WaterAid multi-country research on water security: HSBC Water Programme

Global synthesis report

Analysis of the groundwater resource and governance in Bangladesh, Ghana, India, Nepal and Nigeria

31 January 2020

HSBC | Water Programme

WaterAid

Executive summary

Background

This report is a synthesis of five country reports that were completed as part of the Water Security Research conducted by WaterAid in 2019, under the HSBC Water Programme. The objectives of the research was to: (i) provide a synopsis of the groundwater characteristics and key threats in each of the areas where WaterAid is working; (ii) assess the effectiveness of groundwater governance and management relevant to the threats and risks identified in (i); and (iii) the development of recommendations on how water security considerations, with specific reference to groundwater, could be better integrated in to WaterAid's programmes and policy work. The research was carried out in Bangladesh, Ghana, India, Nepal and Nigeria by Research Associates, and focused on WaterAid project areas in the five countries. More than 160 million people still lack access to an improved drinking water source in these five countries.

WaterAid defines water security as: 'Reliable access to water of sufficient quantity and quality for basic human needs, small-scale livelihoods and local ecosystem services, coupled with a well-managed risk of water-related disasters'. Groundwater was the focus of the research, since the majority of rural people in all five countries depend on groundwater for domestic water security. There is near total dependence on groundwater in some of the WaterAid project areas. Groundwater has advantages over surface water (such as rivers and reservoirs) in terms of ubiquity, drought tolerance, ease of access and protection from some forms of pollution. However, groundwater often remains hidden institutionally as well as physically.

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Methodology

The research examined the groundwater resource (quantity and quality), as well as the political economy and institutional environment that constrains or enables effective water governance and management. Research Associates used a variety of techniques to conduct their analyses including literature review, collation of existing hydrogeological data, field interviews and questionnaires. The institutional analysis component was based on the *Multi-Level Governance Framework* produced by the Organisation for Economic Co-operation and Development (OECD) in 2011.[4] The Research Associates used a common report template, including tables based on the OECD document. The research was conducted in collaboration with a Global Consultant, who worked with the WaterAid country offices and the Research Associates – reviewing the country reports and producing this synthesis report.

The institutional and physical conditions in the five countries vary, but the research identified a general lack of good quality groundwater data and information, as well as inadequate groundwater-specific policy. The lack of groundwater data and information makes it difficult to assess groundwater quality problems – such as arsenic, fluoride, microbiological pollution and salinity – and how groundwater levels and quality might be changing with time. This presents a significant risk and hampers efficient and sustainable delivery of services. WaterAid's global footprint, convening power and local experience are assets in norm-setting and in advocating for solutions to these problems, thereby helping to improve water supply and sanitation services for some of the world's poorest people.

Climate change is likely to bring groundwater further into focus as an important component of resilience and stability. There is an opportunity to link groundwater monitoring to the new impetus for hydrometeorological systems in developing regions. These integrated systems can dramatically improve resilience and predictability across a range of sectors and are commonly considered sound investments.

Recommendations

The recommendations for WaterAid concluded from the five country reports cover four main areas:

1. Importance of groundwater

Groundwater is extremely important to domestic water supplies, livelihoods and resilience – but the resource remains generally undervalued in national, regional and local policy and planning in the administrations of the five countries. There is a role for WaterAid in advocating for, or otherwise supporting, a greater institutional profile for groundwater.

2. Groundwater data and information

There is a general absence of groundwater data and clear communication of data aimed at informing decision makers in many of the study areas. WaterAid may need to become more active in groundwater data collection and curation, or advocating for governments to recognise its importance – since the lack of groundwater data increases risk and uncertainty. WaterAid's convening power in bringing together research partners, agencies and other actors is an advantage here. Equally important is the 'translation' of groundwater data (particularly time-series data) into information products that are useful to decision makers.

3. Groundwater quality

Poor groundwater quality increases risk to water supply planning and in some areas, may even render groundwater unfit for use without treatment. The lack of information on groundwater quality (including on emerging pollutants such as fertilisers or pesticides) heightens the problem. The issue is of growing concern, and in the absence of adequate scientific information, hearsay or perceptions sometimes hold power. In terms of groundwater pollution, prevention is usually simpler and cheaper than treatment.

4. Advocacy and norm-setting

WaterAid's understanding of water supply issues and the sustainability of local water resources, combined with knowledge and experience in water and sanitation, gives them the authority to lead by example and set norms for local water supply provision and policy, including supporting accountability and transparency.

Glossary

Alluvium: A deposit of clay, silt, and sand left by flowing floodwater in a river valley or delta, typically producing fertile soil.

Anthropogenic contamination: Substances found in the environment due to human activities, such as pollutants.

Crystalline basement: The rocks below a sedimentary platform.

Dental fluorosis: Hypomineralisation of tooth enamel caused by excessive fluoride consumption.

Fluvio-deltaic: This type of sedimentary basin consists of a subaerial fluvial plain, where sediment is transported and deposited.

Geogenic: Resulting from geological processes, such as metal mining or combustion of fossil fuels.

Groundwater recharge: A process where water moves downwards from surface water to groundwater.

Kaolinite: A white or grey clay mineral.

Weathered overburden: Material such as rock or soil above a resource open to human exploitation such as coal, which has been worn out due to exposure to natural elements.

Acronyms

GIS: Groundwater Information System

IWRM: Integrated Water Resource Management

L/s: Litres per second

M: Metre/s

MAR: Managed Aquifer Recharge

M bgl: Depth in metres below ground level

MIS: Management Information System

MHa: Million hectares

MM: Millimetres

M&E: Monitoring and evaluation

NGO: Non-governmental organisation

O&M: Operation and maintenance

OECD: Organisation for Economic Co-operation and Development

SADC: South African Development Community

SDG: Sustainable Development Goal

VLOM: Village-level operation and maintenance

WASH: Water, sanitation and hygiene

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1. Introduction

The HSBC Water Programme, which launched in 2012, is a collaborative partnership with Earthwatch, WaterAid and WWF. The eight-year US $150 million programme has been successful in tackling global water challenges through an integrated approach to water provision, protection, education and scientific research in more than 40 countries. The Water Security Research, discussed in this synthesis report, was undertaken as part of WaterAid's contribution to the HSBC Water Programme.

This research is aligned with the outcomes of the UN Sustainable Development Goals (SDGs), agreed in 2015 by the United Nations General Assembly. Goal 6 of the SDGs aims to ensure availability and sustainable management of water and sanitation for all by 2030. Thus making a commitment to the human right to water, which entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use. Further targets of SDG 6 include better water management, higher levels of international cooperation and capacity building, better representation by local communities, and the protection and restoration of ecosystems.

WaterAid defines water security as: 'Reliable access to water of sufficient quantity and quality for basic human needs, small-scale livelihoods and local ecosystem services, coupled with a well-managed risk of water-related disasters'. Two fundamental pillars support this concept of water security: the water resource available (for example, the groundwater, surface water or rainwater available), and the water supply services to abstract, treat and supply that water to households.

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It is necessary to understand both the threats and risks to the water resource; as well as the political economy and institutional environment that either constrains or enables effective water governance and management. An understanding of both elements supports better, more focused, and properly targeted advocacy and programming. This research considers both of these elements (for example, the physical resource, as well as the institutional environment) together for this reason, and also because they tend to influence each other in complex ways that may be difficult to separate for practical purposes.

The focus of this research is specifically on groundwater security in five WaterAid Country Programmes which implemented projects under the HSBC Water Programme. These countries are Bangladesh, Ghana, India, Nepal and Nigeria. All five countries depend heavily on groundwater for rural water supply, irrigation, industrial supply, and for an important component of urban water supply. Groundwater is also vital to ecosystem functioning and is increasingly important in improving resilience to the negative impacts of climate change, such as droughts and floods.

Groundwater is by far the largest component of the world's fresh, unfrozen water resource.[i] Extraction of groundwater around the world has more than tripled since the 1940s and now stands at roughly 1000 cubic kilometres per year,[1] making it the world's most extracted raw material. Groundwater was a cornerstone of the global 'Green Revolution' in agricultural productivity, and it underpins domestic water security and food security for hundreds of millions of people. However,

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over-abstraction, pollution, lack of information on the state and quality of the resource, lack of awareness of the important role of groundwater, poor management and other challenges, prevent the optimal use of groundwater, and in some cases threaten to reverse hard-won progress in water supply and sanitation. Globally, the volume of groundwater abstracted today is thought to be only around 8% of global mean groundwater recharge,[2] but this average value obscures large local variations, including unsustainable abstraction in places – for example, places where abstraction is near or even exceeds local recharge.

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[i] *According to Margat and van der Gun's research in 2013[1] – 97.5% of the world's water is seawater. Of the remaining 2.5% that is fresh water, groundwater makes up 30.1%, with the frozen ice caps, glaciers and permafrost comprising a further 69.5%. Only 0.4% of the world's fresh water is found as lakes, rivers, wetlands, soil moisture, atmospheric water, and water in plants and animals.*


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Groundwater as a water supply source can have advantages over surface water (for example, rivers and lakes) that are not always obvious, but may be pivotal to domestic water security in poorer regions. These advantages include groundwater's ubiquity (so it is often found close to where it is needed), its resilience to drought due to large stored volumes, low susceptibility to evaporation, and its common suitability for drinking with minimal or no treatment.[3,ii] Groundwater can also often be developed incrementally as funds and time permit, rather than requiring a larger initial investment, such as a dam and water treatment plant. It is also often accessible with traditional and low-cost technologies, such as dug wells.

To provide background and context to this research, a summary of the demographics and hydrology of the five research countries is shown in Table 1 overleaf.

This information reveals that the average annual rainfall of all five countries is above the global mean of about 990mm per year, and that on average renewable water resources in each country exceed the 1000 cubic metres per person often regarded as the threshold for water scarcity. Nevertheless, more than 160 million people across the five countries still lack access to an improved drinking water source. More than 400 million people across the five countries also live on less than $1.90 a day,[iii] including more than a fifth of the population of India, and more than half of the population of Nigeria.

[ii] *Groundwater recharge is often much less susceptible to microbiological and other pollution compared to surface water. However, groundwater pollution does occur and this can be serious and very difficult to remediate. Groundwater may also have unsafe levels of natural contaminants, such as fluoride or arsenic.*

[iii] *The World Bank Group has set a global poverty line at $1.90, based on 2011 prices. Around 900 million people lived under this line globally in 2012. For more information, see: datahelpdesk.worldbank.org/knowledgebase/topics/21164-poverty-data*

Table 1: Demographics and hydrology of the five countries

	Bangladesh	Ghana	India	Nepal	Nigeria
Poverty headcount ratio at $1.90 a day (2011 Purchasing Power Parity) (% of population)	15	13	21	15	54
% population with access to improved drinking water source	87	89	94	92	69
Number of people lacking access to improved drinking water source (thousands)	21,407	3,172	80,351	2,344	59,175
Surface area (square kilometres)	147,630	238,540	3,287,259	147,180	923,770
Population (thousands)	164,670	28,834	1,339,180	29,305	190,886
Average annual rainfall (mm per year)	2,666	1,187	1,083	1,500	1,150
Total renewable internal freshwater resources (billion cubic metres per year)	1,227	56	1,911	210	286
Total renewable water resources per capita (cubic metres per person per year)	7,451	1,949	1,427	7,173	1,499
Agricultural irrigated land as % of total agricultural land in 2013	59.7	0.2	36.8	29.7	0.3
Annual freshwater withdrawals, total (% of internal resources)	34	3	45	5	6
Approximate dependence of rural population on groundwater for domestic water supply (% of population)	98	66	85	>90	>90

Data from FAO Aquastat Database (fao.org/aquastat/en/) and World Bank Data Catalogue (data.worldbank.org/) apart from last row (% rural dependence on groundwater) which is derived from the present study.

2. Research purpose and methods

The purpose of this research is to improve the effectiveness of WaterAid's programme and policy work by providing an overview of the status of groundwater in the areas in which WaterAid works. Alongside an analysis of governance and management arrangements to help identify bottlenecks and levers of change. Both the physical groundwater resource, and the wider institutional or governance environment were considered.

The research can be split into three work areas:

(i) A synopsis of the groundwater characteristics and key threats in each of the areas where WaterAid is working.

(ii) An assessment of the effectiveness of groundwater governance and management relevant to the threats and risks identified in (i).

(iii) The development of recommendations on how water security considerations, with specific reference to groundwater, could be better integrated in to WaterAid's programmes and policy work.

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Research methods used

Each of the five country research programmes were required to evaluate the hydrogeological conditions and challenges, as well as the political economy and institutional environment of the WaterAid programme areas in each country. This required a multi-disciplinary approach to the problem across two main areas:

- Characterisation of groundwater resources.
- Institutional and policy mapping, and rapid governance analysis.

The five country Research Associates made use of literature reviews, compilations of available data, secondary sources and key informant interviews to inform the research reports. The Research Associates travelled to the areas representing diverse hydrogeological conditions, and a range of stakeholders from the public, private and non-profit sectors were interviewed.

Limitations of the research included:

- Time and budget constraints.
- Large areas of assessment.
- Difficulties in accessing data and information.
- Inevitable biases consequent on the preferences, technical training and emphases of the research teams.
- The contexts in which the research was carried out.

These limitations were countered to an extent by ongoing communication and experience sharing between the teams, the use of a common report template, broad methodology and peer-review during and after the research.

Characterisation of groundwater resources in each country generally relied on existing hydrogeological data, together with information from individuals and organisations[iv] working in groundwater, water, sanitation, hygiene (WASH) and related fields.

The Institutional and Policy Mapping and Rapid Governance Analysis component was based loosely on the *OECD Multi-Level Governance Framework*.[4,v] The OECD document reports on a multi-level approach to understand water governance, using respondents from 17 OECD countries. The document can be used as a template or tool to carry out similar analyses of water governance and management across a variety of scales.

Based loosely on the OECD tool, two stages of analysis were carried out. The first stage was to identify the main institutions, policies, laws and regulations that apply in the study area(s), and to summarise them as two tables. These tables are:

- Institutions, laws, regulations and policies.
- Actors and organisations.

The second stage was to conduct a Governance Gap Analysis identifying the constraints to effective governance, using the information collected during Stage 1.

The OECD approach acknowledges that the constraints to better water supply and sanitation coverage largely lie in the institutional realm: 'It is now widely acknowledged that there is enough water on Earth for all, even in areas where temporary shortages may exist. Clearly, the current water 'crisis' is not a crisis of scarcity, but a crisis of mismanagement, with strong public governance features.'[4] However, physical constraints on water resources (quantity and quality) are also important, particularly at local level, and this is why both aspects should be assessed.

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The OECD document also recommends a 'multi-level' approach: 'Given the importance of local actors, stakes and specificity in the water sector, policy makers should not avoid complexity by favouring traditional top-down policies but instead, find ways to maintain coherence while preserving diversity, so as to reflect the heterogenous concerns of stakeholders on the ground'.[4] The document also states that: '…most OECD countries have largely decentralised their water policy making'.[4] The Research Associates therefore concentrated on the various levels of governance, from state or federal level down to local communities.

[iv] *Institutions are the patterns of interaction that govern and constrain the relationships of individuals. Organisations consist of specific groups of individuals pursuing a mix of common and individual goals through partially coordinated behaviour.*[5,6] *A water law or the custom of sharing a spring protection between community members are institutions; whereas WaterAid or a state Water Department are organisations.*

[v] *The OECD is an organisation representing 36 mostly high-income countries interested in market economies and world trade.*

3. Characterisation of groundwater resources

Hydrogeological conditions in the five countries vary widely, from extensive alluvial deposits supporting high-yielding irrigation boreholes in Bangladesh, to low-yielding and complex crystalline basement in Nigeria, where the thickness of the weathered zone and the presence of fracturing is critical. In many parts of the study areas, groundwater is the only practical source of water for domestic supply, small-scale irrigation, stock watering, and other essential uses. In Bangladesh, about 98% of all domestic water is groundwater. Rural populations in Ghana (66%), India (85%), Nepal (>90%) and Nigeria (>90%) also depend heavily on groundwater.

Each country report provides an introduction to the groundwater resource in the country and outlines the geographic scope or study areas/districts covered by the research. Each report includes an introduction to the hydrogeology of the study areas, emphasising high risk areas and/or threats to groundwater quality or supplies. Key issues with groundwater quality and quantity are presented, along with a description of the main groundwater-related challenges that need to be resolved.

The hydrogeological information from the five country reports has been summarised in Table 2, with a short summary and discussion provided first:

Lack of data

With the possible exception of India,[vi] data on groundwater conditions and use in the study countries is limited, and in some areas – for example in the hill and mountain regions of Nepal and crystalline basement in Ghana and Nigeria – the lack of data is a serious constraint on understanding, evaluating and managing groundwater. In some cases, such as Nepal and Nigeria, the data and information that is available is often difficult to access as it is stored as paper records or in incompatible digital formats. This lack of data means that predictive capability is lowered, and risk is raised.

Borehole yields

Yields from groundwater sources in the five countries vary widely, from more than 50 L/s for large motorised irrigation tubewells in Bangladesh, India and Nepal, to less than 1 L/s for domestic boreholes in crystalline basement in Nigeria. Similarly, depths to groundwater are also highly variable – from near surface to more than 80m below ground level. In some areas, such as parts of Bangladesh, Nepal and India, water tables are falling due to excessive abstraction. This is particularly a problem in some urban areas where demand is high and populations are growing, such as Dhaka.[vii]

[vi] *In India, the Central Ground Water Board maintains an extensive groundwater monitoring system, and new initiatives, such as Jal Jeevan, are aimed at improving water supply coverage.*

[vii] *The problem of over-abstraction of groundwater from the Dupi Tila aquifer underneath Dhaka in Bangladesh has been reported for years. More recently, an average trend in water table decline of about 3 metres per year has been documented.*[7]

Groundwater quality

Groundwater quality problems can broadly be divided into three categories:

- Geogenic
- Microbiological
- Agricultural/industrial

Naturally-occurring or geogenic contaminants such as arsenic, fluoride, iron and manganese are serious problems in several areas. For example, in Bangladesh, more than 35 million people are exposed to concentrations of arsenic that exceed national maximum allowable concentrations in their drinking water.[8,viii] Arsenic is also known to be a problem in Nepal's Terai region, and in parts of India – and it may occur in groundwater in other parts of the study countries too. Geogenic fluoride is reported as a problem in some areas of crystalline basement, such as parts of Ghana, India and Nigeria. Fluorosis (disease caused by excessive fluoride consumption) was reported in the Ghana, India and Nigeria country reports. Naturally occurring iron and manganese concentrations (reported in Bangladesh, Ghana and Nigeria, but likely to be present in parts of India and Nepal too) are generally not as harmful to health, but higher concentrations affect the taste and appearance of drinking water and may in turn lead people to favour untreated surface water sources that risk being microbiologically polluted.

Microbiological contamination of groundwater sources for drinking water supply is a common issue in all five countries and can lead to serious health problems, which in turn, impact on other sectors, such as education. It is usually linked to poor sanitation practices,[ix] polluted surface water, poor groundwater source construction and protection, or other causes. High concentrations of nitrate (and ammonia in some areas) may arise as a consequence of groundwater pollution by human and animal waste, and are themselves groundwater pollutants.

Pollution from agriculture (fertilisers and pesticides) and industry (solvents, hydrocarbons and heavy metals) are thought to be an issue in areas of intensive agriculture (such as Nepal's Terai region) and in some of the urban study areas (like Dhaka and Kathmandu) respectively, but information on this issue is still limited and much uncertainty remains. As industries grow and agriculture expands, such pollution is likely to become more serious. In many cases, specialised laboratory equipment, training and sampling procedures are needed to assess such problems, and as a result they remain poorly understood. As with other forms of groundwater pollution, prevention is usually simpler and cheaper than treatment. See the article from the World Bank on *The Invisible Water Crisis*.[9]

[viii] *27% of shallow hand pumped tube wells in Bangladesh, used for domestic supply by 80% of the population, provide water exceeding the Bangladesh national limit of arsenic in drinking water (50 µg/L). Fully 46% of these tubewells exceed the World Health Organization guideline value for arsenic in drinking water (10 µg/L).*

[ix] *Risks include open defecation, poorly designed or maintained pit latrines, sewage disposal to surface water, inadequately treated sewage, leaking sewerage systems, some agricultural fertiliser practices, and other sources.*[9] *The ARGOSS guideline*[10] *provides practical and affordable methodologies for minimising risks to groundwater quality.*

Table 2: Summary of the hydrogeology in the five countries

	Bangladesh	Ghana	India	Nepal	Nigeria
Major groundwater related issues	• Arsenic contamination. • Microbiological pollution. • Saline intrusion in coastal areas (worsened by flooding and climate change). • Unregulated shrimp farming. • Falling water tables due to over-abstraction. • Arsenic contamination still estimated to affect 35 million people, and concerted programmes to address the issue are lacking. • Emerging issues with agricultural (fertilisers, pesticides) and industrial pollutants. • Thick clay layers inhibit recharge in some areas.	• Low yields, water quality (fluoride, microbiological pollution, other contaminants such as iron), difficult drilling conditions in places. • Clay rich soils may inhibit recharge. • For most communities, water sources are more than 500m away – significant time spent collecting and carrying water, especially in the dry season. • Lack of data complicates assessment of water table and groundwater quality trends. • Unregulated water use and contamination by illegal mining also reported.	• Backlog of people underserved: 163 million people in India live without access to clean water close to their homes. • Growing threats to water quality and falling water tables in some areas/blocks. • Local issues with fluoride, high salinity, arsenic, microbiological contamination, nitrate etc. • Over-abstraction in some groundwater blocks, high withdrawals for irrigation.	• Road building, floods, landslides, droughts and earthquakes threaten groundwater sources (especially springs) in highland areas. • Large increases in prevalence of droughts reported by respondents. • Lack of hydrological data and fragmentation of existing data. • Limited research in hill and mountain areas. • Lack of institutional provisions for groundwater.	• High failure rates of boreholes linked partly to lack of maintenance and/or lack of community resources. • Low borehole yields, especially in crystalline basement in Bauchi and Plateau states. • Difficult borehole siting and drilling conditions, with kaolinite reported as an occasional problem. • Low borehole success rates in some areas. • Lack of hydrogeological data.
Hydrogeology and groundwater use	• Principally extensive and thick fluvio-deltaic sands, silts and clays associated with the Ganges/ Brahmaputra Rivers. • Complex spatial variations in aquifer properties. • 90% of groundwater in Bangladesh is used for irrigation: an area of 4.2 MHa is irrigated by groundwater. • 98% of drinking water in Bangladesh is groundwater.	• Diverse hydrogeological environments in Ghana. • In the WaterAid study areas hydrogeology is weathered crystalline basement, with occasional unconsolidated drift sediments associated with drainages. • Yields in study areas generally too low for mechanised irrigation. • About two thirds of rural population depend on groundwater.	• Diverse hydrogeology in the 18 districts across six states where WaterAid India is active, ranging from unconsolidated sediments to basement and volcanics. • Sectoral contribution of groundwater in India: irrigation (62%), rural water supply (85%) and urban water supply (45%). • Recharge partly depends on monsoon rainfall.	• Ranges from alluvium of the lowland Terai to fractured crystalline and metamorphic rocks in the mountain regions. • Springs are a common water source in the hills and mountains. • Rain falls mainly during summer monsoon. • About 0.25 MHa irrigated with groundwater in the Terai. • Springs are important to small scale irrigation in the hills and mountains. • In the study areas, practically the entire population relies on groundwater for domestic water supply.	• Consolidated sedimentary rocks, including permeable sandstones, underlie part of Bauchi state. • Crystalline basement is predominant geology in study areas of Enugu and Plateau states, where thickness of weathered overburden and fracture patterns determine groundwater potential. • Occasional alluvium found. • Limited groundwater resources in the basement rocks support mainly hand-powered sources. • Groundwater is the only practical water source in many areas.

	Bangladesh	Ghana	India	Nepal	Nigeria
Typical yields	• Moderate to good – large irrigation tubewells can yield >50 L/s. • Mean transmissivity is 1,270 ± 770 m2/day.	• Generally low yields of hand pump boreholes in WaterAid areas typically 0.5–1 L/s. • Transmissivities in WaterAid areas are around 7 m2/day. • Whilst borehole yields are generally reliable in rainy season, in dry season around 20% of sources reported to fail.	• Highly variable, depending on hydrogeology – e.g. granites and gneisses in Andhra Pradesh generally yield <5 L/s. Dug wells in Chhattisgarh yield only 1–2 L/s. • Large irrigation tubewells in unconsolidated sediments may yield >50 L/s.	• Terai sediments considered moderately to highly productive, where deep tube wells are reported to have yields of around 40 L/s. • Yields in hills and mountains generally much lower, but data availability is poor.	• Yields of up to about 5 L/s in the sandstones, generally less than about 2 L/s in the crystalline basement, where dry boreholes also reported.
Water tables	• Often close to surface, but over-abstraction due to irrigation has led to declines in certain areas. • Water tables in urban areas (particularly Dhaka area) falling due to growing demand. • In coastal areas inundation by seawater can displace fresh groundwater.	• Depth to groundwater is between 50 to 65m in the study areas. These large depths can necessitate special handpump designs. • Lack of data makes it difficult to comment on trends in water tables in the study areas.	• Central Ground Water Board monitors groundwater levels four times a year, has a network of 23,125 observation wells across India. • Around 20% of administrative units (e.g. blocks) considered over-exploited, particularly in the northern states.	• Complex water tables and flow paths in the hill and mountain regions. • Large variation in depth to water depending on terrain. • Water levels generally 6–12m below ground level (m bgl) in the Terai.	• Depth to water ranges from about 2 m bgl to more than 20m below ground level (m bgl). • Limited information on water table trends.
Groundwater quality	• Naturally occurring arsenic contamination is a major issue. • Microbiological pollution of especially shallower sources also serious. • Iron, manganese and other geogenic elements are a concern.	• Major concerns are geogenic fluoride, and microbiological contamination. • Open defecation due to lack of adequate sanitary facilities reported, may impact on local groundwater quality. • Impact of graveyards on groundwater quality also reported.	• Fluoride and other geogenic elements (including arsenic in some areas), microbiological pollution. • Anthropogenic nitrate associated with agriculture, sanitation facilities and polluted surface water.	• Data is limited. • Geogenic arsenic in the Terai is a problem. • High iron is an issue in some areas. • Anthropogenic contamination of groundwater in urban areas. • Microbiological contamination in unprotected hill and mountain sources, and high turbidity during monsoon.	• Geogenic fluoride is a concern in some basement areas, with dental fluorosis reported. • Likely microbiological pollution of shallow groundwater sources, and high vulnerability to surface contamination. • Limited data on groundwater.

4. Institutional and policy mapping and rapid governance analysis

This section uses the two-stage framework based on the *OECD Multi-level Governance Framework* tool[4] described in section 2 above.

Table 3 on the opposite page shows the governance gap analysis approach from the OECD tool, showing seven 'gaps'. A 'gap' is identified when there is a policy need not matched by an appropriate and effective governance response. According to the OECD, this approach has been tested in other areas of public policy, such as regional development.

As OECD[4] states: 'Diagnosing all the co-ordination gaps represents one of the primary challenges in multi-level governance of water policy.' The OECD document acknowledges that the OECD countries studied take different approaches to water governance, and that no clear 'recipe' for success exists. As the report confirms, the institutional organisation of the water sector varies widely across and within OECD countries. Nevertheless, the gap approach has been recommended as an important step in understanding governance shortcomings in developing countries as well as in the OECD countries represented in the report.[4]

Each of the five country reports includes a table based on Table 3, containing the institutional and policy mapping work carried-out by the Research Associates. A summary of this work is shown in Table 4 at the end of this section, also using the OECD framework.

The governance frameworks, institutional structures, groundwater challenges and demographic profiles of the five countries described in Table 4 vary considerably, and this is reflected in the range of gaps that have been identified. The gaps also reflect the research approach and the particular local circumstances of the work done in each country. Despite these variations, a rough comparison and analysis can be made, as follows:

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Table 3: Governance gap analysis (adapted from the OECD)[4]

GAP	Description	Action Type
Administrative gap	This gap refers to a geographical 'mismatch' between hydrological and administrative boundaries. This can be at the origin of resource and supply gaps.	Need for instruments to reach effective size and appropriate scale.
Information gap	Asymmetries of information (quantity, quality, type) between different stakeholders involved in water policy, either voluntary or not. 'A primary concern is lack of information to guide decision makers in the water sector.' Lack of sharing between agencies is also a serious concern.	Need for instruments for revealing and sharing information.
Legal and policy gap	Sectoral fragmentation of water-related tasks across ministries and agencies and/or lack of appropriate regulation. Opportunities to exploit economies of scope and scale, and to undertake cross-sectoral initiatives, are lost.	Need for mechanisms to create multidimensional/ systemic approaches, and to exercise political leadership and commitment.
Capacity gap	Insufficient scientific, technical, infrastructural capacity of local actors to design and implement water policies (size and quality of infrastructure, etc.) as well as relevant strategies. Sequencing of decentralisation is important – may need local capacity first.	Need for instruments to build local capacity.
Funding gap	Unstable or insufficient revenues undermining effective implementation of water responsibilities at sub-national level, cross sectoral policies, and investments requested. Innovative finance mechanisms may be appropriate.	Need for shared financing mechanisms.
Objective gap	Refers to contradictory objectives between levels of government regarding integrated water policy. Different rationales create obstacles for adopting convergent targets, especially in case of motivational gap (referring to the problems reducing the political will to engage substantially in organising the water sector).	Need for instruments to align objectives, and appropriate assessment of water projects before and after implementation.
Accountability gap	Difficulty ensuring the transparency of practices across the different constituencies, mainly due to insufficient users' commitment, lack of concern, awareness and participation. Capture and corruption are associated risks.	Need for institutional quality instruments. Need for instruments to strengthen the integrity framework at the local level. Need for instruments to enhance citizen involvement.

Administrative gaps

None of the five focus countries have dedicated groundwater organisations organised along aquifer boundaries, and such institutions are relatively rare globally.[x] Institutions charged with groundwater governance and management in the five countries are constituted along political boundaries, and take variation in groundwater availability and the mismatch between aquifer and political boundaries into account. Collaboration is required between different levels of government from national to local level, and also across government. For example, the India country report states that the Ministry of Jal Shakti is aware of the requirement to administer groundwater along aquifer boundaries, but that implementation is the responsibility of the States and more local-level jurisdictions. Each country (de facto) has an institutional arrangement for groundwater governance that balances diverse interests and geographical regions. This complexity also reflects some level of compromise between the actual ways in which governance is exercised, and the theoretical (de jure) business of groundwater governance.


WaterAid/ Andrew Esiebo

All of the countries (with the possible exception of India)[xi] report a need for better coordination and planning at the various administrative levels, and particularly the need for an improved focus on groundwater. In many cases there is a lack of alignment between different ministries or agencies, and competing priorities (such as road building in Nepal), which may harm groundwater interests. In Ghana, administrative provision for groundwater governance has been made, but it is reported that there is a lack of complementary focus on sanitation.

Information gaps

India, with its Central Ground Water Board and relatively strong groundwater data collection, reports reasonably good availability of groundwater data, particularly at regional and state level. In the other four countries, a lack of groundwater data and clear communication of data aimed at decision makers hampers groundwater governance. Collaboration between government agencies and other institutions involved with groundwater data collection and interpretation (such as universities, or research institutes like Nigeria's National Water Resource Institute in Kaduna) needs improvement. Lack of time-series data, lack of groundwater quality data, the inaccessibility of existing groundwater data and reports, are also common constraints. The country reports agree that more accessible groundwater databases and better awareness of existing data are required.

In Ghana, Nigeria and Bangladesh drillers are required to provide information on boreholes or tubewells to the relevant groundwater agency, but in practice this rarely happens. The issue of groundwater information is closely tied to a lack of skilled personnel and funds for groundwater governance agencies. Nigeria reports institutional memory loss, and this is likely to be a problem wherever poor salaries and unpromising career paths for public sector groundwater specialists are found.


WaterAid/ HSBC/ Drik/ Habibul Haque

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[x] *The OECD advocates for decentralisation and water governance organisations that share boundaries with water bodies (e.g. river basins, or possibly aquifer boundaries) – but acknowledges that in fact the OECD countries have a multiplicity of organisational and institutional forms and that no clear formula for water governance is applicable across the OECD. A distinction can also be drawn between the organisations charged with groundwater governance, and the complex institutional systems comprised of numerous interests that arise and determine groundwater governance outcomes. Experience from South Africa suggests the organisational decentralisation on its own, without similar attention to the necessary institutional forms that must support it, can be counterproductive.*[11]

[xi] *India's Central Ground Water Board and other organisational and institutional forms aimed at groundwater governance make it a possible exception here.*

Legal and policy gaps

All of the countries report gaps in the legal and policy framework for aspects of groundwater governance. For example, in Bangladesh, policy on fertiliser and pesticide pollution of groundwater is unclear or missing. In Nepal, Nigeria and Bangladesh, specific laws and policies for groundwater governance are lacking in general, despite a high reliance in these countries on the resource. For example, the Nigeria country report states: 'There are no specific laws or policies guiding the management of groundwater resources in the states'. In general, international transboundary issues as they relate to groundwater are also poorly addressed in the five countries.

Capacity gaps

All of the study countries, apart from India, report serious gaps in capacity for administering and governing groundwater. This manifests as lack of funding, lack of technical equipment and lack of qualified staff. In general, capacity building is called-for in the country reports. The Nigeria country report notes a need for a systems approach to capacity building – so a holistic approach that cuts across organisations and institutions and is not limited to training only. In some cases, the capacity gap is worsened by the lack of specific legal provisions for groundwater and the absence of groundwater institutions. Capacity at local level is particularly constrained – Bangladesh, India, Nepal and Nigeria country reports all recommend more involvement of local-level and grassroots organisations including non-governmental organisations (NGOs).

Funding gaps

Funding for groundwater governance, and water supply provision by groundwater, is generally inadequate in all of the study countries except India, where the Indian government's Jal Jeevan initiative[xii] has recently boosted funding. In Ghana, local communities generally maintain their own water supply systems, with user funds collected and pooled to pay for this as part of village-level operation and maintenance (VLOM). The same is likely to apply in large parts of Nigeria. The Nepal country report states that no tradition of paying for water services exists in some rural areas, hampering the funding of new infrastructure and the maintenance of existing installations. Ongoing funding for operation and maintenance (O&M) – for example, operational expenditure as opposed to capital expenditure – is reported as 'poor' in Nepal, and the same is likely to apply to the other countries too. Recurring budgets for a 'hidden resource', such as groundwater, are often vulnerable to reallocation to other seemingly more urgent or more highly visible uses.

[xii] *Jal Jeevan is a contemporary initiative by the Government of India aimed at providing piped water supply to every household in India.*

Objective gaps

Misalignment of governance instruments related to groundwater is common globally due to the numerous interests and stakeholders involved. Objective gaps are found in all five countries, and Bangladesh, India and Nepal all recommend a bigger role for local users and NGOs. In Bangladesh, it is reported that groundwater use and pollution by the industrial sector remains under-regulated and under-reported, and the same is likely to be true in parts of the other study countries. In all five countries, agriculture is a major user of groundwater, so agricultural policy is therefore an important component of groundwater governance. As mentioned, transport policy (road building) in Nepal intersects with groundwater governance. In Bangladesh, coastal flooding and climate change more generally impact on groundwater availability and use. In all of the study countries, pollution by agriculture and/or industry is a concern, and environmental policies or their absence in these sectors (plus the vagaries of enforcement) impact on groundwater governance. Groundwater monitoring and/or governance systems is important to climate change preparation, since groundwater is critical to resilience particularly in impoverished and rural areas.[12]

Accountability gaps

In general, there is a lack of transparency regarding groundwater governance in all five countries. The involvement of communities, NGOs and local level organisations needs to be better facilitated by state organisations charged with groundwater governance. Misallocation of funds, political capture and other corruption in the sector is unfortunately fairly common. This not only consumes funds that could be more constructively used, but it erodes public confidence in governance initiatives. The issue can be linked to the need for more groundwater data, better technical and administrative capacity, and the requirement for more groundwater-specific funding and institutions.

Table 4: Summary of country gap analyses

GAP	Bangladesh		Ghana		India		Nepal		Nigeria	
	Description	Action	Description	Action	Description	Action	Description	Action	Description	Action
Administrative	Lack of harmonisation, coordination and alignment between institutions, and no clear roles and responsibilities. Sectoral and administrative boundaries also not demarcated.	Coordinating body needed. Gap between planning and implementation needs closing.	Lack of focus on sanitation.	Need for improved sanitation services.	Ministry of Jal Shakti aware of need to work with aquifer boundaries, administrative boundaries may take preference.	Better planning and advocacy at national level recommended.	Lack of clearly defined roles and responsibilities, mechanisms for working across local government boundaries are limited.	Stronger federal institutions, establishment of groundwater specialist agencies 'groundwater shells' at different levels.	Inconsistencies and incoherence, lack of understanding of groundwater at administrative level.	Sector coordination efforts between institutions and stakeholders.
Information	Lack of information on water use and demand, and lack of institutional mechanisms for data collection, enforcement, sharing, etc.	Common database needed to promote Integrated Water Resource Management (IWRM), with access for all stakeholders.	Lack of adequate research, lack of depiction of groundwater conditions on hydrogeological maps.	Role for geological surveys, particular need for community water quality measurements.	Consistent efforts to generate water quality data.	Better sampling, better awareness, and more appropriate language availability required.	Lack of data on water demand and availability, limited use of data for decision making, requirement for better databasing.	More groundwater studies, better collaboration with universities, better databases and data access.	Varied levels of information, but generally inadequate information on groundwater. Institutional memory loss.	Improved archiving, regular surveys, better design of information management.
Legal and policy	Overlapping policies, with some gaps (e.g. fertiliser or pesticide pollution) and contradictions. Water Act of 2013 is broadly strong.	Need to fill gaps and ensure coordination. Better legal provision for groundwater, women's participation and for WASH.	Lack of awareness creation on the regulations for groundwater safety, as well as institutions responsible for their enforcement.	Local community level structures required.	Little interaction between agencies, friction between states and central government, poorly addressed transboundary issues.	Better platforms for more effective collaboration.	No laws/policies specifically aimed at groundwater, and links across and between tiers of government are lacking.	Prepare groundwater policy for Nepal, mainstreaming of groundwater in Nepal, better links between stakeholders.	Adequate focus on millennium development goals, but better policy and coordination needed. Inadequate provision for groundwater in policy.	Review of existing legal and policy instruments, better strategic plans.

GAP	Bangladesh		Ghana		India		Nepal		Nigeria	
	Description	Action	Description	Action	Description	Action	Description	Action	Description	Action
Capacity	Severe capacity deficit, especially issues such as non-point-source pollution.	Capacity building, alignment with international organisations, decentralised monitoring.	Technical capacity is limited, particularly at local level.	Training/ capacity building required.	Lack of research-based planning for utilising flood water.	Advocacy, better integration of traditional knowledge.	Shortage of hydrogeologists, lack of technical expertise, lack of equipment, limited capacity of local water user groups.	More recruitment of specialists, better equipment and training, better links with neighbours (e.g. India).	Need for systems approach to capacity building.	Paradigm shift in capacity building beyond training and human resources development.
Funding	No clear financing mechanisms, competition with other ministries.	Better financing, particularly for O&M needed.	Funding of repairs to local groundwater infrastructure is done by communities, and is often inadequate.	Need for stakeholder collaboration.	Jal Jeevan Mission appears to ensure adequate funding at present.		Lack of resources and funding, especially for O&M. Water traditionally regarded as free.	Strengthen capacity, especially at local government and community level. Implement water tariffs, explore other sources of revenue.	Budget for groundwater management poor, low priority given to groundwater.	Existing funds need to work better, piloting of models to improve efficiency.
Objective	Penalties for non-compliance low, need for better representation by NGOs and donors.	Multi-stakeholder platform recommended.	n.d.		Large geographic diversity contributes to imbalances.	Strengthening of state and local government.	No focus on poor and marginalised groups. Clashes with other sectors (especially road building). Non alignment with environmental objectives.	Focus on poor, implementation of rights-based approach, better awareness and collaboration.	Institutional mandates unclear, planning poor.	Measurable, specific, time bound objectives, monitoring and evaluation (M&E) systems required.
Accountability	Communities are not well represented or taken into account. Industrial sector not accountable.	Delegation of authority and implementation of existing regulations is required. Multi-stakeholder platform recommended.	n.d.		Lack of transparency, particularly in rural/tribal areas. Action to rectify misallocation can be slow.	Greater awareness needed, strengthening of NGOs and citizen groups.	Poor monitoring of local government, corruption, political capture.	Better policies, checks and project reviews; more transparency.	Performance management strategies and systems are inadequate.	Governance and accountability are two key issues militating against progress in the sector.

**Derived from Section 3.3 of the Nepal Country Report. Key issues and challenges are listed in Annex 4.1 of the Nepal Country Report.*

5. Summary of recommendations

A summary of the recommendations for WaterAid from each of the country reports are given below.

Bangladesh

The Bangladesh country report includes a detailed section discussing recommendations for WaterAid in the context of ongoing WaterAid projects, including a section summarising the recommendations from communities themselves. WaterAid's activities in Bangladesh have grown considerably over the past few years in scale and in scope – with a focus in water-stressed areas and poorly served communities. Each intervention or project has a specific set of technical and institutional issues that are critical to success, and which have been examined as a SWOT analysis in the country report. The community recommendations tend to focus particularly on the immediate constraints as seen by local people, and sometimes different and seemingly contradictory suggestions may arise. For example, in communities where shallow tubewells are contaminated, deeper groundwater targets are recommended.

However, in coastal areas, or in areas where water tables are falling, a move away from groundwater and towards treated surface water is advocated instead.

The arsenic problem in Bangladesh is very serious, and national policy recommends that, where feasible, surface water should supplant groundwater in the development of new drinking water sources.[xiii]

However, utilising surface water sources has its own challenges and may only be appropriate in certain contexts. WaterAid Bangladesh should continue to explore institutional solutions for arsenic mitigation, particularly since promising government-led initiatives to reduce exposure to arsenic seem to have been implemented too slowly, and in some cases may have stalled. The arsenic problem is as much an institutional or policy issue as it is a technical problem.

The Bangladesh report also emphasises WaterAid Bangladesh's role in advocacy and norm-setting in the country, particularly its ability to advocate for the implementation of measures contained in the Water Act.[13] WaterAid is also able to help mobilise communities and local people in support of water issues, building a platform for them to participate more fully in the decision making process.

[xiii] *A transition to surface water resources has potential pitfalls, including greater risk of microbiological contamination, more centralised treatment and reticulation systems (i.e. higher engineering and infrastructure requirements) and even issues such as the risk of lower levels of nutrients in drinking water.[14] Any new system advocated would also likely need to match the convenience of local groundwater, and mesh with existing institutional systems in rural areas developed around the private ownership of family tubewells.*

[xiv] *Managed Aquifer Recharge (MAR) is growing in importance. MAR reduces the impacts of over-abstraction by augmenting natural (e.g. monsoonal) recharge. India has several million MAR structures in place already, and the technique has considerable further potential there and elsewhere.[15] For example, it is used to guarantee water security in Windhoek, the capital of Namibia.[16]*


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Ghana

Recommendations to WaterAid contained in the Ghana country report focus on the water balance, the low yields in some boreholes in Ghana, and other manifestations of physical water scarcity. A move away from shallow groundwater towards deeper sources may be part of the solution, but needs further research because deeper groundwater targets are poorly understood. Water quality threats (particularly geogenic fluoride, waste disposal and graveyards) are also noted as requiring greater engagement. Aging and obsolete equipment, and a lack of knowledge of the local variations in groundwater conditions, exacerbate water supply problems in Ghana. WaterAid Ghana has a potentially greater role in training Community Water and Sanitation Management Boards on repair and maintenance, and on replacement of equipment where necessary.

WaterAid Ghana's support for further research into groundwater conditions in the study areas in Ghana is also recommended.

India

The India country report notes that administrative structures in India require WaterAid India to work across the various levels of government (community, state and federal), and to understand the ways in which policies develop and find traction in the process of engagement between the levels. For example, the Jalbandhu (or Water Friends) initiative at local level can be amplified by the Jal Jeevan Mission at national level. The India country report recommends that WaterAid develop one or two key intervention themes or flagship initiatives for all its geographic areas of intervention.

The India country report recommends that WaterAid India appoint a groundwater 'data consultant' or similar role, to assess existing hydrogeological data, identify gaps where possible, and present data in a useful and accessible format. This consultant would liaise with data-generating organisations in India, explaining WaterAid's requirements and advocating for the filling of gaps. The consultant would also engage with research institutions, such as universities, in order to invite them to fill gaps or conduct research into pressing issues identified by WaterAid. Finally, the consultant would work to negotiate the different overlapping administrative and decision making roles of the various government agencies tasked with governing groundwater, helping WaterAid have a better understanding of this institutional landscape.

The India country report also recognises the valuable position of WaterAid India in understanding local problems and solutions, and in identifying local 'champions' and success stories that might have potential for replication elsewhere. Such local efforts probably require better documentation and recognition.[xiv]

Nepal

The WaterAid Nepal country report describes WaterAid Nepal's efforts to incorporate social discrimination, gender and the caste system into their work, and to provide assistance to the most deprived and marginalised communities. The report outlines the very high reliance on groundwater for domestic water supply in Nepal, as well as the need for a greater focus on groundwater governance and sustainability. The decline in water availability in rural areas is noted – a consequence of various drivers including drought prevalence, natural hazards and demographic changes. The report recommends that WaterAid Nepal expand its collaboration with government agencies and across government levels, to explore policy instruments and possible synergies.

The lack of groundwater data in Nepal, and relatively poor understanding of the resource, is highlighted. The problem is particularly acute in the hill and mountain areas of Nepal, where difficult topography and reliance on large numbers of springs make monitoring difficult. Here, WaterAid may be able to assist in addressing capacity and policy shortages with specific reference to groundwater. In general, institutional strengthening of local bodies and authorities is recommended as a complement to WaterAid Nepal's existing projects. WaterAid Nepal may also have a role to play in ensuring transparency at local level and helping to promote accountability in the sector.

The Nepal country report concludes with a detailed list of recommendations for WaterAid Nepal to use in programme implementation in the future. These recommendations are organised into seven categories, as follows:[xv]

- Continuation of the existing drinking water and WASH programme.
- Institutional strengthening of local bodies.
- Expansion of Jal Kachari (for example, local community water resource management groups) approach into regular planning of the government.
- Provide technical assistance to the local government to prepare required policies and strategies.
- Take the lead in the groundwater related research to bridge the existing knowledge gap.
- Take the lead role of groundwater Management Information System (MIS).
- Diversify work within the drinking water sector.

[xv] *See the Nepal country report for details of these categories.*

Nigeria

The Nigeria country report lays out several major recommendations. These include recommendations for the wider sector, such as advocating for the implementation of a Well Construction Code of Practice. Developing strategies for the management of groundwater resources and the prioritisation of groundwater quality (particularly fluoride and lead). As well as supporting emphasis on the management of groundwater resources – since groundwater provides more than 90% of drinking water to the rural communities.

Some of the recommendations for WaterAid include organising campaigns for good governance of groundwater systems and a need for increased collaboration with established professional organisations involved in groundwater management in Nigeria (such as the Nigeria Association of Hydrogeologists). To improve linkage and synergy in programmes with relevant national institutions for IWRM, including coordination, capacity building and M&E programmes. The final key recommendation is to support the states and local authorities to designate monitoring wells for the purpose of documenting challenges and improving the management of groundwater resources.

6. Discussion of the recommendations at global level

This section should be considered alongside contemporary global-level recommendations on groundwater management and governance, which summarise major issues, and recent advances and experiences.

There is a growing global recognition of the necessity for better groundwater management: 'By far the most serious groundwater challenge facing the world, then, is not in developing the resource but in its sustainable management.'[17]

Groundwater governance can be complex due to the hidden nature of the resource. The United States Agency for International Development states that: 'Subterranean water resources pose particularly acute governance challenges. They require sophisticated technology and significant knowledge to be sustainably managed. By contrast, even when surface water is not systematically measured it can, at a minimum, be visually monitored.'[18]

The recent international project 'Groundwater Governance. A Global Framework for Action' investigated mechanisms for better groundwater governance. A first phase reviewed the global groundwater governance situation and a second phase led to the main project outcome, which is a 'Global Framework for Action'. The first phase included case studies, thematic papers and five regional consultations. The second phase consists of a set of policy and institutional guidelines, recommendations and best practices aimed at various geographical levels.[19]

The following sections summarise the main points made in the five country reports:

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Importance of groundwater

Groundwater is essential to WaterAid's work in all five countries, with near total dependence on the resource in some project areas. Yet this research suggests that groundwater remains generally undervalued in national, regional and local policy and planning in the administrations of the five countries. For example in Nepal, it is reported that there are no laws specifically dealing with groundwater governance. The country reports describe the lack of effective collaboration between different government agencies whose remit includes groundwater. Such provisions for groundwater that may exist in policy and legislation, may not be enforced, or may be subordinate to other issues (such as road building, industrial growth, urbanisation or agriculture). With population growth and the need to increase resilience to climate change, groundwater governance will become even more important.

In areas where water tables are in decline MAR, at various scales, is likely to grow in importance, including at community level.[15] The appropriateness and effectiveness of MAR depends of course on local context.

Groundwater data and information

The relative absence of groundwater-specific policy in the five countries is compounded by, and in turn worsens, the lack of groundwater data. It is of course hard to make decisions about water supply based on a groundwater resource that is poorly understood, and this presents a risk to WaterAid and other organisations with operations based on groundwater. Time-series data at local level is especially scarce – not only is it difficult to define the groundwater resource, but it is often impossible to evaluate how groundwater conditions might be changing with time.

Advocacy for better groundwater monitoring is necessary, but the issue can be more intricate than it might appear. For example, monitoring of groundwater resources at national level can be an expensive and often complex undertaking. It can be difficult to justify the diversion of scarce resources to groundwater monitoring, particularly if the monitoring data is not efficiently 'translated' into timely and useful information products for decision makers. Wherever possible, attempts to realise value from existing data resources, or to 'piggyback' on existing initiatives[xvi] are recommended. As discussed, budgets for monitoring a hidden resource, such as groundwater, are vulnerable to reallocation to other more visible uses, particularly if the benefits of groundwater monitoring are obscure.

WaterAid already represents a repository of experience and information on local groundwater in the study areas that is likely to be the best available in many cases. WaterAid might consider a longer-term and more strategic approach to the problem of poor groundwater information, especially in places where low yields or poor quality makes better scientific information vital. Such an approach might include:

- Better data holdings or hydrogeological databasing at WaterAid itself.[xvii]
- Closer collaboration with groundwater research institutes, universities, geological surveys and others.
- Exploring ways to make existing data more available or transparent, such as digital repositories or Groundwater Information System (GIS) viewers.
- Using advocacy to increase data collection in other ways, such as advocating for better reporting by drillers, or for the sharing of groundwater data and maps.[xviii]
- The translation or summary of groundwater data into concise information products suitable for decision makers, or the summary and presentation of hydrogeological data on digital 'dashboards'.

[xvi] *For example, where surface water or meteorological data is already being collected, it may be most cost-effective to add a groundwater monitoring site at the same location and as part of the same system. Recent initiatives to expand hydrometeorological systems in the developing world[20] may provide opportunities to greatly improve groundwater monitoring without excessive costs. Sophisticated and integrated hydrometeorological systems provide benefits across a range of sectors and are considered sound investments, particularly in the context of climate change resilience.[21,22]*

[xvii] *Most of the country reports recommend some variation on this theme, and the India country report further recommends the appointment of a specialist data consultant at WaterAid India. The India report also discusses contemporary difficulties with the perceived acceptability of data generated by non-profits for decision making in the public sector.*

[xviii] *The 'Grey Data' initiative of the Southern African Development Community (SADC) succeeded in making available and freely sharing little-known or hard-to-obtain groundwater data and reports for the SADC area, via a web portal. For more information see: bgs.ac.uk/sadc/index.cfm*

Groundwater quality

All of the country reports find that poor groundwater quality is affecting service delivery in at least some places and at some times. The problems range from naturally occurring (but very serious) contaminants, such as arsenic or fluoride, to anthropogenic pollution and salinity. Policy and legislation on pollutants, such as pesticides or fertilisers, is commonly lacking or inadequate, and where it is present, implementation is often slow. The laboratory facilities to evaluate common groundwater quality issues like nitrate or geogenic fluoride are often lacking, or may be expensive and inconvenient.

The lack of a scientific understanding of groundwater quality is sometimes replaced by hearsay or perception, which can nevertheless be key factors in determining whether a groundwater source is acceptable to a community or not. The issue has implications for the construction of water sources (for example, tubewell depth in Bangladesh, or surface completions where polluted runoff is anticipated), and for long term O&M. Linking groundwater management to sanitation initiatives, and emphasising appropriate water point siting, latrine design and well or borehole construction, can lead to great improvements in the microbiological quality of groundwater.

The problem of arsenic contamination of groundwater in Bangladesh remains very serious, and there is some evidence to suggest that programmes designed to tackle the problem are failing. Surface water alternatives in many parts of Bangladesh have their own risks (usually microbiological pollution), and also require different strategies for implementation, O&M and financial sustainability. It is recommended that WaterAid make arsenic mitigation and risk reduction in Bangladesh an even higher priority.


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Advocacy and norm-setting

WaterAid's knowledge and experience in the water sector at local level, in the deprived or remote parts of the five study countries, is very considerable. Even where local groundwater is relatively well-understood or monitored, WaterAid's experience stands out. In several places it is reported that WaterAid has a better understanding of water supply issues and the sustainability of the local water resource than government agencies or research organisations.

This knowledge and experience gives WaterAid the authority to lead by example and set norms for local water supply provision and policy. It strengthens WaterAid's ability to advocate for better groundwater policies, and for improved implementation of existing policies. WaterAid also has considerable international experience and footprint, and substantial convening power in the WASH fields. Taken together, these factors make WaterAid a major player in the ongoing technical, political-economic and ideological debates over the best ways to realise the human right to water and sanitation for the world's poorest people. Some of the areas raised in the five country reports that WaterAid might consider focusing further advocacy efforts on include:


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- Wider attention in national, state and local policy to groundwater governance for domestic water supplies – particularly for the poorest members of society.
- Better collection and storage of groundwater data, and better conversion of groundwater data into information products useful to decision makers – or a strategy to convene partners to achieve this.
- Wider and closer collaboration between donors, research institutes, universities, NGOs and government departments in tackling water supply and sanitation backlogs.
- Norm-setting and institution-building in water project implementation, transparency, efficiency, and consultation to combat real and perceived foot-dragging and lack of transparency in the sector.
- Capacity building and training in the private, non-profit and public sectors to address the lack of groundwater knowledge and skills.
- Direct attention to and convene a response to acute groundwater quality problems, such as arsenic in Bangladesh.
- Work towards better and more sustainable arrangements for water supply O&M, including financial sustainability.
- Research into groundwater's role in improving resilience to climate change (particularly floods, droughts and extreme temperatures) and natural disasters (such as landslides and earthquakes) and mapping this on to national policies.

7. Conclusions

This synthesis of the five country reports compiled as part of the Water Security Research conducted by WaterAid in 2019–20, provides an overview of the findings of the Research Associates. The full country reports should be consulted for more detail.


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Despite varying groundwater conditions and demographics in the five countries, there are common themes which can be used to inform WaterAid's future work and advocacy. There is very high reliance on groundwater for domestic water security in all five countries and in many other impoverished global regions. With a few exceptions, however, groundwater conditions are not well understood, particularly locally, and data and useful information on groundwater quantity, quality and trends are lacking. In some areas, serious groundwater quality problems exist, such as arsenic in Bangladesh, microbiological pollution and salinity. Emerging pollutants, such as pesticides and fertilisers are suspected, but lack of data and poor laboratory capacity makes the problem difficult to resolve and hinders effective decision making. The prevention of groundwater pollution is usually simpler and cheaper than treatment. The general lack of data and associated groundwater information increases risks to WaterAid operations.


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Provision for groundwater in national, regional and local government structures is also generally lacking.[xix] Collaboration between government agencies and with other organisations such as universities, is often poor and may even be non-existent. Implementation of water supply projects, at all levels of government, can be slowed by delays, lack of transparency, lack of consultation and poor collaboration. WaterAid's convening power could be used to strengthen these areas.

The issue of climate change, whilst not emphasised in the reports since they concentrated on local and immediate concerns, will bring groundwater further into focus – as a buffer and an important component of resilience and stability. If possible, groundwater monitoring should be incorporated into nascent hydrometeorological systems in developing regions designed to improve resilience and predictability across a range of sectors as the impacts of climate change become more apparent.

[xix] *India is a possible exception, with organisational and institutional provisions for groundwater monitoring and governance, which are not found in the other four countries.*

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Acknowledgements

Written by Jude Cobbing.

With special thanks to the Research Associates: Kushal Roy, H M Nurul Islam, Kousik Ahmed, Dr Francis I. M. Bukari, Dr Raymond Aabeyir, Amir Poudel, Martin Eduvie and Govind Singh.

January 2020

About us

WaterAid is an international not-for-profit, determined to make clean water, decent toilets and good hygiene normal for everyone, everywhere within a generation. Only by tackling these three essentials in ways that last can people change their lives for good.

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