Accelerating Progress towards Universal Water Sanitation and Hygiene (WASH): Governance, Technology and Data for Urban Settings

Access to safe water, sanitation and hygiene (WASH) continues to be a universal challenge that affects human health and well-being. The latest global reports from the Joint Monitoring Programme (JMP) for Water Supply, Sanitation and Hygiene led by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) have highlighted the global scale of WASH issues, particularly in the least developed countries (LDCs). In 2020, it was estimated that there were 2 billion people that did not have access to safe drinking water, 2.3 billion people who lacked access to basic hygiene services, and 3.6 billion people who did not have safe sanitation in their households (WHO/UNICEF JMP, 2021). In addition, more than 500 million children still lack basic WASH services in their schools (WHO/UNICEF JMP, 2022). This is also common in health care facilities, which are fundamental for the prevention and control of diseases such as diarrhoea, and more recently COVID-19 (WHO/UNICEF JMP, 2020). Moreover, those living in slums and informal settlements, which are characterised by the lack of durable housing, insufficient living space, lack of access to clean drinking water, inadequate sanitation and insecure tenure (UN HABITAT, 2010), have a disproportionately higher disease burden due to the lack of access to safe WASH. Slums and informal settlements also reinforce gender inequalities and gender-based violence, due to the higher vulnerabilities of women and adolescent girls, in part because of their menstruation and sanitation requirements (Goddard and Sommer, 2020).

Access to safe WASH is now firmly embedded within the United Nations Sustainable Development Goals (SDGs), which were adopted by all United Nations Member States in 2015. SDG 6 (By 2030, ensure availability and sustainable management of water and sanitation for all) includes WASH under Target 6.1 with the indicator "proportion of population using safely managed drinking water services", Target 6.2 with the indicator "Proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water", and Target 6.3 with "halving the proportion of untreated wastewater". Access to WASH is also captured in SDG Target 11.1 (By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums).

Governments, international development organizations, NGOs and the private sector have invested heavily in WASH services in recent decades to make progress towards achieving universal access to water and sanitation. However, the progress has been slow and uneven, and the benefits have yet to be systematically captured, especially for vulnerable and marginalized groups such as the poor, the disabled, women and children. Achieving the relevant SDG targets on WASH by 2030 will require a quadrupling in the current rates of progress in providing safely managed drinking water and sanitation and basic hygiene (WHO/UNICEF JMP, 2021). In 2020, the UN launched the SDG 6 Global Acceleration Framework, aiming to deliver fast results at an increased scale through financing, data and information, capacity development, innovation and governance. However, there is still a clear need to better understand what solutions have been implemented in different contexts, especially with regards to financing, governance and technology. Examining a diversity of case

studies on WASH may help pinpoint what progress has been achieved, where efforts are still lacking, and what types of programs work. Such evidence-driven research may also provide a strong foundation on which practitioners and policy makers can work with local communities to achieve the WASH-related SDG targets.

Within this context, the commentary and the nine research papers within this special issue provide a range of approaches and data sources that address different topics related to WASH. Five of the research papers deal with issues in India, where access to WASH is still lacking (e.g. access to safely managed sanitation systems is only available to 37% of urban India, Mitra et al., 2022, this issue). Three of the papers are focused on urban areas in other parts of the global south (in Indonesia, Uganda and Bangladesh), while one paper deals with faecal sludge management in Japan, highlighting that sanitation management is not only an issue confined to LDCs. Although the papers cover many different topics individually and collectively, there are key themes that emerge as discussed below.

Citizen science for integrated community planning

Setting the scene for this special issue is the commentary by Corburn (2022, this issue), which highlights the urgent need to provide access to WASH, particularly for the most vulnerable populations, i.e. the urban poor and people living in slums and informal settlements. Moreover, Corburn makes the point that WASH is not an issue that should be disconnected from communities and solved using only technology, financing and private sector investment, but rather it is also about climate justice and the need for equitable and sustainable solutions. Part of this approach is working with communities as citizen scientists to help co-create solutions; a powerful example is provided from Nairobi's Mukuru slum area in which water points, toilets and other impacts such as un-regulated waste and flooding were documented by the community. The data collected further empowered the women in the community to file a class-action lawsuit against the government for failure to provide basic rights to safe water and sanitation. Such an example, which led to an integrated community redevelopment plan, provides evidence that community-led climate justice strategies can yield tangible benefits, build resilience, by taking local context into account, and be responsive to the needs of the community.

Use of household data

Household survey data provide a valuable source of information on household characteristics and behaviours, including those related to WASH. Using survey data from India for 2018–2019, Tiwari et al. (2022, this issue) investigated what types of toilets are used by a household (from flush toilets to open defecation), what determines this choice, and if sanitation and the household's microenvironment have had an impact on household health. Using multinomial logit models, the authors looked at the relationships between toilet type, illnesses related to poor sanitation or unhygienic microenvironments and a range of socio-economic and other relevant variables. The results provide a very detailed picture of the factors that influence the type of toilet used by different households, which were shown to be primarily driven by income but were also affected by many other factors including culture and caste, government incentives, home ownership and the size of household, among others. The investigation into health highlighted that a higher level of education, houses with ventilation, and the availability and access to water were associated with lower prevalence of disease while other factors such as caste, proximity to an animal farm and problems with mosquitos were associated with poorer health outcomes. The study also highlighted the current disconnect between the responsibilities for different elements, i.e. initiatives at the national level, the surrounding microenvironments by local authorities, and the household responsibility for the toilet and the environment within the house. Finally, the

authors noted the lack of community participation in planning, which could bridge this type of disconnect and result in more integrated community development planning like that articulated by Corburn (2022, this issue).

Using the same household survey data set but in a different application, Tirumala and Tiwari (2022, this issue) investigated household expenditure on water in urban areas using a regression analysis and a range of household characteristics. The results showed that households with greater income and that are smaller in size have greater water affordability than households that are poorer or larger in size. Although these findings may seem unsurprising, the study also provided empirical evidence that rolling out piped water supplies in urban areas should be accelerated, and that water subsidies benefit higher income households more than those with lower incomes. The latter can be addressed by optimising the targeting of these subsidies in combination with a more appropriate tariff system, i.e. one that takes household size and affordability into account rather than the current flat tariff structures used. Hence, the study provides empirical evidence that can be used to make policy changes that can in turn promote equitable access to water.

Digital tools and remote sensing

Advances in digital tools and access to new data sources for monitoring, including from satellite remote sensing, are areas where WASH can clearly benefit. In the study by Okaali et al. (2022, this issue), three different tools were used to provide decision makers in Kampala, Uganda, with recommendations for how to improve the sanitation in the city while reducing the exposure to pathogens that affect human health. First, the Pathogen Flow and Mapping Tool (PFMT) was used to model the flow of the rotavirus pathogen through the sanitation system to the surface water, allowing for the effect of any interventions to the system to be determined. Second, the HyCRISTAL tool was used to map health risks related to the drainage infrastructure and the presence of human excreta, which is particularly relevant because parts of the city are low lying and prone to flooding. Such a model can also capture the impacts of climate change from increased flooding. Finally, the SaniPath tool was used to identify the dominant faecal exposure pathways for adults and children in different parts of the city, e.g. from drainage water, flood water, street food, etc. Together, the tools provided the locations of the hotspots for health hazard and the main sources of faecal waste so that a set of appropriate management interventions could be recommended, providing a richer assessment than that from only a single tool. Moreover, this set of tools can be easily adapted to other cities to provide similar support to decision making related to city wide inclusive sanitation.

Slums and informal settlements are areas characterised by poor access to WASH, but access to safe drinking water and sanitation are only two of five factors that capture deprivation in these areas, which also includes access to adequate living space, the presence of permanent structures and tenure security (UN HABITAT, 2010). However, accurate information on slum locations and characteristics is lacking in many countries, so alternative approaches to mapping are needed, e.g. that take advantage of open access imagery from remote sensing. In their paper, Patel et al. (2022, this issue), go beyond mapping slums using remote sensing, which is normally a mapping of the presence or absence of slums. Instead, they used remote sensing in combination with household survey data to predict the six dimensions of deprivation in slums and informal settlements in Dhaka, Bangladesh, adding access to electricity as a sixth indicator of housing quality. Inputs to the regression models included features extracted from the remote sensing images for neighbourhood characteristics, land use and land cover data, and street pattern indicators extracted from OpenStreetMap while the data on slums were collected through a survey of 600 households. The results showed which factors are the most critical in predicting where slums and informal settlements are located. For example, as distance from the central business district increases, access to safe drinking water decreases. These

types of relationships can help to better understand what factors contribute to WASH, and housing deprivation more generally, but can also be used to target these areas with policy interventions and monitor them more frequently over time.

Governance, policy and management

The next set of papers all deal with the complex and inter-related issues of governance, policy development and the management and choice of sanitation systems. Willetts et al. (2022, this issue) in their paper, address how to build sanitation resilience, particularly with respect to climate change and resultant weather-related hazards. The authors note that sanitation is barely mentioned in climate change policy in Indonesia so there is a clear need to improve the evidence base for climate risks and sanitation adaptation responses. Working with stakeholders using a co-production approach in four cities of varying sizes and types of weather hazards, seven key elements of a climate resilient sanitation system were identified. More than 30 adaptation actions were then mapped onto these elements, which can be integrated into future planning and budget allocation at the local level. This process of co-production also served to raise awareness of the issues related to climate change and sanitation in the local governments of the participating cities in Indonesia.

Bhan (2022, in this issue) undertook a study to investigate why sanitation outcomes (i.e. the infrastructure and the access to services such as water) can vary across poor communities (i.e. slums, public housing, homeless shelters) in Delhi, India. The author used process-tracing to first observe the sanitation outcomes in seven communities sampled from these different types of poor communities and then determined the set of policy decisions and reasoning that led to these sanitation outcomes. By carrying out interviews with elected officials and non-elected civil servants, NGOs and community members, it was revealed that the perception of policymakers regarding how deserving the poor are of particular sanitation outcomes and service delivery has influenced policy decisions and led to disparate service provision within these poor communities. For example, improper cultures and deviant habits were used to frame the sanitation problem in some of these poor communities, which was then used to justify the provision of minimum infrastructure and non-compliance with regulations. This case study demonstrated how the provision of WASH can be a complex and biased process.

The management of faecal sludge is an example of a complex sociotechnical system, with multiple agents interacting that can affect the performance of the system and the water quality. To study one such system, Bugalia et al. (2022, this issue) applied a Systems Theoretic Process Analysis (STPA) framework to the governance of faecal sludge management (FSM) in Japan to identify risks in the current system and to suggest improvements to the governance structures. The procedure involved creating a detailed model of the current governance structure, which maps the actors, their roles and the interactions and decision-making processes in the system. The authors then identified ten unsafe control actions, e.g. unsuitable procedures implemented in the field. This was followed by the development of a range of loss scenarios that can occur by examining the effect of the unsafe control action on the information flow through the system. As an innovation, the authors then related the outcomes of the STPA to the three objectives of good governance: (i) improved efficiency (ii) increased accountability and (iii) enhanced legitimacy, which revealed potential areas for improvement in all three of these areas. This case study represents the first example of where an STPA approach has been applied to an FSM, which can easily be extended to other countries for improving existing governance systems.

Planners need guidance in choosing the appropriate sanitation system technology, particularly where a mix of approaches, i.e. sewered and non-sewered, could be a feasible solution for a city or neighbourhood, and is aligned with the principles of city-wide inclusive sanitation. Mitra et al.

(2022, this issue) developed a catalogue of 14 criteria in collaboration with experts, identified through a social network analysis, to help planners when deciding between a sewered and non-sewered solution. An analysis of the drivers and barriers to non-sewered sanitation systems revealed that costs and opportunities for resource recovery are positive factors while the lack of political will, poor maintenance and negative perceptions were potential barriers. The catalogue provides a way of systematically weighing up the various criteria that can then be tailored to the local context. The catalogue was then tested in one ward in the mega-city of Chennai, India, which indicated that a sewered system would be preferable given the favourable environment for this technology. However, such a catalogue can help to promote the co-existence of a mix of sanitation solutions where they are appropriate.

Improving water quality with scheduled desludging

Developing sanitation for all is important, and additionally, the cleaning and maintenance of existing systems should be a priority. Septic tanks are still a commonly used form of sanitation system in many developing countries, where the emptying or desludging of these tanks is often undertaken on a demand-driven basis. However, if septic tanks are not emptied regularly, they can affect the performance of the system and hence the water quality in the surrounding environment. The city of Wai was the first city in India to implement scheduled desludging, which prompted the study by Jaiswal et al. (2022, in this issue), who examined the impact of this approach on the water quality in drains, rivers and groundwater as well as on the performance of these systems. Samples of water were taken from the groundwater, from drains that empty into the river and from seven septic tanks that were emptied during the first year of the study at various points in time to monitor the water quality. The results showed that the performance of the septic tanks and the water quality in the drains generally improved as scheduled desludging progressed over time while the concentration of faecal coliform in the river and groundwater decreased, which is a trend that should continue in the future because of this intervention. The positive experiences from this case study can, therefore, help to inform decision making related to consideration of this practice in other cities in India and internationally.

Concluding remarks

The papers in this special issue cover a wide range of topics and themes, from technological innovation to alternative data sources, governance and management. These papers focus on three out of the five SDG accelerators under the SDG acceleration framework, namely data and information, innovation, and governance. This special issue will, therefore, help to guide acceleration towards safe WASH for all, especially in an Asian and African context. Given the major data gaps in LDCs, it is necessary to use innovative tools and analysis methods (e.g. remote sensing and household data reanalysis) to complement conventional WASH data generation. Nevertheless, the transferability and scaling potential of different tools and methods need to be thoroughly assessed. The papers highlight the complexity of WASH provisioning from the perspectives of policy design, technological advancement and implementation, and cultural contexts, covering various aspects of WASH services. However, the consideration of the system as a whole, from policymaking to governance to implementation and technological solutions, is still somewhat limited and could benefit from future studies and interventions. Lastly, several papers have mentioned the lack or benefits of stakeholder co-design and engagement of policies and solutions. Access to WASH, as a fundamental human right, is relevant to all people, and therefore, it requires the engagement of all actors, local communities and the highest decision-makers alike.

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