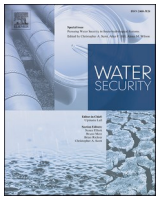
Water Security 20 (2023) 100143

Contents lists available at ScienceDirect

Water Security

journal homepage: www.sciencedirect.com/journal/water-security



Inequalities in water, sanitation and hygiene: Challenges and opportunities for measurement and monitoring

Sarah Dickin [a,*], Sara Gabrielsson [b]

[a] Department of Women's and Children's Health, Uppsala University, Sweden
[b] Lund University Centre for Sustainability Studies, Sweden

ARTICLE INFO

Keywords:
Water
Sanitation
Inequalities
Gender
Intersectionality
Monitoring

ABSTRACT

While there is significant awareness of the importance of addressing water, sanitation and hygiene (WASH) inequalities, measurement continues to present a challenge. Addressing how inequalities are measured, tracked and communicated is fundamental to accelerating progress in ensuring universal WASH coverage and associated benefits. We review how WASH inequalities have been measured and monitored to date on a global level, particularly in relation to SDG 6. We describe gaps in several areas, including how inequalities are measured in relation to gender and social differences, and limitations due to a focus on measuring access to infrastructure that overlooks other contributions of WASH services to wellbeing. Approaches for improved measurement and monitoring of inequalities are discussed, including making better use of existing datasets, as well as developing a broader range of indicators for the WASH sector. Finally, we emphasize the importance of improving visualization and communication of inequalities to policy audiences.

1. Introduction

Addressing inequalities related to water, sanitation, and hygiene (WASH) is critical from both a social justice perspective as well as to address the ways that inequalities impede progress towards sustainable development. Equitable access to water, sanitation and hygiene services is critical to enable human wellbeing, including public health, gender equality and women's empowerment, poverty reduction, and economic development [1]. Significant progress remains as 2 billion people lack safely managed drinking water services, and 3.6 billion people lack safely managed sanitation services [2]. Beneath these numbers the situation is uneven and certain groups are disproportionately impacted, requiring a careful approach to measuring and monitoring WASH inequalities. In the WASH sector a particular emphasis has been placed on measuring inequalities related to poverty, indicating that poorer households are substantially more likely to have inadequate WASH services. For instance, in the majority of countries with available data, basic sanitation coverage was twice as high in the richest wealth quintile compared to the poorest quintile [3]. Similarly, an emphasis has been placed on measuring inequalities at the rural–urban divide, indicating that urban residents are likely to have better WASH services. In 2020, eight out of ten people who still lacked even basic drinking water services lived in rural areas [2]. While such disparities have received significant attention, there are gaps related to other forms of inequalities such as due to gender, ethnicity, and caste, which have been less measured and monitored [4,5]. Furthermore, approaches for measuring inequalities related to WASH have focused on measuring access to services at the household level, which risks overlooking how WASH services meet the needs of different groups, particularly those disadvantaged in several ways. In particular, this includes gaps in monitoring mobile populations such as unsheltered people, refugees, deportees, migrants, and internally displaced people. These gaps indicate that while there is significant awareness of the importance of WASH inequalities, measurement continues to present a challenge. A key issue is understanding to what extent the current Sustainable Development Goal (SDG) indicators for WASH actually capture inequalities. Agenda 2030 places a large focus on inequalities as 'leaving no one behind' is one of its three universal values. This seeks to address criticism of the aggregated metrics used in the Millennium Development Goals, which in some cases masked slower progress [6,7]. Universal access to safe water and sanitation are some of several 'universal' targets in the SDGs and achieving these universal targets requires evidence of eliminating the inequalities linked to these services for all [8]. In practice this depends on what indicators are actually used to monitor progress. With this in

* Corresponding author at: SWEDESD, Department of Women's and Children's Health, Akademiska sjukhuset, Uppsala universitet, SE-751 85 Uppsala, Sweden.
E-mail address: sarah.dickin@uu.se (S. Dickin).

https://doi.org/10.1016/j.wasec.2023.100143
Received 8 May 2023; Received in revised form 10 October 2023; Accepted 12 October 2023
Available online 20 October 2023

mind the aim of this paper is to review gaps in how WASH inequalities are currently measured and monitored at a global level and to discuss ways forward to address these limitations.

2. Starting with the basics: Challenges in measuring WASH inequalities within the SDG 6 framework

To understand the challenges related to measuring WASH inequalities, it is important to consider the current status quo, including the SDG 6 WASH targets 6.1 and 6.2 that have dominated the sector's attention in terms of measuring and tracking inequalities. The WHO/UNICEF Joint Monitoring Programme (JMP) is the custodian of global data on WASH, and is responsible for tracking progress for SDG 6.1 and 6.2. The JMP has tracked progress and produced country and global estimates of progress on WASH since 1990 using drinking water and sanitation 'service ladders' (See [9] for a historical overview of more than 80 years of global WASH monitoring). These ladders are designed to benchmark and compare service levels in a simple way, using a series of progressive 'rungs', with surface water and open defecation at the bottom of each respective ladder and 'safely managed' at the top, which corresponds to the SDG WASH targets (Table 1). These service ladders are based on an 'improved' or 'unimproved' facility classification, where improved facilities have the potential to deliver safe water and sanitation (and have often been used as proxies of such, despite variable safety [10]), combined with some additional service criteria [11]. Data used to track WASH progress are obtained from international household survey programmes, such as the Demographic and Health Surveys (DHS), the Multiple Indicator Cluster Surveys (MICS), and the Living Standards Measurement Study (LSMS), as well as national census data.

While targets 6.1 and 6.2 themselves use inclusive language, there are limitations in the types of inequalities that can be measured using the associated indicators which are based on household WASH service ladders used by JMP. First, tracking progress only at the household level limits collection and analysis of individual-level data. Using households as the only unit of analysis limits possibilities for disaggregation and assessing disparities based on sex, age and disability, in particular, despite the emphasis on disaggregation in the 2030 Agenda. This is despite growing evidence of intra-household disparities in water quantity and quality, indicating that achieving household access does not mean inequalities are eliminated [12,13]. For instance, at the household level, a multi-country study found no significant differences between households with and without members with disabilities in access to an improved sanitation facility or water source. But when collecting and analyzing individual data, people with disabilities reported greater difficulties accessing WASH compared to people without disabilities [14]. In terms of gendered intra-household differences, women have reported allocating more water to male household members when there is limited water availability, such as to avoid intimate partner violence, as well as being excluded from using existing household sanitation facilities during menstruation [12,15].

A second limitation with the SDG 6 WASH indicators is that a focus on households has overlooked measuring progress in other spaces. While the JMP tracks inequalities in schools and healthcare facilities, and more recently refugee camps and crisis-affected areas [2], this is not adequately captured by the SDG indicators. Beyond these spaces, there are many locations where WASH data have not yet been collected or reported by the JMP, such as prisons, migratory worker camps, large-scale agricultural farms and public spaces such as transport hubs, where people spend significant parts of their lives and thus risk being left behind if such WASH use is not measured. Already marginalized people, such as those experiencing precarious housing and homelessness is another group who are overlooked and are often left out of national and global monitoring efforts [16,17]. For people with households but spending large amounts of time outside their homes, there is little information on what water sources are being used. In surveys with informal settlement residents in Accra, Ghana, Stoler et al. [18] found that men reported frequently purchasing sachet water when in town, i.e. away from the home, and information on how individuals within a household may use different water sources of varying quality and safety when away from the home is missing. Another area beyond the household that requires better tracking is WASH workers as the emphasis is currently on users. One gap is tracking under-representation of women employees in water and sanitation utilities and service providers [19]. In addition, sanitation workers face a range of deprivations, health risks and indignities linked to and sometimes exacerbated by what social categories they belong to [20]. Understanding who is participating in sanitation work, as well as monitoring working conditions and health outcomes are all important data for the WASH sector to measure and

Table 1
JMP service ladder for global monitoring of household WASH and associated SDG 6 targets. The drinking water, sanitation and hygiene service ladders are comprised of several rungs moving from no service to the highest level of service at the top of each ladder.

Service type	JMP service ladder		Associated SDG 6 indicator
Drinking water	Safely managed	Drinking water from an improved water source that is located on premises, available when needed and free from faecal and priority chemical contamination	Proportion of the population using safely managed drinking water services
	Basic	Drinking water from an improved source, provided collection time is not more than 30 min for a round trip, including queuing	
	Limited	Drinking water from an improved source for which collection time exceeds 30 min for a round trip, including queuing	
	Unimproved	Drinking water from an unprotected dug well or unprotected spring	
	Surface water	Drinking water directly from a river, dam, lake, pond, stream, canal or irrigation canal	
Sanitation	Safely managed	Use of improved facilities that are not shared with other households and where excreta are safely disposed of in situ or transported and treated offsite	Proportion of population using safely managed sanitation services
	Basic	Use of improved facilities that are not shared with other households	
	Limited	Use of improved facilities shared between two or more households	
	Unimproved	Use of pit latrines without a slab or platform, hanging latrines or bucket latrines	
	Open defecation	Disposal of human faeces in fields, forests, bushes, open bodies of water, beaches or other open spaces, or with solid waste	
Hygiene	Basic	Availability of a handwashing facility on premises with soap and water	Proportion of population using a hand-washing facility with soap and water
	Limited	Availability of handwashing facility on premises without soap and water	
	No facility	No handwashing facility on premises	

track, and could contribute to SDG 8 that focuses on decent work [21].

The challenges with the status quo highlighted above indicate the complexity and ongoing tensions within monitoring, of deciding what, where, and at what scale to measure, as both the JMP and national data collection agencies have limited budget and competing priorities. With a global focus on tracking the SDG indicators, this has a large influence on our understanding of the extent of inequalities in the sector, and the types of WASH interventions, policies and programmes that are prioritized by decision-makers globally and within countries. The gaps in the SDG 6 indicator framework may thus contribute to a smaller number of outcomes measured by governments, external support agencies, and practitioners which we review in more detail below.

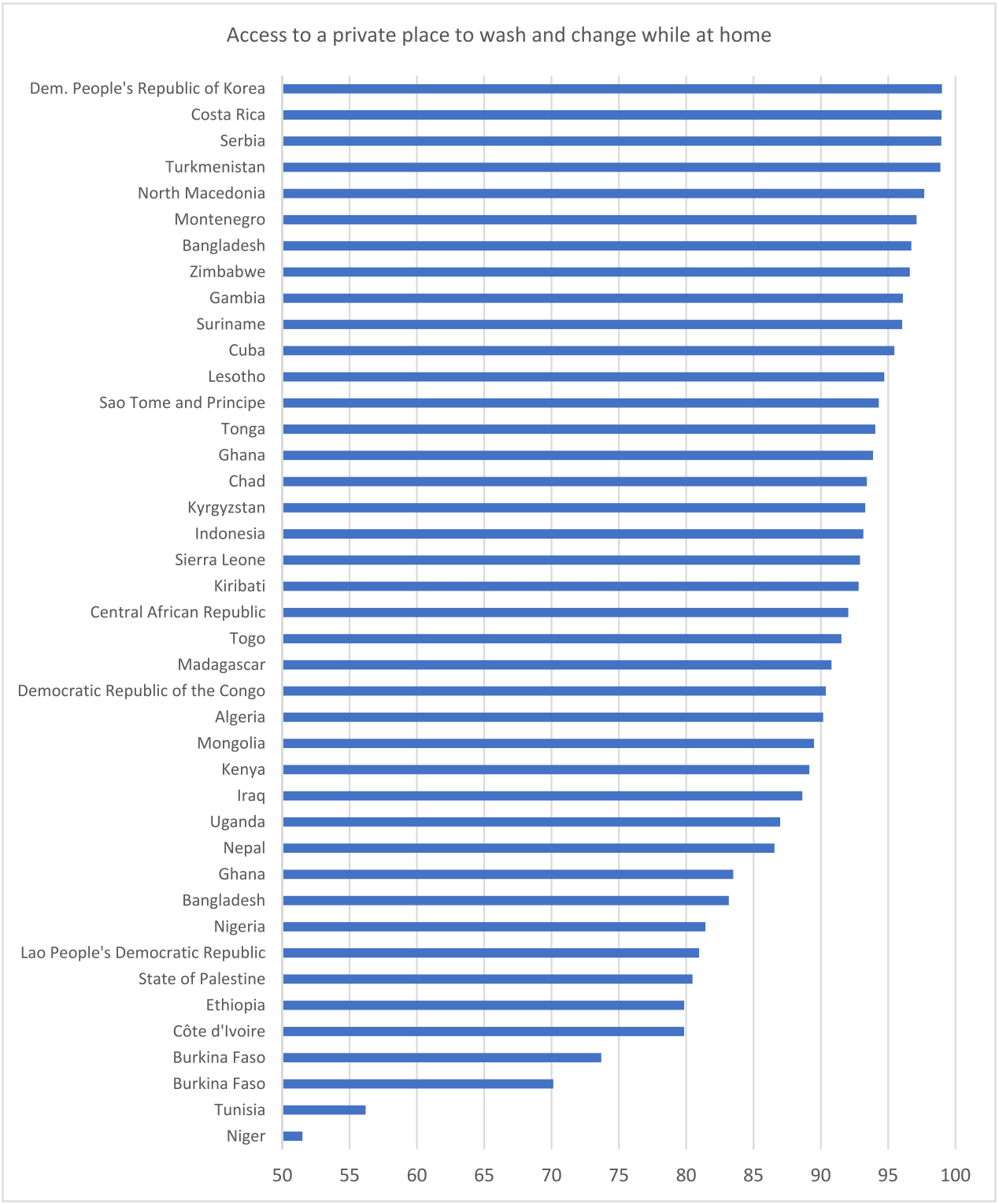


Fig. 1. Monitoring data available on menstrual health reports % of respondents with access to a private place to wash and change while at home (among women and girls ages 15 to 49 who have recently menstruated). Data: JMP menstrual health data.

3. Challenges in measuring WASH inequalities related to gender and intersectionality

Compared to socio-economic inequalities, less effort has been put into measuring WASH inequalities related to gender, and how gender intersects with other forms of social exclusion, despite the importance of addressing these challenges to ensure no one is left behind. Gender disparities related to WASH are particularly important to understand, due to strongly entrenched gender norms related to water and sanitation, and their widespread nature and consequences for society [22,23].

An analysis of gender considerations across the SDG targets and indicators found that SDG 6 is gender blind, currently lacking gender-specific indicators altogether (UN [24]). While the indicators can be described as gender-related, because it is assumed that WASH improvements may lead to positive impacts for women and girls, current SDG 6 indicators do not directly measure this. In the case of access to drinking water, type of water supply is monitored but gender-specific indicators that could be used, such as total time spent collecting water by sex of person collecting water are not included in SDG 6.1. This would also contribute to tracking progress in SDG 5 on gender equality and women's empowerment, which includes a target on social norms related to uneven burdens of unpaid work like fetching water [25,26]. In the case of sanitation, target 6.2 calls for "special attention to the needs of women and girls and those in vulnerable situations" but the corresponding indicator does not explicitly monitor how these needs are met, and fails to address menstrual health directly, which goes beyond infrastructure requirements [27,28]. In terms of monitoring, presence of a household toilet facility may meet the SDG 6.2 target but does not guarantee access by all household members at all times, as barriers may exist due to social and cultural norms governing toilet use within the household, as well as the infrastructure itself, including lockable doors and bins for menstrual waste [29]. Beyond the SDG indicators, the latest JMP reports (2021, 2023) greatly advance efforts in measuring inequalities related to gender and menstrual health [27], such as data on access to a private place to wash and change at home, although this does not fully capture issues such as use of public WASH facilities or facilities for disposal of menstrual waste (Fig. 1). However, due to a lack of open data practices existing disaggregated data (e.g. by disability or age) are not available for others to download and use [2]. Further efforts could present existing data on menstrual health together with other indicators such access to water and sanitation to better track these relationships.

To address the gaps in gender-specific indicators there are a number of efforts underway. Previously, the UNESCO World Water Assessment Programme published a toolkit for collecting sex-disaggregated water data aiming to achieve a global standard for gender-responsive data collection and monitoring [30]. More recently in connection to SDG 6.1 and 6.2, a JMP consultation is underway to examine gaps related to gender to recommend indicators for implementation, and a UN Water coordinated 'gender contextualization' process across the SDG 6 global indicators is also underway (See the JMP website for more details: https://washdata.org/). This has led to a draft list of priority indicators for enhanced monitoring of gender in WASH, with a proposal to disaggregate data by sex and age. While these gender-specific indicators have yet to be taken up into the SDG 6 indicators, this work will greatly improve the global WASH monitoring work by the JMP linked to gender. In addition, there will be another opportunity during the 2025 Comprehensive Review of the global indicator framework, although additions are only considered in exceptional cases.

In addition, WASH inequalities often manifest in differences beyond gender, which cannot be omitted from monitoring efforts. While socio-economic inequalities between individuals or households are easier to measure in many cases and are more globally comparable, group-based inequalities are thought to be more persistent, and require specific interventions that address discrimination [31]. To enable these kinds of interventions, there is a need for greater collection of disaggregated data according to ethnicity, religion, race, age, class, disability status, indigenous status, migrant and housing status, and other relevant social descriptors. The Global Multidimensional Poverty Index (MPI) Report provides some insight on these inequalities, showing for example that Paraguay has a large 'equity gap' of 61 % in water access due to the differences in access between indigenous and non-indigenous groups [32].

There is also a need to measure intersecting forms of exclusion, as certain groups may face more than one form of disadvantage [33,34]. For WASH this particularly relates to women as described above, who may also be members of marginalized groups, including ethnic and religious minorities, single-adult headed households, indigenous groups, internally displaced populations, people experiencing homelessness and people with disabilities [35–37]. For instance, the gendered implications of poor WASH can be unequally distributed across the life course, as reported in Ghana where use of unimproved sanitation was associated with depression among older people, particularly women [38]. Better tracking of these inequalities across several axes of marginality is critical from a policy perspective to avoid providing misleading information to decision-makers, as while certain gaps may close, such as due to socio-economic status, and appear to indicate progress, others gaps may remain intractable or increase [37,39]. It is however important to be aware of limitations in terms of categorical approaches to analyze intersectionality [40].

Many of these group-based disadvantages are the result of discrimination or historical disadvantage. For instance, intersections between caste, migrant status, and religion, can influence use, exclusion, and attitudes towards different types of WASH services [41]. WASH inequalities in high income countries are often driven by historically embedded and institutionalised forms of racism and social exclusion [42]. In Canada, some Indigenous groups have limited access to safe water which can be obscured among high overall coverage levels, highlighting the need to continue measuring inequality everywhere [43].

Social marginalization often intersects with other types of inequalities, such as temporal and spatial inequalities, which go beyond urban–rural divides and are not well captured in monitoring. For instance, marginalized inhabitants of border areas, such as the Mexico-US border crossing, experience particularly high WASH inequalities [44,45]. Recently, growing efforts have been made to show localized heterogeneity and inequalities in WASH services [46,47]. Further, inequalities may vary temporally or accumulate over the short or long term. For instance, there is a need for better monitoring of WASH in emergency settings or during extreme events where inequalities may be particularly exacerbated. In addition, services may be extremely variable and thus WASH inequalities can also fluctuate and should be measured with this in mind [48]. Seasonal changes have been measured for food security using the Months of Adequate Household Food Provisioning tool (MAHFP) using a 12 months recall period [49], and similar measures could assess months of water availability above a minimum level year round to assess who is most impacted by seasonal changes.

4. Gaps in measuring inequalities beyond 'access' and household infrastructure

The focus of global monitoring is almost exclusively on types of WASH infrastructure that protect users from fecal exposure, which obscures many other issues that contribute to WASH inequalities [50]. A growing number of studies show that individuals with 'access' to a particular facility may not benefit from it due to a range of social, economic, political, cultural and environmental barriers [51,52]. This requires a more holistic understanding of how people differentially use and benefit from access to WASH services to inform measurement of inequalities. Some scholars have proposed that expanding WASH indicators to align more with the human rights to water and sanitation (HRWS) criteria may be helpful to consider broader dimensions of WASH [53]. The HRWS state that the right to water includes

availability, quality, safety, accessibility, affordability and acceptability (such as appearance, taste and odour), and the right to sanitation also assures hygiene, privacy and dignity. However, there is very limited information on the social distribution of the HRWS criteria and how they differ between groups. Collecting this data would mean expanding surveys and data collection tools where this information is not collected, with associated costs. For instance, privacy and personal safety when using a toilet or practicing open defecation have emerged as important factors influencing mental and social well-being, but are not currently tracked on a global level, or included as part of the SDG target, despite being included in the Human Right to Sanitation [54]. In the case of water, efforts to measure affordability are underway although less so with sanitation [55,56]. Other aspects like cultural acceptability have been rarely measured despite examples of the importance of services also meeting this criterion, as this has often hindered the uptake of chlorination or solar disinfection treatment [57].

Many aspects of the HRWS are linked to one another so certain improvements may exacerbate or ameliorate inequalities in other aspects of service delivery, and certain groups may be impacted by a number of service quality problems at the same time, particularly due to gender or other social exclusion as discussed above. In the case of water, accessibility has been linked to safety, as associations have been observed between traveling more than 30 minutes to collect drinking water and risks of waterborne illness [58]. Likewise, intermittent piped water services are more likely to be contaminated than continuous piped water services, or result in the use of unsafe sources [59,60]. Cleaner, safer and more accessible sanitation comes at a higher price, lowering affordability for some households and potentially leading to exclusion of the urban poor [61]. Thus, use of a wider range of indicators can provide a deeper understanding of why some inequalities persist, such as why safety and accessibility issues remain wherever price is a barrier. While WASH monitoring is focused on the user level, Meyer et al., [62] suggest metrics for utility performance, such as indicators on water supply continuity and the associated hours of storage needed by their consumers to better understand inequalities. Data collected at the institutional or company level are used for several other SDGs so this could also be taken up by the water sector.

The JMP water and sanitation service ladders were updated in connection to the SDGs to include some service aspects beyond access to infrastructure, such as water that is 'available when needed' but in practice inadequate data is collected to monitor progress and many countries remain focused on access to 'improved' infrastructure alone. This lack of measurement will continue to mask inequalities related to safety and availability of drinking water, for instance in Sub-Saharan Africa both unsafe water sources and lack of safety testing disproportionately affect rural areas, and there is limited information on how poor quality water may be unevenly distributed within communities and households [63]. In Kathmandu Valley, Nepal, measuring supply hours indicated high inequality due to a small percentage of households receiving piped water for longer hours which would not be evident from only measuring water source type [64]. Climate change is likely to exacerbate many of these service quality aspects [65], and climate resilient WASH systems may also be distributed unequally but have yet to be measured systematically. Developing methods for measuring unequal climate outcomes is a critically important issue for the sector to explore and requires consideration of different approaches for measuring climate impacts, vulnerability and resilience [66], however this discussion is beyond the scope of the current review.

Furthermore, while WASH monitoring and the HRWS generally focus on water for drinking only, there are calls for a broader interpretation, encompassing water for food production, face and body hygiene needs, income generation and cultural practices, to inform how universal access is delivered and measured [67,68], and this perspective is missing from global monitoring efforts. For instance, monitoring of water for hygiene could be expanded beyond hand-washing to better account for water needed for other hygiene practices with social, cultural and health implications. Being able to practice body hygiene is critically important for menstrual health, reducing the burden of many neglected tropical diseases (NTDs) that cause debilitating conditions, and for reducing social marginalization faced by unhoused individuals. Avelar Portillo et al., [16] identified a need for water for laundry among unhoused groups in Skid Row, Los Angeles. In the case of NTDs, facial cleanliness involving daily face-washing practice with soap is linked to reduced prevalence of trachoma, but requires adequate safe water and soap to practice [69]. For individuals who contract lymphatic filariasis, regular skin and foot washing is needed to reduce the disease progression [70]. These examples highlight the importance of monitoring data on water and soap for hygiene going beyond hand-washing. Access to water for hygiene also holds cultural importance, and inadequate water may lead to stigmatization or psychosocial distress, for instance residents of Lilongwe informal settlement, Malawi, bathed 2–3 times a day to maintain a positive self-image and reduce stigma associated with being 'dirty' [71]. Similarly, the Special Rapporteur on the human rights to water and sanitation acknowledges that meeting the HRWS should move 'towards questions centered on people and the social and economic environment in which they live and work' [72]. Importantly, advances in measuring and monitoring progress for these aspects would provide greater evidence of the ways that WASH contributes widely to human wellbeing and social justice, such as women's empowerment, human dignity, housing security, and poverty reduction [73,74].

While we focus on SDG targets 6.1 and 6.2, a number of recommendations have been put forth to improve targets SDG 6a and 6b which focus on water and sanitation implementation, such as to revise 6b to better capture users' right to information, voice and remedy to address their respective issues with services provision [75]. However, these are not monitored by the JMP and instead through WHO and OECD as part of the UN Water Global Analysis and Assessment of Sanitation and Drinking-water (GLAAS), indicating a certain lack of coherence in monitoring and communication of inequalities as the data are not integrated.

5. Opportunities for improved measurement of inequalities using existing data

Many of the gaps in tracking inequalities highlighted here are limited by data availability, data quality and the use of different methodologies and non-comparable metrics. Existing resource constraints limit further data collection in many regions, as there are substantial costs of carrying out additional surveys and adding questions to existing surveys, so a question may need to be dropped to add another. Therefore, a first urgent step is the greater utilization of existing data that has not adequately been applied to raise awareness and accountability for groups being left behind. There are relevant data collected through international survey programs but not widely reported on since they do not respond to the SDG indicators and also due to a lack of open data practices in the JMP. For example, main person collecting water disaggregated by age and sex (Fig. 2), is included in the JMP recommended list of 'core questions' and is collected in MICS household surveys, but cannot be downloaded on the JMP website. The value of such data can be seen in a JMP report on inequalities, which includes a case study using this data on Sierra Leone, and it would be valuable for any user to be able to easily generate such analyses [3]. It could also be added to the JMP inequality profiles for instance to provide more detailed information on inequalities related to person collecting water. Similarly, some countries conduct time use surveys that provide valuable information on gender-specific burdens of unpaid water collection work, and these datasets could be compiled where available to kick-start and champion greater uptake of such surveys. In addition, data can be combined from multiple sources when survey length or frequency is a limitation, which was the case for the recent JMP work on menstrual health that brought together four indicators from a number of different surveys. Model disability surveys, World Health Surveys, and Washington Group Short

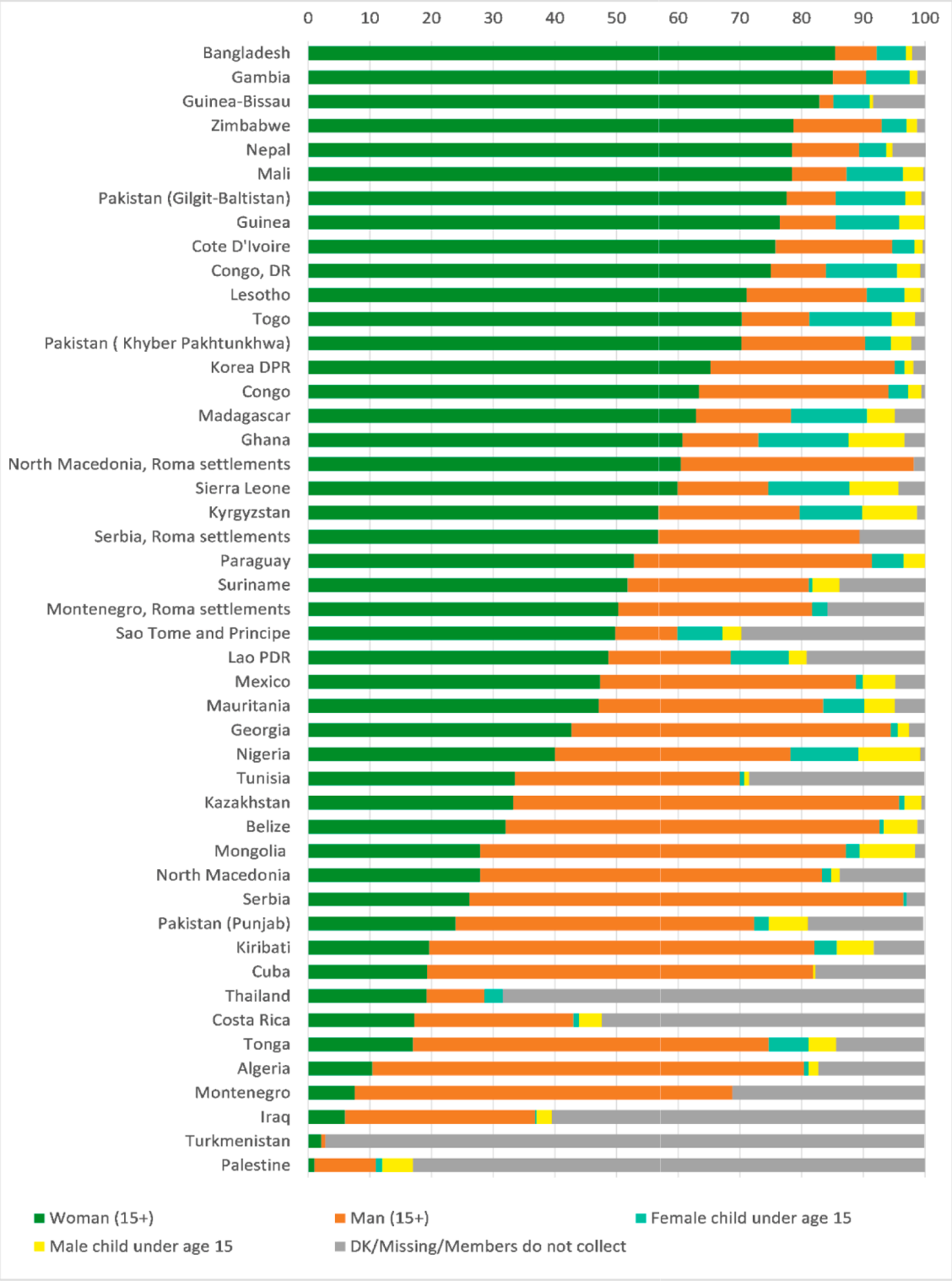


Fig. 2. Person usually collecting drinking water in the household dis-aggregated by sex and age. Note: In some countries such as Turkmenistan, households without piped water mainly use tanker trucks as their main source of drinking water so few households collect water (Data: UNICEF MICS surveys 2015–2019).

Set of Questions surveys could provide data on WASH related to people with disabilities (UN [76].

There is also a need for more insightful analysis of existing data, such as approaches that combine several axes of exclusion, as certain groups may be particularly disadvantaged but hidden due to limitations in analysis. For instance, female-headed households (generally a term used to refer to single adult households without a male adult) are associated with better access to improved water and sanitation in Sub-Saharan Africa compared with male-headed households despite very limited consideration of household type [77]. In other cases, WASH inequalities related to wealth are decreasing but inequalities due to social marginalization of certain ethnic groups are expanding [78]. For example, in Nepal differences in WASH access are affected in large part by caste, and religious and ethnic identity, rather than economic disadvantage. [79].

However, to demonstrate the existence, magnitude and interaction of various types of social inequalities attention to sample size is needed in data collection to ensure adequate information to disaggregate data [80]. This is particularly the case with multiple levels of disaggregation. Methodologically, many group-based inequalities are harder to address as people may be members of multiple social groups, and group membership is culturally determined. Discussions of how to define different groups are needed, for instance there are several ways to collect data on ethnicity.

Elsewhere, composite indices have been used to combine simple parity indices to identify who is most excluded and where [81]. This can build on existing efforts to create composite indices for WASH service ladders, which have been used from a public health perspective because interrupting multiple pathways of transmission is likely to be more effective. For instance, when basic coverage of water, sanitation and hygiene was analyzed together, combined basic SDG coverage was 4%, while rural combined basic SDG coverage was close to zero in many countries [82]. In addition, Calderón-Villarreal et al., [44] developed a six-item female WASH access index to compare WASH conditions across 21 refugee camps, with large inequalities identified across social and geographic stratifiers. Such composite indices could be used to monitor which groups have the lowest level of combined WASH services in a particular context and thus more effectively allocate scarce resources.

6. Opportunities for improved metrics and approaches for measurement of inequalities

Regular monitoring and reporting should expand beyond the SDG target 6.1 and 6.2 indicators to address the gaps discussed previously. This will require more research and co-design among stakeholders to improve the range of metrics and approaches used in tracking global WASH inequalities. While prioritization of resources is always a challenge, the COVID-19 pandemic has opened doors for new forms of WASH data collection such as through phone or SMS surveys, e.g. MICS plus surveys [2].

One area for greater attention is the development of individual-level metrics and tools for data collection in the WASH sector, such as the use of novel survey instruments to track individual realization of human rights and intra-household differences. Recent development of water and sanitation insecurity scales that measure individual experiences are one way of providing such additional information [83], while several emerging tools seek to evaluate intra-household WASH-related gender dynamics [84–86]. Improving individual data collection is also aligned with the SDG Agenda's aim to significantly increase the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, and other characteristics relevant in national contexts. In contrast to SDG 6, a number of other SDGs seek to monitor individual-level data: SDG 4 on education tracks gender disparities in 8 of 11 indicators and SDG 1.1 'people living below the poverty line' is disaggregated by sex, age, employment status and geographic location. In addition, food security has been tracked using a diverse range of individual and household food security scales, including as part of SDG target 2.1 with the indicator 'Prevalence of moderate or severe food insecurity in the population' which allows disaggregation of data by sex, age and other factors. This highlights progress that has been made in other sectors and the need to place more attention on explicitly tracking individual outcomes.

A further opportunity is greater development and uptake of metrics to directly measure inequality itself. This is particularly important for high-income countries with substantial inequalities in WASH. For instance, in Canada, where JMP data indicate 99% coverage for safely managed drinking water, disaggregation of this data by Indigenous status would highlight large disparities in the remaining 1% [87]. Some approaches have been proposed adjusting WASH access levels based on the intensity of inequality between different groups. For instance in Latin America and the Caribbean this resulted in significantly adjusting access levels in several countries (e.g. El Salvador, Jamaica, and Bolivia) with differences of 10p.p. or more [88]. Similarly, focusing on measuring progressive realization indicated that coverage level should not be used as an indicator of progress [89]. Certain countries with high coverage had low equity scores while some countries with low coverage had high equity scores.

Finally, it is important to acknowledge politics and power dynamics within the conceptualization and process of monitoring itself to address inequality. While it may seem objective, what and how data is collected and interpreted, communicated and used by stakeholders is a contested and political process, resulting in the exclusion of some voices and certain knowledge not counted. While we focus on largely quantitative indicators it is also important to keep in mind the caveat that focusing simply on 'counting' may take a reductionist view to unequal gender power relations [90]. Qualitative approaches or mixed methods such as the SenseMaker® instrument that collects micronarratives within survey data could be investigated for ways to complement standard survey data [91]. Despite these best efforts some critical information on inequalities will always be 'unmeasurable' due to its complexity.

More opportunities for open consultations and bottom-up participatory co-creation processes related to monitoring global WASH inequalities would be beneficial to collect a more diverse range of perspectives on priorities for measuring WASH inequalities. Although we focus on global monitoring approaches, efforts to 'localize' measurement of the SDGs are taking place, as well as community-based participatory approaches for measurement, and may offer solutions to some measurement challenges [92,93]. For example, spatial inequalities were analyzed across Belo Horizonte municipalities in Brazil for a number of population subgroups, highlighting inequalities that were not evident in aggregated national data, and providing an example that could be replicated for other urban areas [94]. Such localization of monitoring efforts may also be important to increase uptake of monitoring data into decision-making, as little evidence has been identified that goal-setting at the global level leads directly to political impacts in national or local politics [95]. In some cases measurement innovations taking place at a local scale have driven demand for global level monitoring efforts, such as in the case of menstrual health and hygiene indicators that were informed by efforts to evaluate programmes implemented by local governments or nonprofits [96]. Participatory or 'citizen' science and other related tools should be explored for their contributions to how inequalities are measured in the WASH sector [97].

7. Improving data sharing and communication of inequalities in WASH

A key part of improved tracking of inequalities is better communication of existing and emerging evidence to policy audiences. Due to the importance and dominance of the JMP WASH data platform for global WASH monitoring, this should be the starting point for improved communication of inequalities. A first step to enhance this platform is to use open data practices to provide a wider range of downloadable data for users to create their own materials for dissemination and generating more interactive visualizations to illustrate inequalities on the JMP website based a user's interest. Currently, the JMP website provides downloadable data on WASH service levels and inequalities due to wealth and rural or urban location (https://washdata.org/), providing 'inequalities files' for 105 countries. This information is fairly limited and does not correspond to all data used for the JMP reports, including the significant advances made by the JMP in recent years to monitor inequalities such as for displaced populations or at a sub-national level. The inequality files could be expanded to include accessible disaggregated data on a larger number of indicators, such as sex and age of person responsible for collecting water in a household and time spent collecting water, which are data that are already collected in some MICS surveys but not accessible or downloadable through the JMP website. A core set of inequalities that are most relevant for the WASH sector to

track and report on beyond service ladders could also be developed. This could be calculated for countries with existing data, and could also serve to guide improved data collection in countries with more limited data. In addition, all available global WASH datasets should be gathered on the WASHdata.org website or together in another location, to enable better coherence and learning, for instance UNHCR uses standardized WASH surveys, and has a microdata library on refugee camps and crisis-affected areas [44], while the GLAAS data is on yet a different website.

There are other examples to learn from, for instance the World Inequality Database on Education highlights inequalities across and between countries, including disparities by social groups on its website. The WHO Health Inequality Data Repository brings together many publicly available datasets to facilitate data exploration and analysis, most of which are disaggregated by age and sex, while some data includes information on ethnicity, disability, and migrant status. Finally, there is potential for expansion of interactive and visualization tools on the JMP website itself, as there is a focus on written reports when presenting inequalities. This could include the use of interactive equiplots to clearly show disparities in services for different groups, such as due to ethnicity or disability where data is available, or interactive maps at urban or regional levels to facilitate better awareness of spatial inequalities.

8. Conclusions

Rising inequalities pose one of the most urgent challenges for sustainable development, and in the case of WASH services many people are denied access because of who they are, their status in society, and where they live. Central to monitoring these inequalities, the SDG Agenda places a large focus on leaving no one behind and gender and women's empowerment but corresponding indicators to track achievement of these aspirations are limited within the current SDG WASH targets. While there are competing priorities for what can be monitored, privileging measurement of certain inequalities over others leads to an incomplete picture for policymakers, and leaves many people underserved and benefiting unevenly from services. For instance, while more difficult to identify and less globally comparable in some cases, intersecting social identities strongly mediate inequalities in WASH and are likely to impede progress, making them essential to track. We highlight the importance of considering how inequalities are measured across the sector and highlight several entry points to address gaps and advance existing approaches, with the goal of informing efforts to ensure equitable access and benefits related to WASH services.

Funding sources

This work was supported by Formas, the Swedish research council for sustainable development, Grant/Award Number: 2018-00805.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data is publicly available

References

[1] Chirgwin, H., S, Cairncross, S., Zehra, D., Waddington, H., 2021. Interventions promoting uptake of water, sanitation and hygiene (WASH) technologies in low- and middle-income countries: An evidence and gap map of effectiveness studies. Campbell Evidence and Gap Map 17, e1194.
[2] WHO and UNICEF JMP, 2021. Progress on household drinking water, sanitation and hygiene 2000-2020: five years into the SDGs. WHO and UNICEF, Geneva.
[3] WHO/UNICEF JMP, 2019. Progress on household drinking water, sanitation and hygiene 2000-2017. Special focus on inequalities. WHO/UNICEF, Geneva.
[4] Stewart, F., 2005. Horizontal Inequalities: A Neglected Dimension of Development BT - Wider Perspectives on Global Development, in: Atkinson, A.B., Basu, K., Bhagwati, J.N., North, D.C., Rodrik, D., Stewart, F., Stiglitz, J.E., Williamson, J.G. (Eds.), . Palgrave Macmillan UK, London, pp. 101–135. doi: 10.1057/9780230501850_5.
[5] M. Khadka, D. Joshi, L. Uprety, G. Shrestha, Gender and socially inclusive WASH in Nepal: Moving beyond 'engineering fixes', Front. Hum. Dynam. 5, 1181734.
[6] E. Stuart, J. Woodroffe, Leaving no-one behind: can the Sustainable Development Goals succeed where the Millennium Development Goals lacked? Gend. Dev. 24 (2016) 69–81, https://doi.org/10.1080/13552074.2016.1142206.
[7] I.T. Winkler, M.L. Satterthwaite, C. De Albuquerque, Treasuring what we measure and measuring what we treasure: post-2015 monitoring for the promotion of equality in the water, sanitation, and hygiene sector, Wis. Int'l LJ 32 (2014) 547.
[8] G. MacNaughton, Vertical inequalities: are the SDGs and human rights up to the challenges? The International Journal of Human Rights 21 (2017) 1050–1072, https://doi.org/10.1080/13642987.2017.1348697.
[9] J. Bartram, C. Brocklehurst, M.B. Fisher, R. Luyendijk, R. Hossain, T. Wardlaw, B. Gordon, Global Monitoring of Water Supply and Sanitation: History, Methods and Future Challenges, Int. J. Environ. Res. Public Health 11 (2014) 8137–8165, https://doi.org/10.3390/ijerph110808137.
[10] A. Shaheed, J. Orgill, M.A. Montgomery, M.A. Jeuland, J. Brown, Why "improved" water sources are not always safe, Bull. World Health Organ. 92 (2014) 283–289, https://doi.org/10.2471/BLT.13.119594.
[11] WHO/UNICEF JMP, 2017. Progress on drinking water, sanitation and hygiene: 2017 update and SDG baselines. WHO/UNICEF, Geneva.
[12] S.M. Collins, P. Mbullo Owuor, J.D. Miller, G.O. Boateng, P. Wekesa, M. Onono, S. L. Young, 'I know how stressful it is to lack water!' Exploring the lived experiences of household water insecurity among pregnant and postpartum women in western Kenya, Glob. Public Health 14 (2019) 649–662, https://doi.org/10.1080/17441692.2018.1521861.
[13] L. Rodríguez, Intrahousehold Inequalities in Child Rights and Well-Being. A Barrier to Progress? World Dev. 83 (2016) 111–134, https://doi.org/10.1016/j.worlddev.2016.02.005.
[14] L.M. Banks, S. White, A. Biran, J. Wilbur, S. Neupane, S. Neupane, A. Sharma, H. Kuper, Are current approaches for measuring access to clean water and sanitation inclusive of people with disabilities? Comparison of individual- and household-level access between people with and without disabilities in the Tanahun district of Nepal, PLoS One 14 (2019) e0223557.
[15] V. Venkataramanan, S.M. Collins, K.A. Clark, J. Yeam, V.G. Nowakowski, S. L. Young, Coping strategies for individual and household-level water insecurity: A systematic review, WIREs Water 7 (2020) e1477.
[16] L.J. Avelar Portillo, G.L. Kayser, C. Ko, A. Vasquez, J. Gonzalez, D.J. Avelar, N. Alvarenga, M. Franklin, Y.-Y. Chiang, Water, Sanitation, and Hygiene (WaSH) insecurity in unhoused communities of Los Angeles, California, Int. J. Equity Health 22 (2023) 108, https://doi.org/10.1186/s12939-023-01920-8.
[17] Liera, C., Dickin, S., Rishworth, A., Bisung, E., Moreno, A., Elliott, S.J., 2023. Human rights, COVID-19, and barriers to safe water and sanitation among people experiencing homelessness in Mexico City. Frontiers in Water 5.
[18] J. Stoler, R.A. Tutu, K. Winslow, Piped water flows but sachet consumption grows: The paradoxical drinking water landscape of an urban slum in Ashaiman, Ghana, Habitat Int. 47 (2015) 52–60.
[19] WBG and GWSP, 2019. Women in water utilities. Breaking barriers. World Bank Group and Global Water and Sanitation Partnership.
[20] World Bank, 2019. Health, Safety and Dignity of Sanitation Workers. World Bank, Washington, DC. doi: 10.1596/32640.
[21] M. Zaqout, S. Cawood, B.E. Evans, D.J. Barrington, Sustainable sanitation jobs: prospects for enhancing the livelihoods of pit-emptiers in Bangladesh, Third World Q. 1–19 (2020), https://doi.org/10.1080/01436597.2020.1810560.
[22] Dickin, S., Caretta, M.A., 2022. Examining water and gender narratives and realities. WIREs Water e1602. doi: 10.1002/wat2.1602.
[23] J. MacArthur, N. Carrard, J. Willetts, WASH and Gender: a critical review of the literature and implications for gender-transformative WASH research, Journal of Water, Sanitation and Hygiene for Development 10 (2020) 818–827, https://doi.org/10.2166/washdev.2020.232.
[24] UN WOMEN, 2018. Turning promises into action: Gender equality in the 2030 Agenda for Sustainable Development.
[25] J. Geere, M. Cortobius, J.H. Geere, C.C. Hammer, P.R. Hunter, Is water carriage associated with the water carrier's health? A systematic review of quantitative and qualitative evidence, BMJ Glob. Health 3 (2018) e000764.
[26] L. Heise, M.E. Greene, N. Opper, M. Stavropoulou, C. Harper, M. Nascimento, D. Zewdie, G.L. Darmstadt, M.E. Greene, S. Hawkes, L. Heise, S. Henry, J. Heymann, J. Klugman, R. Levine, A. Raj, G. Rao Gupta, Gender inequality and restrictive gender norms: framing the challenges to health, Lancet 393 (2019) 2440–2454, https://doi.org/10.1016/S0140-6736(19)30652-X.
[27] J. Hennegan, I.T. Winkler, C. Bobel, D. Keiser, J. Hampton, G. Larsson, V. Chandra-Mouli, M. Plesons, T. Mahon, Menstrual health: a definition for policy, practice, and research, Sexual and Reproductive Health Matters 29 (2021) 31–38, https://doi.org/10.1080/26410397.2021.1911618.
[28] Loughnan, L., Mahon, T., Goddard, S., Bain, R., Sommer, M., 2020. Monitoring Menstrual Health in the Sustainable Development Goals BT - The Palgrave Handbook of Critical Menstruation Studies, in: Bobel, C., Winkler, I.T., Fahs, B., Hasson, K.A., Kissling, E.A., Roberts, T.-A. (Eds.), . Springer Singapore, Singapore, pp. 577–592. doi: 10.1007/978-981-15-0614-7_44.

[29] M.L. Schmitt, D. Clatworthy, T. Ogello, M. Sommer, Making the Case for a Female-Friendly Toilet, Water 10 (2018), https://doi.org/10.3390/w10091193.
[30] Miletto, M., Pangare, V., Thuy, L., 2019. Tool 1 – Gender-responsive indicators for water assessment, monitoring and reporting, UNESCO WWAP Toolkit on Sex-disaggregated Water Data. UNESCO, Paris, France.
[31] C. Tilly, Durable inequality, Univ of California Press, 1998.
[32] OPHI and UNDP, 2021. Global Multidimensional Poverty Index 2021 – Unmasking disparities by ethnicity, caste and gender. United Nations Development Programme and Oxford Poverty and Human Development Initiative.
[33] C. Harrington, P. Montana, J.J. Schmidt, A. Swain, Race, Ethnicity, and the Case for Intersectional Water Security, Global Environmental Politics 23 (2023) 1–10, https://doi.org/10.1162/glep_a_00702.
[34] Y. Truelove, Rethinking water insecurity, inequality and infrastructure through an embodied urban political ecology, WIREs Water 6 (2019) e1342.
[35] S. Chant, Women-Headed Households: Poorest of the Poor?: Perspectives from Mexico, Costa Rica and the Philippines1, IDS Bull. 28 (1997) 26–48, https://doi.org/10.1111/j.1759-5436.1997.mp28003003.x.
[36] M.L. Schmitt, O.R. Wood, D. Clatworthy, S.F. Rashid, M. Sommer, Innovative strategies for providing menstruation-supportive water, sanitation and hygiene (WASH) facilities: learning from refugee camps in Cox's bazar, Bangladesh, Confl. Heal. 15 (2021) 1–12.
[37] Soeters, S., Grant, M., & Carrard, N. and Willetts, J., 2019. Intersectionality: Ask the other question, Water for Women: Gender in WASH - Conversational article 2. Institute for Sustainable Futures, University of Technology Sydney.
[38] S. Simiyu, M. Bagayoko, R.M. Gyasi, Associations between water, sanitation, and depression among older people in Ghana: empirical evidence from WHO-SAGE Wave 2 survey, Aging & mental health 26 (6) (2022) 1112–1119.
[39] A. Cornwall, A.M. Rivas, From 'gender equality and 'women's empowerment'to global justice: reclaiming a transformative agenda for gender and development, Third World Q. 36 (2) (2015) 396–415.
[40] S.H. Shah, L.M. Harris, V. Menghwani, J. Stoler, A. Brewis, J.D. Miller, C. L. Workman, E.A. Adams, A.L. Pearson, A. Hagaman, A. Wutich, S.L. Young, Variations in household water affordability and water insecurity: An intersectional perspective from 18 low- and middle-income countries, Environment and Planning F 2 (2023) 369–398, https://doi.org/10.1177/26349825231156900.
[41] F. Sultana, Embodied Intersectionalities of Urban Citizenship: Water, Infrastructure, and Gender in the Global South, Ann. Am. Assoc. Geogr. 110 (2020) 1407–1424, https://doi.org/10.1080/24694452.2020.1715193.
[42] J. Brown, C.S. Acey, C. Anthonj, D.J. Barrington, C.D. Beal, D. Capone, O. Cumming, K.P. Fedinick, J.M. Gibson, B. Hicks, The effects of racism, social exclusion, and discrimination on achieving universal safe water and sanitation in high-income countries, Lancet Glob. Health 11 (2023) e606–e614.
[43] S. Duignan, T. Moffat, D. Martin-Hill, Be like the running water: Assessing gendered and age-based water insecurity experiences with Six Nations First Nation, Soc. Sci. Med. 298 (2022), 114864, https://doi.org/10.1016/j.socscimed.2022.114864.
[44] A. Calderón-Villarreal, R. Schweitzer, G. Kayser, Social and geographic inequalities in water, sanitation and hygiene access in 21 refugee camps and settlements in Bangladesh, Kenya, Uganda, South Sudan, and Zimbabwe, Int. J. Equity Health 21 (2022) 27, https://doi.org/10.1186/s12939-022-01626-3.
[45] A. Wutich, W. Jepson, C. Velasco, A. Roque, Z. Gu, M. Hanemann, P. Westerhoff, Water insecurity in the Global North: A review of experiences in US colonias communities along the Mexico border, Wiley Interdisciplinary Reviews: Water 9 (4) (2022) e1595.
[46] C. Anthonj, J.W. Tracy, L. Fleming, K.F. Shields, W.M. Tikoisuva, E. Kelly, M. B. Thakkar, R. Cronk, M. Overmars, J. Bartram, Geographical inequalities in drinking water in the Solomon Islands, Sci. Total Environ. 712 (2020), 135241, https://doi.org/10.1016/j.scitotenv.2019.135241.
[47] Local Burden of Disease WaSH Collaborators, 2020. Mapping geographical inequalities in access to drinking water and sanitation facilities in low-income and middle-income countries, 2000–17. The Lancet Global Health 8, e1162–e1185. https://doi.org/10.1016/S2214-109X(20)30278-3.
[48] H.D. Price, E.A. Adams, P.D. Nkwanda, T.W. Mkandawire, R.S. Quilliam, Daily changes in household water access and quality in urban slums undermine global safe water monitoring programmes, Int. J. Hyg. Environ. Health 231 (2021), 113632, https://doi.org/10.1016/j.ijheh.2020.113632.
[49] P. Bilinsky, A. Swindale, Months of Adequate Household Food Provisioning (MAHFP) for Measurement of Household Food Access, Indicator Guide (version 4) (2010) 11.
[50] J. Stoler, D.B. Guzmán, E.A. Adams, Measuring transformative WASH: A new paradigm for evaluating water, sanitation, and hygiene interventions, WIREs Water 10 (2023) e1674.
[51] É.D. Coswosk, P. Neves-Silva, C.M. Modena, L. Heller, Having a toilet is not enough: The limitations in fulfilling the human rights to water and sanitation in a municipal school in Bahia, Brazil, BMC Public Health 19 (2019) 1–9.
[52] S.L. Smiley, J. Stoler, Socio-environmental confounders of safe water interventions, WIREs Water 7 (2020) e1438.
[53] R. Giné-Garriga, Ó. Flores-Baquero, A. Jiménez-Fdez de Palencia, A. Pérez-Foguet, Monitoring sanitation and hygiene in the 2030 Agenda for Sustainable Development: A review through the lens of human rights, Sci. Total Environ. 580 (2017) 1108–1119, https://doi.org/10.1016/j.scitotenv.2016.12.066.
[54] G.D. Sclar, G. Penakalapati, B.A. Caruso, E.A. Rehfuess, J.V. Garn, K.T. Alexander, M.C. Freeman, S. Boisson, K. Medlicott, T. Clasen, Exploring the relationship between sanitation and mental and social well-being: A systematic review and qualitative synthesis, Soc Sci Med 217 (2018) 121–134, https://doi.org/10.1016/j.socscimed.2018.09.016.
[55] Andres, L., Brocklehurst, C., Grabinsky, J., Joseph, G., Thibert, M., 2020. Measuring the Affordability of Water Supply, Sanitation, and Hygiene Services: A New Approach. Water Economics and Policy 2050002.
[56] N. Turman-Bryant, Measuring progress towards sanitation and hygiene targets: a critical review of monitoring methodologies and technologies, Waterlines 37 (2018) 229–247.
[57] R.C. Rainey, A.K. Harding, Acceptability of solar disinfection of drinking water treatment in Kathmandu Valley, Nepal, International Journal of Environmental Health Research 15 (2005) 361–372.
[58] B.L. Nygren, C.E. O'Reilly, A. Rajasingham, R. Omore, M. Ombok, A.O. Awuor, P. Jaron, F. Moke, J. Vulule, K. Laserson, The relationship between distance to water source and moderate-to-severe diarrhea in the global enterics multi-center study in Kenya, 2008–2011, Am. J. Trop. Med. Hyg. 94 (2016) 1143–1149.
[59] A.W. Bivins, T. Sumner, E. Kumpel, G. Howard, O. Cumming, I. Ross, K. Nelson, J. Brown, Estimating Infection Risks and the Global Burden of Diarrheal Disease Attributable to Intermittent Water Supply Using QMRA, Environ. Sci. Tech. 51 (2017) 7542–7551, https://doi.org/10.1021/acs.est.7b01014.
[60] P.R. Hunter, D. Zmirou-Navier, P. Hartemann, Estimating the impact on health of poor reliability of drinking water interventions in developing countries, Sci. Total Environ. 407 (2009) 2621–2624, https://doi.org/10.1016/j.scitotenv.2009.01.018.
[61] G. McGranahan, Realizing the Right to Sanitation in Deprived Urban Communities: Meeting the Challenges of Collective Action, Coproduction, Affordability, and Housing Tenure, World Dev. 68 (2015) 242–253, https://doi.org/10.1016/j.worlddev.2014.12.008.
[62] D.D.J. Meyer, S. Singh, J. Singh, M. Kumar, M. He, Learning from intermittent water supply schedules: Visualizing equality, equity, and hydraulic capacity in Bengaluru and Delhi, India, Science of the Total Environment 892 (2023), 164393, https://doi.org/10.1016/j.scitotenv.2023.164393.
[63] S. Nowicki, J. Koehler, K.J. Charles, Including water quality monitoring in rural water services: why safe water requires challenging the quantity versus quality dichotomy, npj Clean Water 3 (2020) 14, https://doi.org/10.1038/s41545-020-0062-x.
[64] B. Guragai, S. Takizawa, T. Hashimoto, K. Oguma, Effects of inequality of supply hours on consumers' coping strategies and perceptions of intermittent water supply in Kathmandu Valley, Nepal, Science of the Total Environment 599–600 (2017) 431–441, https://doi.org/10.1016/j.scitotenv.2017.04.182.
[65] D.J. MacAllister, A.M. MacDonald, S. Kebede, S. Godfrey, R. Calow, Comparative performance of rural water supplies during drought, Nat. Commun. 11 (2020) 1099, https://doi.org/10.1038/s41467-020-14839-3.
[66] J. Kohlitz, J. Chong, J. Willetts, Rural Drinking Water Safety under Climate Change: The Importance of Addressing Physical, Social, and Environmental Dimensions, Resources 9 (2020) 77, https://doi.org/10.3390/resources9060077.
[67] L. Mehta, Water and Human Development, World Dev. 59 (2014) 59–69, https://doi.org/10.1016/j.worlddev.2013.12.018.
[68] Neves-Silva, P., Lopes, J.A. de O., Heller, L., 2020. The right to water: Impact on the quality of life of rural workers in a settlement of the Landless Workers Movement, Brazil. PLOS ONE 15, e0236281.
[69] M.E. Stocks, S. Ogden, D. Haddad, D.G. Addiss, C. McGuire, M.C. Freeman, Effect of Water, Sanitation, and Hygiene on the Prevention of Trachoma: A Systematic Review and Meta-Analysis, PLoS Med. 11 (2014) e1001605.
[70] M.E. Stocks, M.C. Freeman, D.G. Addiss, The Effect of Hygiene-Based Lymphedema Management in Lymphatic Filariasis-Endemic Areas: A Systematic Review and Meta-analysis, PLoS Negl. Trop. Dis. 9 (2015) e0004171.
[71] M. Rusca, C. Alda-Vidal, M. Hordijk, N. Kral, Bathing without water, and other stories of everyday hygiene practices and risk perception in urban low-income areas: The case of Lilongwe, Malawi, Environ. Urban. 29 (2017) 533–550.
[72] UN, 2020. Progressive realization of the human rights to water and sanitation: Report of the Special Rapporteur on the human rights to safe drinking water and sanitation. Geneva, Switzerland. https://doi.org/A/HRC/45/10.
[73] F.M. Gimelli, J.J. Bos, B.C. Rogers, Fostering equity and wellbeing through water: A reinterpretation of the goal of securing access, World Dev. 104 (2018), https://doi.org/10.1016/j.worlddev.2017.10.033.
[74] M. Goff, B. Crow, What is water equity? The unfortunate consequences of a global focus on "drinking water", Water Int. 39 (2014) 159–171, https://doi.org/10.1080/02508060.2014.886355.
[75] J. Bartram, C. Brocklehurst, D. Bradley, M. Muller, B. Evans, Policy review of the means of implementation targets and indicators for the sustainable development goal for water and sanitation, npj Clean Water 1 (2018) 1–5, https://doi.org/10.1038/s41545-018-0003-0.
[76] UN DESA, 2019. Disability and Development Report: Realizing the Sustainable Development Goals by, for and with persons with disabilities. United Nations, New York, USA.
[77] F.A. Armah, B. Ekumah, D.O. Yawson, J.O. Odoi, A.-R. Afitiri, F.E. Nyieku, Access to improved water and sanitation in sub-Saharan Africa in a quarter century, Heliyon 4 (2018) e00931.
[78] A. Kumar, Access to Basic Amenities: Aspects of Caste, Ethnicity and Poverty in Rural and Urban India—1993 to 2008–2009, Journal of Land and Rural Studies 2 (2014) 127–148, https://doi.org/10.1177/2321024913515113.
[79] S. Balasubramanya, D. Stifel, M. Alvi, C. Ringler, The role of social identity in improving access to water, sanitation and hygiene (WASH) and health services: Evidence from Nepal, Development Policy Review 40 (2022) e12588.
[80] I.T. Winkler, M.L. Satterthwaite, Leaving no one behind? Persistent inequalities in the SDGs, The International Journal of Human Rights 21 (2017) 1073–1097, https://doi.org/10.1080/13642987.2017.1348702.

[81] J. Friedman, H. York, N. Graetz, L. Woyczynski, J. Whisnant, S.I. Hay, E. Gakidou, Measuring and forecasting progress towards the education-related SDG targets, Nature 580 (2020) 636–639.
[82] R. Roche, R. Bain, O. Cumming, A long way to go – Estimates of combined water, sanitation and hygiene coverage for 25 sub-Saharan African countries, PLoS One 12 (2017) e0171783.
[83] S.L. Young, H.J. Bethancourt, Z.R. Ritter, E.A. Frongillo, The Individual Water Insecurity Experiences (IWISE) Scale: reliability, equivalence and validity of an individual-level measure of water security, BMJ Glob. Health 6 (2021) e006460.
[84] N. Carrard, J. MacArthur, C. Leahy, S. Soeters, J. Willetts, The water, sanitation and hygiene gender equality measure (WASH-GEM): Conceptual foundations and domains of change, Women's Studies International Forum 91 (2022), 102563, https://doi.org/10.1016/j.wsif.2022.102563.
[85] S. Dickin, E. Bisung, J. Nansi, K. Charles, Empowerment in water, sanitation and hygiene index, World Dev. 137 (2021), 105158, https://doi.org/10.1016/j.worlddev.2020.105158.
[86] S.S. Sinharoy, A. Conrad, M. Patrick, S. McManus, B.A. Caruso, Protocol: Protocol for development and validation of instruments to measure women's empowerment in urban sanitation across countries in South Asia and Sub-Saharan Africa: the Agency, Resources and Institutional Structures for Sanitation-related Empowerment (ARISE) scales, BMJ Open 12 (2022).
[87] R.J. Patrick, Uneven access to safe drinking water for First Nations in Canada: connecting health and place through source water protection, Health Place 17 (2011) 386–389, https://doi.org/10.1016/j.healthplace.2010.10.005.
[88] V.C. Queiroz, R.C. Carvalho, L. Heller, New Approaches to Monitor Inequalities in Access to Water and Sanitation: The SDGs in Latin America and the Caribbean, Water (2020), https://doi.org/10.3390/w12040931.
[89] J. Luh, R. Baum, J. Bartram, Equity in water and sanitation: Developing an index to measure progressive realization of the human right, Int. J. Hyg. Environ. Health 216 (2013) 662–671, https://doi.org/10.1016/j.ijheh.2012.12.007.
[90] K. Lahiri-Dutt, Counting (gendered) water use at home: Feminist approaches in practice, ACME: an International Journal for Critical Geographies 14 (2015) 652–672.
[91] S.A. Bartels, S. Michael, L. Vahedi, A. Collier, J. Kelly, C. Davison, J. Scott, P. Parmar, P. Geara, SenseMaker® as a monitoring and evaluation tool to provide new insights on gender-based violence programs and services in Lebanon, Eval. Program Plann. 77 (2019), 101715, https://doi.org/10.1016/j.evalprogplan.2019.101715.
[92] K. Ceaser, D. Tim, G. Fraser, G. Ellen, C. Sokhadeva, K. Benjamin, Strengthening country-led water and sanitation services monitoring and data use for decision-making: lessons from WaterAid experience in four countries, H2Open Journal 5 (2022) 348–364, https://doi.org/10.2166/h2oj.2022.028.
[93] J. Stoler, D.B. Guzmán, E.A. Adams, Revisiting transformative WASH: measuring impact, Lancet Glob. Health 11 (2023) e493–e494, https://doi.org/10.1016/S2214-109X(23)00013-X.
[94] R.C. de Carvalho, M.I.P. Nahas, L. Heller, Localizing sustainable development goal 6: An assessment of equitable access to sanitation in a Brazilian Metropolitan Region, Sustainability (switzerland) 12 (2020), https://doi.org/10.3390/SU12176776.
[95] F. Biermann, T. Hickmann, C.-A. Sénit, M. Beisheim, S. Bernstein, P. Chasek, L. Grob, R.E. Kim, L.J. Kotzé, M. Nilsson, A. Ordóñez Llanos, C. Okereke, P. Pradhan, R. Raven, Y. Sun, M.J. Vijge, D. van Vuuren, B. Wicke, Scientific evidence on the political impact of the Sustainable Development Goals, Nat Sustain 5 (2022) 795–800, https://doi.org/10.1038/s41893-022-00909-5.
[96] E. Larson, S. Turke, N.H. Miko, S. Oumarou, S. Alzouma, A. Rogers, K.J. Schwab, J. Hennegan, Capturing menstrual health and hygiene in national surveys: insights from performance monitoring and accountability 2020 resident enumerators in Niamey, Niger, Journal of Water, Sanitation and Hygiene for Development 11 (2021) 295–303, https://doi.org/10.2166/washdev.2021.177.
[97] E.M.M. Wanda, M. Manda, J. Kushe, O. Msiska, C. Mphande, D. Kamlomo, J. Kaunda, Using citizen science approach to monitor water, sanitation and hygiene related risks in Karonga town, Malawi, Afr. J. Environ. Sci. Technol. 11 (2017) 304–323.