



The need for a standard approach to assessing the functionality of rural community water supplies

Helen Bonsor¹ · Alan MacDonald¹ · Vincent Casey² · Richard Carter³ · Paul Wilson⁴

Received: 8 August 2017 / Accepted: 14 December 2017 / Published online: 23 January 2018
© The Author(s) 2018. This article is an open access publication

Abstract

The Sustainable Development Goals have set an agenda for transformational change in water access, aiming for secure household connections globally. Despite this goal, communal groundwater supplies are likely to remain the main source of improved water supplies for many rural areas in Africa and South Asia for decades to come. Understanding the poor functionality of existing communal supplies remains, therefore, a priority. A critical first step is to establish a sector-wide definition of borehole supply functionality and a standard method of its assessment.

Keywords Water supply functionality · Borehole · Groundwater development · Rural · Sustainable Development Goals (SDGs)

Poor functionality: a stubborn concern in rural water supply

The development of groundwater resources by drilling boreholes and equipping them with handpumps has been fundamental to increased access to safe water across rural Africa and South Asia (MacDonald and Calow 2009; Howard et al. 2016). Between 1990 and 2015, 1.2 billion people in South Asia and sub-Saharan Africa gained access to improved water sources from boreholes, wells and springs, more than halving the number of people reliant on unsafe supplies from rivers and ponds (JMP 2014). However, these positive statistics mask stubbornly high rates of poor functionality and service levels in community boreholes when taking account of quantity, quality, access and reliability. Estimates of the number of non-functional water points vary from 15 to 50% at any one time between different studies (Harvey and Reed 2006; Lockwood and Smits 2011; Banks and Furey 2016). These estimates of functionality have

persisted since the 1970s, despite different approaches to introduction of services such as an increased emphasis on demand responsive approaches and community management (Cairncross et al. 1980; Arlosoroff et al. 1987; McPherson and McGarry 1987; Carter and Ross 2016; Whaley and Cleaver 2017). As a result, the original investment and the intended benefits (improved health, nutrition, time-savings and education) are lost for the communities affected (Hunter et al. 2010; UN 2013).

Being able to understand the relative drivers of existing functionality of rural borehole supplies across different settings is essential for future investment and interventions to be able to deliver water supply services of increased sustainability and lasting benefit. However, in the absence of a sector-wide definition of borehole functionality, it is currently difficult to compare existing estimates of functionality accurately (Harvey and Reed 2006; Banks and Furey 2016). There is now a growing research community focussed on this issue as well as efforts to standardise definitions led by the Sanitation and Water For All coalition (Wilson et al. 2016). This essay discusses the implications drawn from a review of this growing literature and suggests guidelines for defining and assessing functionality as a first step to being able to confidently compare studies and understand the relative drivers of poor functionality across different settings.

✉ Helen Bonsor
helnsob@bgs.ac.uk

¹ British Geological Survey, Lyell Centre, Research Avenue South, Riccarton, Edinburgh EH14 4AP, UK

² WaterAid, 47–49 Durham Street, London SE11 5JD, UK

³ Richard Carter and Associates Ltd, The Oxlip, Ampthill, Bedfordshire MK45 2EH, UK

⁴ British Geological Survey, Dundonald House, Upper Newtownards Road, Ballymiscaw, Belfast BT4 3SB, UK

Lack of a standard definition

Currently, there is no single accepted definition of functionality, or what constitutes a functioning water point. This inhibits the

ability of the research community, government, donors and practitioners alike to be able to understand the inter-related causes of water point failure. Consequently, solutions may be proposed and implemented that do not address the most significant drivers or deliver lasting benefit. A recent review of 111 studies from published and grey literature (for details see Wilson et al. 2016) found six main categories of how functionality is defined within studies (Table 1; Fig. 1). Within these categories, functionality is mostly measured using qualitative approaches and direct quantitative assessment measurements of functionality are rare.

Thirty-four percent of the studies employ a simple binary approach to define water point functionality based on whether the source is ‘in use’ or ‘not in use’ at the time of the visit. A further 28% of the studies reviewed were found not to explicitly define functionality, but by default usually assume a simple binary working/not working definition. The limitation of a simple binary approach has led some to define multiple categories such as *partially functioning* but this in itself has made comparison of surveys more difficult. A tiered approach has been advocated by a few (4%) recent studies (Leclert 2012; Tincani et al. 2015; Carter and Ross 2016) in which several different levels of assessment and indicators are used to assess functionality. Fourteen percent consider functionality as a category within a much broader sustainability assessment of water service, but definitions used within this are often unclear.

Three major projects (Triple 2009; Cross et al. 2013; Prat et al. 2015) have highlighted the need for clearer definitions of water point functionality in order to be able to understand, and move towards, improving service sustainability. These projects and related literature have drawn attention to the relationship between functionality and sustainability (Duti 2012; Moriarty et al. 2013; Prat et al. 2015). Indeed, Lockwood and Smits (2011) observe that functionality (which they express as the percentage of water points working at any given time) often serves as a proxy for sustainability; however, it is important to recognise that the two are not synonymous, as noted by Carter and Ross (2016). Water points can be non-functional at the moment they are inspected but, with an effective maintenance system may, over the course

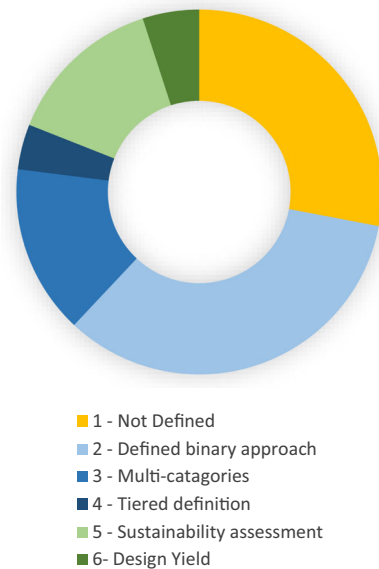


Fig. 1 The proportions of published studies employing different approaches to define water point functionality

of a year, have limited downtime and deliver a sustainable supply of water. Equally, other water points which are found to be functioning at the time of inspection, may in reality experience significant downtime over a year, due to fundamental faults or issues, or less effective maintenance, and are less likely to deliver a sustainable supply (Carter and Ross 2016).

Guidelines for assessing functionality

A major drawback of having such different definitions of functionality, and more worrying, no definition, is that it is difficult to compare studies. The term “functionality” is used by studies to represent both functionality at a point in time (‘snapshot’) and the performance of a water point, which includes a temporal/ reliability dimension. It is essential to differentiate between the two, and understand to which domain different functionality figures relate. Taking the findings from the literature review and

Table 1 The six main approaches used to define and assess water point functionality (details in Wilson et al. 2016)

Definition class	Summary
1. Not defined	Functionality not explicitly defined: by default, working or not working
2. Defined binary approach	Defined to be ‘working’ or ‘not working’ based on whether the water point is working at the time of the visit: ‘in use’/‘not in use’
3. Multi-categories	Different categories are used to capture the different levels of functionality status: functional, minimally functional, functioning through difficulties, broken, missing parts, seasonal
4. Tiered definition	Several different levels of assessment are used to assess functionality. As a minimum, functionality is assessed using a binary approach of ‘working’/‘not working’, but can be examined in greater detail using several levels of assessment
5. Sustainability assessment	A broader assessment approach which includes several factors indicating the reliability of the supply
6. Design yield	A water point is functional if it produces the design yield at the time of the visit

developing thinking from an earlier paper (Carter and Ross 2016), it is suggested here that the following guidelines should form core criteria for assessing functionality of water points:

- Functionality should be measured against an explicitly stated standard and population of water points.
- Functionality should be measured separately from the users' experience of the service it provides.
- The assessments should be tiered, allowing for further information, but always being able to be reduced to a simple measure.
- A distinction can be made between surveying functionality as a snapshot (e.g. for national metrics) and monitoring individual water point performance and reliability (including a temporal aspect).

These guidelines are applied in the following to develop a tiered approach for defining functionality of boreholes equipped with handpumps. The tiered approach enables functionality to be assessed in terms of the performance of that water point with an increasing level of detail:

1. Binary: Is the water point physically working and producing some water at the time of the survey visit? (yes/no)
2. Yield snapshot: Does the water point provide the sufficient minimum design yield (for example, 10 L/min)?
3. Reliable yield: Does the water point provide a reliable yield (meeting criteria 1 and 2 above) year round (less than 30 days downtime in the previous 12 months)?
4. Reliable yield including water quality: Does the water supply pass WHO inorganic and pathogen guidelines, as well as provide a reliable yield year-round?

At the highest level, this approach assesses functionality based on a binary definition of 'working'/'not working' at the time of a survey. The subsequent levels of assessment beneath this binary definition then move to provide a more detailed understanding of

the yield and reliability of supply. This enables a more refined assessment of functionality to be undertaken where possible, whilst acknowledging that such detailed assessments are not feasible or appropriate in all cases. The 'binary' and 'yield snapshot' assessments match the requirements of national survey assessments, whilst the more performance-focused definitions, which assess the reliability of the functionality, are more relevant to local or regional surveys looking to track the functionality of individual water points or programmes through time.

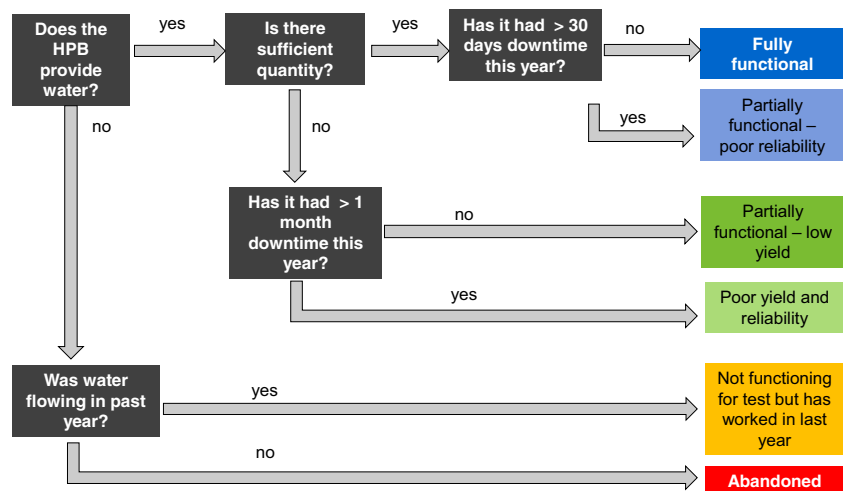
Measuring functionality performance

The set of aforementioned tiered assessment approaches require different quantities of data to be collected, and therefore increasing resources of time and cost. Importantly, the assessment criteria for the binary functionality definition at the highest level of the tiered approach is accessible to all survey types, and ensures a minimum level of functionality data can be compared between studies.

The tiered approach also enables a clear distinction to be made between data collated to assess functionality at a point in time (tiers 1 and 2), and the data required to assess reliability of the water point functionality over time – i.e. reliability (tier 3). Figure 2 shows an assessment approach and the different levels of information which must be collated to assess the functionality of a water point according to different tiers in the approach. A tier 1 assessment could be undertaken by just answering the first question (Fig. 2), or a tier 2 assessment by answering the first two questions. All the questions need to be answered to complete a tier 3 assessment.

Good statistical design can be used to gain maximum information for limited resources. A tier 1 assessment can be undertaken rapidly for an entire domain—for example a district, region, or even country. Good sampling design could then enable a smaller sample to be assessed within the domain at tiers 2, 3 or 4, and the result used to estimate results across the entire domain.

Fig. 2 An approach to assess the functionality of a water point according to the reliability of yield. This performance assessment includes a temporal dimension of the water point's reliability



More than a definition: creating the necessary framework to understanding the underlying causes of community water supply failure

Defining and measuring functionality is only a starting point. Water point failure and functionality is a multi-faceted, multi-layered issue, with growing complexity emerging as one looks beyond the immediate causes of failure. If the SDGs are to be met, and water supply service across the world to become increasing sustainable and offer acceptable service levels (UNDP 2016), the relative reasons for poor functionality in different environments and cultures need to be understood. Earlier work by the authors (Bonsor et al. 2015) identified a pathway for examining causes of poor functionality that includes: *primary causes* (e.g. mechanical failure, reduced yield, poor water quality); *secondary causes* (e.g. geology, poor siting, lack of spare parts, basic maintenance, local governance arrangements); the *underlying conditions* (including the institutional, financial and social factors that shape an environment in which failure is more or less likely); and *long-term trends* (e.g. changes in demand for water, evolution of governance arrangements, reduction in regional groundwater availability, climate change, deterioration of water quality). Given the scale of the problem, many are now working to understand poor functionality, and there are increasing efforts to standardise definitions and existing indicators. This provides an opportunity to reflect and consolidate approaches. By improving definitions, and the systematic collection of data pertaining to failure, efforts in the sector could be further focussed to better understand the primary drivers of functionality in different settings, and the specific interventions which will be able to deliver lasting benefit.

Acknowledgements This work is part of the Hidden Crisis project within the UPGro research programme and is co-funded by Natural Environment Research Council (NERC), UK Department for International Development (DFID), and the Economic and Social Research Council (ESRC). The paper is published with the permission of the Executive Director of the British Geological Survey (NERC).

Open Access This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

References

- Arlosoroff S, Tschannerl G, Grey D, Journey J, Karp A, Langenegger O, Roche R (1987) Community Water Supply: the handpump option. Rural Water Supply Handpumps Project, UNDP/World Bank, The World Bank, Washington, DC
- Banks B, Furey S (2016) What's working, where and for how long: a 2016 water point update. Poster, 7th RWSN forum, November 2016, Abidjan, Côte d'Ivoire
- Bonsor HC, Oates N, Chilton PJ, Carter RC, Casey V, MacDonald AM, Calow R, Alowo R, Wilson P, Tumutungire M, Bennie M (2015) A hidden crisis: strengthening the evidence base on the sustainability of rural groundwater supplies—results from a pilot study in Uganda. OR/15/019, British Geological Survey, Nottingham, UK, 85 pp
- Cairncross S, Carruthers L, Curtis D, Feachem R, Bradley D, Baldwin G (1980) Evaluation for village water supply planning. International Reference Centre for Community Water Supply. Wiley, Chichester, UK, 179 pp
- Carter R, Ross I (2016) Beyond “functionality” of handpump-supplied rural water services in developing countries. *Waterlines* 35(1):94–110
- Cross P, Frade J, James AJ, Trémolet S (2013) WASH cost end-of-project evaluation. IRC End-of-Project Evaluation Report, The Hague
- Duti VA (2012) Tracking functionality for sustainability. Conference proceedings paper, 2011 Annual Review Conference of the Community Water and Sanitation Agency, Kumasi, Ghana
- Harvey P, Reed R (2006) Community-managed water supplies in Africa: sustainable or dispensable? *Commun Dev J* 42(3):356–378
- Howard G, Calow R, MacDonald A, Bartram J (2016) Climate change and water and sanitation: likely impacts and emerging trends for action. *Ann Rev Environ Resour* 41:253–276
- Hunter PR, MacDonald AM, Carter RC (2010) Water supply and health. *PLoS Med* 7(11) e1000361, 9 pp. <https://doi.org/10.1371/journal.pmed.1000361>
- JMP report (2014): progress on drinking water and sanitation. World Health Organisation, Geneva. Joint Monitoring Programme (JMP) WHO/UNICEF. Available at: http://www.who.int/water_sanitation_health/publications/jmp-report-2014/en/. Accessed June 2017
- Leclert L (2012) Status review of BSF's borehole drilling component in South Sudan (2006–2012). BMB/Euroconsult, Mott MacDonald report, MacDonald, Croyden, UK, 67 pp
- Lockwood H, Smits S (2011) Supporting rural water supply: moving towards a service delivery approach. IRC International Water and Sanitation Centre, The Hague, 187 pp
- MacDonald AM, Calow RC (2009) Developing groundwater for secure rural water supplies in Africa. *Desalination* 248(1–3):546–556
- McPherson HJ, McGarry MG (1987) User participation and implementation strategies in water and sanitation projects. *J Water Resour Dev* 3(1):23–30
- Moriarty P, Smits S, Butterworth J, Franceys R (2013) Trends in rural water supply: towards a service delivery approach. *Water Alternatives* 6(3): 329–349
- Prat M-A, Ross I, Kebebe S (2015) Value for money (VFM) and sustainability in WASH programmes: assessing the VFM of DFID's contribution to the water supply and sanitation programme (WSSP) in Ethiopia. Oxford Policy Management Report, OPM, Oxford, 82 pp
- Tincani L, Ross I, Zaman R, Burr P, Mujic, A, Evans B (2015) Regional assessment of the operational sustainability of water and sanitation services in Sub-Saharan Africa. Report by Value For Money, VFM-WASH. <http://vfm-wash.org/regional-assessment-of-the-operational-sustainability-of-water-and-sanitation-services-in-sub-saharan-africa/>. Accessed December 2017
- Triple S (2009) Providing reliable rural water services that last. Triple-S Briefing November 2009, Triple S, San Juan, Puerto Rico, 5 pp
- UNDP (2016) Sustainable development goals: Goal 6—clean water and sanitation. UNDP, New York, 12 pp
- UN Water (2013) A post-2025 global goal on water: synthesis of findings and recommendations from UN-water. UN Water, New York, 41 pp
- Whaley L, Cleaver F (2017) Can ‘functionality’ save the community management model of rural water supply? *Water Resour Rural Dev* 9:56–66
- Wilson P, Bonsor HC, MacDonald AM, Whaley L, Carter RC, Casey V (2016) UPGro Hidden Crisis Research consortium: unravelling past failures for future success in rural water supply—initial project approach for assessing rural water supply functionality and levels of performance. OR/16/044, British Geological Survey, Nottingham, UK, 35 pp