unstructured data, such as customer service centres collecting consumer-reported data regarding breaches in the system, the use of drones equipped with lidar collecting spatial data to map new urbanisation patterns and water needs, the use of a georadar to collect data about the exact location of underground pipes and detect potential unregulated water connections, and the use of Google products such as Google Earth and Streetview to validate outliers flagged in the data in the consumption information system.

These systems have embedded in them the conceptualisation of water as a commercial resource whose flows and consumption must be managed to reduce losses. This is reflected in the categorisation of leaked water as 'non-revenue water' and the labelling of auto-constructed pipes as 'clandestine', and the design and mobilisation of specific digital technologies such as the georadar and Google products to surveil and counter unregulated water consumption. Together, these various information systems and partially interoperable datasets create a layered view of the water distribution system in which some areas and types of water consumers are fully legible while others are (partially) out of sight (Hoefsloot, Richter, et al., 2022).

This lack of transparency has to be considered in relation to the Peruvian governance structure in which data is considered leverage. In addition to informing policy-making, data are important for the negotiation between various governmental actors and between administrations (Filippi et al., 2014). Filippi et al. (2014) explain how the control over data also signifies the control over the narrative and can serve to maintain the status quo in Peruvian water governance and the vested interests of big capital, such as mining companies.

By presenting an alternative data practice which centres justice rather than efficiency or control, the MWO brings to the fore the biases and embedded values in SEDAPAL's data practices. Most importantly, it illustrates how knowledge and data regarding water can be conceptualised and scrutinised in different ways. It follows that designing information infrastructures that contribute to just water governance, particularly in a context of societal, climate, and material transformations, requires a transdisciplinary approach and novel alliances between stakeholders. The MWO is an intervention that aims to contest the current data practices and empower those working towards overcoming injustices in the field of water governance. This speaks to critical strands of data studies and scholarship on digitalisation, which pursue the dual aims of contributing to knowledge and dismantling unjust orders in society (e.g., D'Ignazio & Klein, 2020; Eubanks, 2018).

Moreover, the collaborative, bottom-up development of the MWO shows how digital information infrastructures can be civil society-led, diverse, and small, as opposed to the dominant image of corporate-led, homogenising, and big (Taylor & Broeders, 2015). Within digital infrastructure, 'smart citizens'

participate as important nodes in the infrastructure by generating data and validating knowledge claims. On the other hand, 'expert-amateurs' – a concept used to refer to urban residents with tacit knowledge of the water infrastructure (Hoefsloot et al., 2020) but broadened here to include rural and indigenous experts on water governance – while situated on the side-line of the digital infrastructure, in turn, challenge the norms embedded in the technology, readjust it according to what they see fit, and self-govern the water distribution within their communities. Contrary to conceptualisations of citizens' participation in urban development and governance departing from top-down, organised, and consensus-oriented interactions, these types of participation or involvement are bottom-up, sometimes subversive, which are examples of auto-constructing urban infrastructure (Holston, 1991; Watson, 2009).

The development of the MWO illustrates how digital infrastructure, when designed in collaboration with residents and following design and data justice principles (*Design Justice Network Principles*, 2018; Hoefsloot, Jimenez, et al., 2022), can potentially serve as a tool for residents to help transform the system to meet their needs. However, a central challenge we encountered was balancing and engaging with widely diverging conceptualisations of fundamental concepts, such as 'water' and 'knowledge', in developing digital technologies to be able to use them as a tool for integration rather than differentiation. The scope of the MWO – being the metropolitan city – and its emphasis on generating numerical data to engage with policymakers automatically positions it within the modern-scientific knowledge system and its related utilitarian definition of water as a resource for people.

From the perspective of everyday life of Lima's residents, it is possible to see how the impact of the digital infrastructure is double-edged: it can undercut the common aspirations of improving the water distribution system and, at the same time, allow us to see people's knowledge, labour, and capacity for organisation to better water governance. These findings underscore the value of making bottom-up infrastructural practices the focal point, locating residents' agency and capabilities at the centre of the debate on the digitalisation of the city (Milan & Treré, 2019), and explore how a decolonial approach to innovation may result in digital infrastructures which are better aligned with social concerns (Jimenez et al., 2022).

Yet, pluralising the cultural and political understandings of water and knowledge embedded in infrastructure proves to be difficult, abiding work. We note this challenge not only in our work but also in the literature on water governance in general. We increasingly see the concept of 'digital water' used in academic research to refer to how water is datafied and managed through digital technologies (Amankwaa et al., 2021). At the same time, there is a growth of attention to ancestral, indigenous, and nature-based approaches to water governance, which present plural ontologies about water (Hartwig

et al., 2021; Vera Delgado & Zwarteveen, 2008; Viaene, 2021; Wilson & Inkster, 2018). Very rarely do these two bodies of literature speak to each other, something we have attempted to do in this research. Only by combining an urban focus with a regional focus did it become possible to understand Lima's digital water management infrastructure within the region's plural knowledge systems.

10.4 Discussion: Centring Residents' Experiences of Injustice in Design

With the MWO, we offer an alternative imagination of information infrastructure as a bottom-up development that functions by its residents' agency. In this infrastructure, residents can give direction to future design, use, and application of knowledge in urban governance. We are essentially grafting another element onto Lima's water and digital infrastructure, which makes the digital infrastructure decentralised and communal and highlights the expertise of residents. We hope that by democratising digital technologies and envisioning and materialising critical technologies for urban futures, we will be able to mitigate unintended consequences and contribute to the collective interest of society.

Moreover, this chapter shows how this relational approach is useful not only for the analysis of the information infrastructure in Lima's water governance but also for informing its design practices. Given the continuous development of digital information infrastructures for urban governance, one of the most important contributions of this research to previous work on urban infrastructure from a sociotechnical perspective (e.g. Amin & Thrift, 2017; Anand, 2017; Salamanca, 2015; Simone, 2004, 2015) is that we work towards bringing the fields of urban geography and ITC4D into conversation by bridging the gap between theory and practice through the conceptualisation and design of a participatory urban observatory.

Drawing on our experiences designing the MWO, we argue that the digital information infrastructures designed for just water governance should engage with and be based on the experiences, needs, and plural knowledges of diverse residents at all stages of development. This argument has roots in the work of Shklar (1990) and Zwarteveen and Boelens (2014), who argued that theories about justice, be it in general or specifically focused on water, should pay more attention to citizens' experiences of injustice. Specifically, with the acknowledgement that the data infrastructure is part of a larger water governance system where competing interests are at play, we need to assess the fairness of and access to participation in knowledge generation and mobilisation. Centring residents' experiences of injustice in the formulation of the data justice design principles thus becomes a powerful tool to bring the water distribution system into conversation with the voice of residents.

Although many digital technologies that emerged during neoliberalism can reproduce long-term asymmetries in knowledge production along the lines of coloniality and capitalism (Mattern, 2021), we agree with Couldry and Mejias (2021), who argued that the value of designing critical and experimental platforms lies not directly in the accuracy of the data generated, but rather in showing the messiness and complexity of the city and visualising a perspective on the city that is not the dominant one. For us, this is not a failure but continues to explain the idea of ontological completeness. We argue that as long as the approach to justice is clear, it should be seen as a process rather than a final product.

10.5 Conclusions and Ways Forward

It is unlikely that technological development will slow down to fully accommodate other narratives and visions for the future of water in Lima. In the meantime, we need to continue exploring ways to overcome the juxtaposition between water and data justice. Zwarteveen and Boelens' (2014) framework for water justice, which grants equal importance to the distribution and acknowledgement of knowledge systems, may form a good starting point. If water justice can only be achieved when plural conceptualisations of water are respected and listened to, we need to steer our digital systems and their inscribed ontologies to recognise the value of other ways of knowing. It is through the pluralisation of knowledge that the symbolic boundaries drawn up between the city and landscape, urban and rural, scientific and indigenous, and producer and consumer seem to be slightly redrawn.

To be able to do so, we need to centre people as experts, users, and beneficiaries in our design practices. Putting forward a novel approach to designing digital tools for participation in urban infrastructural governance contributes to advancing approaches for governments and citizens alike to develop information infrastructures that contribute to just water governance. We hope this inspires the development of information infrastructures that bring together an assemblage of tools to accommodate the different voices and purposes in urban governance.

Nevertheless, also within the MWO, we risk reproducing the dominant modernist approaches to water governance in the city. Our decision to focus on quantitative data and data justice in the MWO was partly informed by the fact that data is considered a powerful asset within the fragmented yet entangled institutional network that is Lima's water sector (Filippi et al., 2014; Miranda Sara, 2021), yet is still exclusionary to the plural ontologies of water prevalent in the region. Additionally, we have focussed firmly on how data (in)visibilises, structures, and can be made more transparent but not yet on people's capacities to mobilise data and digital technologies to improve the water infrastructure according to their needs and ambitions. This should

and will be the focus of the next steps of the MWO project. This is relevant to understand not only the utility of the MWO but also the challenges related to people's access and capabilities to use digital technologies and data.

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Note

1 https://observatoriodelagua.ciudad.org.pe.

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