6

Conclusion

6.1 Living with the Global Water Crisis

From the hot and humid deltaic plains of Bangladesh to the parched drylands of Kenya, the narratives of water risks are shaped by the drops of rain, the flows of rivers, and the stores of groundwater. In March–April, as rising temperatures, drying ponds, and declining groundwater tables intensify the salinity crisis in Khulna, the first drops of rains bring life to the dry riverbeds of Kitui, filling up earthdams and rock catchments. In July–August, as the tropical monsoon dilutes the pollution in Dhaka's rivers, men and boys dive into the deceptively cleaner waters for respite from the afternoon sun. Meanwhile, women and girls in Lodwar scoop out water from the Kawalase River and roll the heavy jerrycans back home. In October–November, as the second rainy season starts, the fear of flash floods grips the riverbank residents of Lodwar, while the Bay of Bengal becomes a breeding ground for cyclones. As the days and months of the year go by, the nature and distribution of water risks change across geographies. The water diaries of urban and rural Bangladeshis and Kenyans in this book document how people of different cultures in diverse environments cope with these risks while living in poverty.

Despite the stark contrast in sociopolitical history and hydroclimatic contexts, we observed many commonalities in behaviour across our four study sites. Rains stand out as the most defining driver of water source choice, as rural populations in both Khulna and Kitui shift to rainwater, whether harvested in containers from own roof catchments or in rocks and dams in slopes and valleys. Whether in sarees or sarongs, in *kolshis* stacked on the waist or jerrycans balanced on the head, women are the primary drawers and haulers of water. When water needs to be transported via motorcycles or boats, a well is dug or a community tube well is installed, men come into the scene. Behavioural clusters emerge within the same localities based on proximity to infrastructure. Some resort to free and often unimproved sources, while others can afford to pay for vended water from distant sources all year round.

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While water expenditures vary between these clusters, food expenditures remain generally stable except for festival times such as Christmas or Eid. Smell, colour and taste of water are stronger drivers of choice, compared to knowledge on invisible pathogenic or chemical contamination without immediate health impacts.

Geography and culture also shape differences in acceptable level of risks, behaviours, and policy outcomes. While handpumps were introduced in Kenya and Bangladesh at roughly the same time, high population density and easy availability of groundwater at shallow depths spurred the growth in local markets and private tube wells in rural areas like Khulna, whereas in Kenya and much of Sub-Saharan Africa, handpump installation continues to be a donor-funded investment. In Khulna, while drinking water access may be constrained by salinity, there is an abundance of water for washing, bathing and livestock. In Kitui and Lodwar, where limited water availability contributes to daily collection of around 20 litres per person per day, every drop counts. Yet, our diary respondents often reported having sufficient water as their habitus of place, culture and practice has influenced what is 'acceptable'. For Dhaka's marginalised people, bathing and fishing in the polluted rivers might be acceptable, though the city's middle and upper class residents would maintain their distance from these waterbodies. For our Khulna diary participants, the photo of scooping out water from dry riverbeds in Kitui felt alien. Likewise, with the photo of the Khulna boat vendor transporting water through water, our Kitui participants found it difficult to conceive the notion of water scarcity in Khulna.

Individual practices are linked to institutional behaviours, embodying the legacies of colonial and post-colonial aid-dependent policy regimes. While a series of policies outline the roles of public and private actors, from national to local levels, these often remain on paper with limited impact in practice. Regulation is missing or ineffective for rural drinking water services in Kitui and Khulna, while non-compliance is normalised in case of urban water pollution in Dhaka and unreliable piped supply in Lodwar. In Dhaka, private governance by global fashion brands and consortiums, and mounting civil society pressures have emerged in response to weak regulatory enforcement of river health by the state. In Khulna and Kitui, absence of effective monitoring and coordination have resulted in overlapping investments in rural water infrastructure by donors and governments and sub-optimal usage of financial resources. Regardless of technology type and user capacity, infrastructure is routinely handed over to communities assuming that since they need it, they will maintain it. Extensive private investments by households and small enterprises are a response to the poor sustainability of public investments, posing uncertain water quality risks and high-cost burdens. The proliferation of around 16 million shallow tube wells in rural Bangladesh (Fischer et al., 2020), for instance, may have facilitated the MDG target of increasing access, but it now creates an immense behavioural challenge to convince people to shift

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away from their own sources and pay for publicly provided higher service levels such as piped schemes. The process to influence local habits and cultural norms will take time, patience and money.

6.2 Responding to the Global Water Crisis

So, what lessons can we take to guide policy and practice to do better in the future? Two areas deserve attention – first, the interactions between rainfall and water use behaviours and the implications for public health and financial sustainability of waterpoints in a changing climate; and second, the need for better information on water risks for institutional accountability and sustainable finance for delivering impacts at scale.

As rains replenish wells, ponds, and storage tanks, and washes away pollutants from rivers and floodplains, people's water source choices and river use behaviour take a sharp turn. For households with low and variable incomes, use of rainwater reduces the collection burden and expenditures associated with alternative sources. Besides the rationale of cost and convenience, these behavioural dynamics are also driven by deeply ingrained psychological and cultural dispositions. Paul et al. (2018)'s study in Ethiopia found trust in social institutions as a predicator of choice, as the need for community level coordination and management varies across source types – being highest for boreholes and lowest for surface water sources. Borehole use was associated with lower-income, and users exhibited lower trust, worrying about competing water access and others not doing their share of maintenance. The freshly collected rainwater and rising river flows evoke a sense of abundance and natural blessing amongst the rural residents of Khulna and Kitui and urban riverbank populations in Dhaka, whose lives and livelihoods are intricately linked to water. However, this rainfall driven behaviours have two major implications for water policy – public health and financial sustainability of rural water services.

Water quality results from Kitui and Khulna confirm the high prevalence of faecal contamination in ponds sand filters (Figure 3.7), earth dams and rainwater storage tanks (Figure 4.4), with increased risks in the wet season even among shallow groundwater sources. This is supported by various studies showing that in contexts with multiple sources, households may not choose the safest option (Hamilton et al., 2019, Foster and Willetts, 2018), particularly when the contaminant does not affect taste, smell or colour, as in the cases of arsenic and fluoride as well. Those living in poverty, may choose to discount a possible future health benefit over an immediate water payment cost (Ray and Smith, 2021). In Dhaka, men, women and children are daily exposed to high-levels of pathogens while swimming and bathing in the rivers in monsoon. Modifying behaviour for risks that do not have immediate consequences is challenging and complicated by the lack of monitoring and risk communication.

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Kiosks and handpumps in Kenya suffer from a significant drop in revenues in the wet season, to the extent that many piped schemes in Kitui close operations seasonally (see Section 4.5). This is more prevalent for pay-as-you-fetch services, as also observed in the case of small water enterprises in coastal Bangladesh. Intra-seasonal variability is shown to moderate these revenue fluctuations, as users will value continued operations of piped schemes and handpumps if there is likelihood of dry spells interrupting wet seasons. This may be a potential silver lining in influencing use of improved sources during the wet season, given the increased trend of sub-seasonal rainfall variations in certain regions of Africa (Dyer and Washington, 2021). Climate shocks such as cyclones, floods and droughts also disrupt functioning of water supply systems posing higher cost burdens on users. We saw this in the cases of LOWASCO's boreholes being flooded (see Section 5.4) and Khulna's pond sand filters being filled with saline storm surge water during cyclone Amphan (see Section 3.4).

A key response to the water crisis is to improve institutional accountability and decision-making through timely and accurate data on risks. Global and nationally representative aggregate statistics are useful for public advocacy and sector funding, but not for defining appropriate responses to locally specific challenges. In Dhaka, our river water quality monitoring data have helped calibrate hydrodynamic models to simulate impacts of different policy interventions such as river flow augmentation, planned construction of sewage treatment plants, and relocation of tanneries (Bussi et al., 2023, Whitehead et al., 2019, Whitehead et al., 2018). The river diaries have illustrated the social inequalities in pollution exposure across space and seasons, supporting the call for risk communication and provision of better water and sanitation facilities to reduce exposure in the short term. Installation of automated water quality monitors can improve institutional accountability by identifying pollutant discharge events, address the information gaps for tracking progress towards SDG 6.3, and communicate real time risks to river users.

In case of drinking water services, we have shown how data on 'one main source' can be misleading in rural contexts with multiple source use. While water diaries may not be systematically implemented at large scales due to logistical and budgetary constraints, traditional household surveys can be modified to incorporate issues of multiple sources, quality, costs, and water insecurity experiences, potentially on a sub-sample of the survey population. The inclusion of arsenic and *E. coli* analysis in the 2019 Multiple Indicator Cluster Survey Bangladesh, for example, shows the value of better data in challenging traditional statistics on access (see Section 3.3). Performance of water supply infrastructure remains a grey area for rural service delivery, as most developing countries like Bangladesh and Kenya lack comprehensive inventories of public and donor-funded waterpoints,

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their functionality, and water safety. Professional service delivery models emerging in Asia and Africa can plug these gaps through regular reporting on performance metrics to attract results-based funding (McNicholl and Hope, 2024). Such data would be consistent with the diary data but be monitored as service delivery contracts providing governments and donors with more granular, longitudinal and effective information.

As described in Section 3.5, the Government of Bangladesh has collaborated closely with research aligned to the diary work to pilot a results-based contract for safe drinking water in the coastal zone. The SafePani model will guarantee safe drinking water for 1,200 schools and healthcare facilities from 2024 to 2030 aligning with the government's commitment to SDG 6.1. A central feature of the model is co-funding of the operational costs with the government committing 45 per cent of the operational costs for seven years, which will be matched by external donors. In contrast, current funding for drinking water is bundled into a wider set of facility management service costs (energy, sanitation, buildings, etc.) with no effective monitoring or evaluation of results. At a cost of less than USD 1 per person per year, the SafePani costs are modest whilst the outcomes for health and education are likely to be high. Quarterly data on water safety (faecal and chemical contamination, sanitary inspections) and service reliability (breakdown events and response times), reported by the professional service provider, are being verified by third party checks and sensor technologies.

The critical importance of ensuring functioning waterpoints in dry periods, as revealed by the rainfall driven behavioural shifts documented by the water diaries, has contributed to funding support for professional water service delivery. In Kenya, FundiFix has progressively increased its share of funding from corporate partners with performance on water safety being incorporated as new metrics for results-based funding. Generous support from corporations and charitable foundations also catalysed a global results-based funding initiative led by Uptime with 5 million rural users in 16 countries as of 2024 (McNicholl and Hope, 2024). Sustaining and scaling out these models require high-level political support and donor cooperation, given that cost recovery from users is challenging. While Kenya's Water Act 2016 expanded the scope of service providers from community management and formal utilities to include private actors, the government is yet to act on these opportunities. The SafePani model provides one example of government leadership and action with financial commitment, though it is rare.

Water supplies in schools and clinics lie under government mandates. There is less local political interference compared to communities where powerful individuals control the local revenue and have no interest or incentive to lose this source of money. The process of scaling up community water supplies is fraught with vested interests and political obstacles which stymie, slow and generally stop

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progress. Benin[1] and India[2] are two examples of countries embarking on ambitious national models to systematically address the unsatisfactory nature of the current situation with the financial support of the World Bank (World Bank, 2018), in the former, and the leadership of the Prime Minister (Ministry of Jalshakti, 2024), in the latter. If successful, these could serve as important and influential national examples for wider policy adoption and adaptation in the future.

6.3 Investing in Partnerships for Sustainable Results

Our final reflections consider the role of partnerships for progressive achievement of water security in line with the SDGs. There is a saying that '*science without policy is science, and policy without science is gambling*'. Interdisciplinary collaboration with governments and practitioners is often touted as the means to identify and remove such barriers to progress. There are useful lessons for the design and funding of international development programmes based on our research and impact-oriented work under the REACH Programme.

REACH's long-term funding commitment, extending from £15 million for seven years to £22 million for 10 years, allowed us to implement a suite of innovative social and biophysical research in each of our study sites or 'observatories', aligned to the interests and priorities of government partners. The diary work emerged in the early days of the REACH Programme as it became clear that any meaningful interdisciplinary work required greater efforts to align biophysical data with social data. While climate scientists can generate 15-minute data points of rainfall, temperature and humidity at regional scales, social researchers often struggle to generate longitudinal evidence on local practices. Designing and implementing year-long diaries require clear understanding of the study populations and contexts, which could be generated from household surveys, infrastructure mapping or water quality monitoring, which in turn, take years to develop, implement and analyse. The behavioural dynamics revealed by the diary study also prompted the need to advance our understanding of rainfall events, such as the risks of intra-seasonal variations or delayed onsets. Like the diary work, we and our colleagues also engaged in other longitudinal research, such as the year-long water quality monitoring in Kitui, the year-long recording of operation and maintenance expenditures and user payments by water point managers in Khulna,

[1] The Rural Water Supply Universal Access Program Project for Benin aims to increase access to water supply services by supporting investments in piped rural water supply and strengthen operational and financial sustainability by delegating service delivery to private operators through regional performance-based contracts, supported by appropriate tariff policy and regulation arrangements.

[2] The Jal Jeevan Mission aims to provide safe and adequate drinking water to all households in rural India through individual household tap connections by 2024. It is based on a community approach involving extensive information and education campaigns.

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and the monthly analysis of river water quality in Dhaka (refer to Section A.4 in Appendix). These research activities complemented one another and helped explain the distribution of risks and drivers of behaviours, providing new insights for driving action. This would not have been achievable with short-term funding.

Research activities often end with a portfolio of recommendations for policy-makers, who usually are never engaged in the process and unaware of the findings published in academic journals. Driving research into action requires long-term engagement with practitioners through regular in-person meetings, workshops, and co-authored publications. These relationships are hardly restricted to one project and span over years of collaboration through multiple work streams. UNICEF has been a core global, regional and national partner of REACH, and the motivation of key staff has been instrumental in facilitating research impact. In Bangladesh, UNICEF's longstanding technical support to the country's water, sanitation and hygiene sector created opportunities to engage with key government agencies, including DPHE, the Policy Support Branch of the Local Government Division, the Directorate of Primary Education, the Directorate of Secondary and Higher Education, and the Deputy Commissioner of Khulna district. These networks paved the way to co-designing, piloting and scaling up the SafePani model for schools and healthcare facilities and mobilise government funding. The water diary work gained traction among UNICEF staff in Ethiopia, leading to the method being piloted to evaluate impacts of water, sanitation and hygiene interventions in refugee camps. The methodology and findings also informed a global initiative to monitor drinking water affordability, led by the UNICEF Headquarters in New York (see WHO/UNICEF (2020)). The diaries challenged affordability norms derived partly from practices in the global north where there is fairly standard use of piped water in the home on a daily basis.

The river diaries in Dhaka prompted policy discussions on distributional implications and investment priorities, through our colleagues at BUET who have been closely involved with the government and donor organisations from before the inception of REACH. Water quality planning and management for Greater Dhaka is based on fragmented, ad hoc, and suboptimal data that do not address the watershed dynamics at a system level. The REACH Programme's water quality monitoring data, as presented in Section 2.3, supported modelling exercises to evaluate the potential impacts of the 12 proposed sewage treatment plants to be constructed in the next two decades under the DWASA's sewerage masterplan. In line with the river diaries, which revealed highest vulnerability for populations along the Tongi Khal, the modelling study concluded that the construction of the Tongi Khal sewerage treatment plant needs to be brought forward to achieve the greatest and earliest benefit for exposed populations (Bussi et al., 2023). Based on recommendations by the Bangladesh Water Multi-Stakeholder Partnership, which

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partly draws on REACH's river water quality monitoring, the World Bank funded 'Bangladesh Environmental Sustainability and Transformation' project will establish the first DoE network of 22 continuous surface water quality monitoring stations to monitor real time water quality of Dhaka rivers (World Bank, 2022).

The positive direction of the improvements discussed have partly been achieved through navigating the regular rotation of government and donor staff, who hold positions of influence in driving, slowing or ignoring change. Our long-term engagement with many local partners has provided political capital and trust to transition the work and maintain momentum, despite rotation to individual staff and disruption caused by COVID-19 pandemic. Some individuals with vested interests in the status quo have actively campaigned against change. In case of rural water services, the shift to investing more in low-cost maintenance of waterpoints is a threat to traditional high-cost capital investment programmes, where contracts and payments benefit many people in a short period. The change also questions those agencies with existing responsibilities for constructing high-quality waterpoints with good water safety. The availability of higher-quality information on actual water practices challenges assumptions on the effectiveness of current practices. This is not welcome by some as careers and promotion depend on perceived progress of current work. As most research engagements usually conclude quickly, influential local actors have time on their side to challenge or ignore inconvenient new evidence.

The water diaries have presented daily practices to water insecurity risks in Bangladesh and Kenya from the lives of those most at risk. Those risks are predicted to increase over time with uncertainty in where and when they will occur. International climate finance is increasing in response to these significant but uncertain local adaptation and global mitigation challenges and costs. Whether this finance will reach the most vulnerable is unclear. While academic terminology and policy jargon can seem to endlessly produce new terms and frameworks, there are simple measures of improving water security for the poor. Improving river health and delivering safely managed drinking water are universally compelling though beguilingly difficult. The river never lies, unlike vested interests from those gaining by over-abstracting water or avoiding treatment costs, so effectively monitoring river health is a necessary condition for all actors to focus action on outcomes which benefit rivers, society and economies in the short and long term. Safe drinking water services are equally a common and critical measure of government performance. If a government cannot achieve and sustain this fundamental anchor of development and prosperity, it is hard to imagine how associated goals for education, health and prosperity will be sustainably achieved. Water diaries offer a modest lens to examine global policy and local practice challenges to view the conditions and the choices vulnerable people contend with each day in search of a more sustainable and equitable future.

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