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Access to safe and year round functional water: an estimation of coverage for three central regions in Tanzania

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Water Point Mapping has been extensively used in Tanzania. An enhanced approach, including quality and seasonality of water points has been recently applied in Same District, Tanzania. This paper shows the results of extrapolating the influence of Water Quality and Seasonality in access to water in three central regions of Tanzania,: Dodoma, Tabora and Singida, covering a rural population of 4.5 million, in three statistical scenarios. Influence is assessed by type of water point. The most probable scenario shows that 56% of all rural population served by functional improved water points would be drinking unsafe water from improved water points. Conclusions highlight that the assumption that improved water points provide safe and sustainable water must be revised. More flexible policies towards service provision and revised indicators to track sector evolution should be adopted.

Introduction

Goal 7 of the Millennium Development Goals focuses on environmental sustainability and directly addresses the issue of water supply. One of its targets, Target 10, is to "halve by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation". WHO and UNICEF lead the Joint Monitoring Programme for Water Supply and Sanitation (JMP), whose main goal is to track the fulfilment of the Millennium Development Goals. The indicator used by the JMP for Target 10 is the number of people with "access to improved" water sources (WHO/UNICEF, 2000, 2005,2008). However, it is well-known that the coverage figures from technological indicators do not provide enough information about the quality of the water provided or about its use (WHO/UNICEF, 2000). Moreover, this indicator does not give any information regarding the sustainability of the service.

Alternatively, the Water Point Mapping (WPM) approach has been specifically designed as a procedure to measure access indicators. It has been applied extensively by Water Aid and other NGDO in some African countries for a number of years. Water point mapping (WPM) can be defined as an "exercise whereby the geographical positions of all improved water points in an area are gathered in addition to management, technical and demographical information. This information is collected using GPS and a questionnaire located at each water point. The data is entered into a geographical information system and then correlated with available demographic, administrative, and physical data. The information is displayed using digital maps." (WaterAid, ODI, 2005). WPM's main function is to simply and objectively demonstrate how water points are distributed within a territory; thus it serves as a valuable analysis and planning tool for decentralized governments. It helps improving efficiency and accountability.

An extension of usual WPM approach has been recently applied in Same District, Tanzania. The Standard WPM campaign was complemented with quality assessments at the water points. Moreover the seasonality of water points was examined, in what we called the Enhanced WPM. Portable water kits were used to test all the functional water systems. Quality in networks was examined at either one or two points, depending on their size. All the individual functional water points were analysed. The parameters that were measured include pH, turbidity, chlorine, electrical conductivity and concentration of thermotolerant (faecal) coliforms. Detailed methodology and resources needed have been presented elsewhere (Jiménez and Pérez-Foguet, 2008).

This paper addresses the relationship between the access to improved water sources, as defined by the JMP, and the real level of service delivered. It estimates the coverage of sustainable access to safe water in three regions of central Tanzania assessing the influence of technology. Data considered comes from a Standard WPM campaign on the three regions and the Enhanced WPM campaign in Same district. The following two subsections present some introductory definitions and main characteristics of data used in the study. After that, main goals and methodology, results and conclusions are presented in separate sections.

Definitions

An Improved Community Water Point (ICWP) is a place with some improved facilities where water is drawn for various uses such as drinking, washing and cooking (Stoupy et al., 2003). The types of water points considered as improved are consistent with those accepted internationally. Access is normally defined by establishing a ratio of the maximum distance and number of people served by each water point. In the case of Tanzania, this ratio would be one water point for 250 people within a radius of 400 m. In order to accurately assess the number of people served using distance as a criterion, the population distribution at the household level is required, which is problematic in many cases. On the other hand, due to the implementation of the periodic sociological census, population distribution in administrative structures is usually quite well documented. Thus, access is measured through the number of people served per water point, 250 people, regardless of whether their households are further than 400 m from the water point. The first indicator of access defined is Improved Community Water Point Density (ICWPD), which is equal to the number of ICWP per 1000 inhabitants. In the case of Tanzania, a certain area would have access if its density were four or more water points per inhabitant. The percentage of people not served in an area would be proportional to the lack of water points available compared to that threshold. However, as information on functionality for each water point is also collected during the survey, this can be included in the access definition. Consequently, Functional Community Water Point Density (FCWPD) is used by WaterAid as the real access indicator.

The Enhanced Water Point Mapping allows for the definition of further indicators, by including quality and seasonality information. The Bacteriological Acceptable Functional Community Water Point Density (BAFD), is defined as the amount of FCWP per 1000 inhabitants providing water with an acceptable concentration of faecal coliform at the time of the test (Tanzanian standards), and the Presumably Potable Functional Community Water Point Density (PPFD), defined as the amount of FCWP per 1000 inhabitants providing acceptable value of all measured parameters (also Tanzanian standards). Seasonality of water points, reported by water users, is included as a precondition for sustainability. One water point is not considered functional all year round if water users report a seasonality of more than one month. Including this concept, the Year-round Functional Community Water Point Density (YRFD) is defined as the number of FCWP per 1000 inhabitants working at least 11 months per year.

Water point mapping data

Between 2005 and 2006, Wateraid implemented the WPM in the rural areas of three regions in central Tanzania: Dodoma, Tabora and Singida, covering 15 districts. There are significant differences among the official data and the data obtained through the WPM methodology. With the exception of Singida Town council where WPM coverage is higher than the official figure, coverage is significantly reduced in the rest of the cases, by an average factor of 0.55. In Singida Region, coverage reduces from 37% to 21%. Extreme differences are found in Dodoma Region, where WPM access figure is 25%, compared to the official 61%: Kongwa and Mpwapwa have coverage of 29%, compared to the official figures of 74.4% and 65% respectively. In Tabora region, coverage calculated through WPM is 8%, compared to the official 14%. Same District drops from 51.6% to 43.6%, a small quantity compared with other districts.

The Enhanced WPM campaign done in Same allowed to define the new indicators including quality and seasonality aspects. Quality analyses were performed with the following criteria. Quality was tested for all isolated (not belonging to a network) water points. For networks, analyses were made both at the tank and at one or two Water Points, depending on the size of the system. In all cases, results were coherent between the tank contamination measured and the one found at the point of delivery. This suggests that there is low contamination in the small networks that provide water to these rural communities, and contamination mainly comes directly from the source, and leakages in the main line (usually more exposed than the distribution lines) and/or at the tank. This confirms the hypotheses taken to calculate the share of population served by safe water, as we have assumed that the quality of one water point (compared with that of the tank) was the same for the rest of water points belonging to the same system.

Table 1 summarizes the results obtained, compared to the indicators provided by central government and Standard WPM. The difference in coverage obtained is very significant. When basic quality aspects are included, coverage figures reduce from 43.6% to 29.6%, and it drops to 22% if seasonality is also considered. Reduction factors are 0.67 and 0.50 respectively.

Table 1. Comparison among different methodologies and access indicators provided, Same District results, 2006. (2006 Population by village provided by Same District Council

Methodology	Indicators provided	% access
Governmental Household Surveys	Aggregated Access Indicator	51.64
Standard Water Point Mapping	Improved Community Water Points Density	73.13
	Functional Improved Community Water Points Density	43.61
Enhanced Water Point Mapping	Bacteriological Acceptable Functional ICWP Density	33.41
	Presumably Potable Functional ICWP Density	29.56
	Bacteriological Acceptable and Year-round functional ICWP Density	25.14
	Presumably Potable and Year Round functional ICWP Density	22.02

Goals and methodology

The specific goal of this paper is to quantify the influence of Water Quality and Seasonality in access to water in the central regions of Tanzania, by extrapolating Same districts' results and taking into account the influence of the technology providing the service. By doing this, we will also highlight the importance of including quality and sustainability aspects in international indices, as those used by the Joint Monitoring Programme.

Direct extrapolation of Same PPFD and PPYRFD results to the three regions simply cuts FCWPD figures uniformly by a factor 0.67 or 0.50, respectively. However, direct extrapolation provides no information about the relationship between technology used and quality and its influence in access figures. In order to improve analysis of the results, a two steps methodology has been followed; firstly data is analysed and divided in few technology-type categories; afterwards, data is extrapolated for each category to the all 15 districts. Extrapolation is done both with the most probable percentage of failure (water quality, or seasonality, or both), and with the extreme values of the confidence interval with the 0.9 of significance level. The significance level of a confidence interval is the minimum probability to find the real value in the interval given. The confidence interval is computed following Lemis and Trivedi (1996).

Technology categories

Standard Water Point Mapping uses three variables to define a water point: Source type, Water point Type, and Extraction System. These three parameters help to discriminate the kind of water point. In this study, the type of water points has been grouped in four categories, as defined in Table 2. Data from EWPM in Same district has also been grouped under same categories. These categories help to group in a meaningful and understandable way all the possible combinations of water types, type of sources and extraction systems, facilitating the analysis of data. Table 2 provides also the number of water points in each category, both for central regions and for Same District (used as reference for extrapolating). As the sample for Same is small, some categories have not been further split. For instance, it has been decided to keep Hand pumps altogether although they might have different quality risks depending on the depth of the water table. Hand pumps from shallow wells could have been separated from the rest of hand pumps, but more quality data of this kind of water points would be needed therefore.

Motorized pumping systems by non manual extraction system were chosen as a separated category. 99.1% of the water points studied under this category had groundwater as the source. These are usually less prone to human contamination, since water users do not go to the place were water is extracted, regardless water table depth, in contrary to the case of handpumps. On the other hand, contamination due to poor maintenance of the network is usually the critical factor for contamination of these systems.

Gravity fed systems are mainly based on surface water (89% of water points studied). Bad quality (Faecal contamination) at the source is one of the risks that this category of water points face, produced by inadequate water uses upstream and/or bad source protection. Contamination can also occur from poor maintenance of the network. The pending 11% of gravity fed water points studied is fed by springs, with some exceptions of rainwater harvesting. Water points fed by springs are less exposed to contamination at the source that those fed by rivers or lakes, and could therefore be splitted in a different category. This has not been done for this case, since not many water points belong to this sub-category, and more sample data about quality of spring-fed water points should be available to make a precise extrapolation.

Water points under "Others" Category represent a variety of types of water points, with different aspects that might affect their quality and seasonality. They have been grouped as they represent all together a 2.2% of the number of water points examined. On the other hand, there are not enough data from each of them to extrapolate data on quality measurements.

Seasonality of the water service is usually caused by a flow reduction in the dry season (surface water and springs), or by the variability of the water table in the case of groundwater. These aspects highly depend on the geological and geographical conditions of each particular water point. This applies as well for the contamination of water by high salinity. For our study, it has been assumed that the results of Same District are a representative statistical sample of the reality in the central regions of Tanzania. The purpose of the study is to show the effect of including these aspects in the aggregated figures of water sector information, as they can have considerable impact related to health and in the event of droughts. As an extrapolation, the results can only be taken as approximated.

Table 2. Categories of water points defined for the study and size of samples

Category	Definition	Central regions		Same district	
		Number of WP	% of total	Number of WP	% of total
All handpumps	All water points providing water through a handpump, regardless its brand and the type of well/borehole	2326	39.28%	21	3.51
Motorized pumping systems	All water points fed by a pumping device operated through any kind of non-manual extraction system, excluding windmills	2180	36.82%	14	2.34
Gravity fed	All water points fed by gravity systems, regardless the type of source	1263	21.33%	550	91.97
Others	Protected springs and rainwater-harvesting not feeding networks; water points fed by windmills	152	2.57%	13	2.17

Results

Data used for the extrapolation of quality measurements to different categories of water points is shown in table 3. It is important to highlight that these results are "exact" for Same District. They are considered as a sample from the overall three regions under analysis. The extrapolation was done considering the category of each water point, and using three scenarios, the most probable one (given by the probability estimator "number of cases/sample size"), the "worst" one (with the maximum probability given by a significance level of 0.9), and the best one (with the minimum probability given by a significance level of 0.9).

The table show that 34.6% of gravity fed water points are expected to have quality problems in the most probable scenario, along with 69.2% of handpumps and 42.9% of water points fed by motorized systems. These percentages increase to 39%, 88.7% and 77.5% respectively, in the worst statistical scenario. At the contrary, in the best scenario, the percentages of quality problems by technology are reduced to 30.3% for gravity fed, 42.7% for handpumps and 12.9% for motorized fed water points. The width of the interval is determined by the size of the sample. Thus, the extrapolation could be improved if more data about quality and seasonality of handpumps and motorized systems could be obtained. Similar interpretation can be done of other parameters of table 3. Note that introducing technology categories is relevant not only for the variation in the most probable scenario, but also because it increases size of significance intervals, thus the uncertainty of the prediction.

Table 3. Quality and seasonality data used for extrapolation

Category of WP	**All handpumps**	**Gravity fed**	**Motorised**	**Others (Spring, Windmill)**	**General (regardless category)**
Total FWP	13	344	7	11	375
Influence of quality					
WP with bad quality	9	119	3	2	133
Best scenario	42.,7%	30.3%	12.9%	3.3%	31.4%
Worst scenario	88.7%	39.0%	77.,5%	47.0%	39.7%
Most probable scenario	69.2%	34.6%	42.9%	18.2%	**35.5%**
Influence of Seasonality					
Seasonal WP	0	111	1	1	113
Best scenario	0.0%	28.1%	0.7%	0.5%	26.2%
Worst scenario	20.6%	36.7%	52.1%	36.4%	34.3%
Most probable scenario	0.0%	32.3%	14.3%	9.1%	**30.1%**
Influence of quality and seasonality					
WP with quality or seasonality problems	9	180	4	3	196
Best scenario	42.7%	47.7%	22.5%	7.9%	47.9%
Worst scenario	88.7%	56.9%	87.1%	56.4%	52.3%
Most probable scenario	69.2%	52.3%	57.1%	27.3%	**56.6%**

Figure 1 shows the expected coverage (including quality, PPFD) grouped by Region and in the three scenarios considered. The results are impressive. In the most probable scenario, coverage is halved in Dodoma region, and cut into one third in Tabora and Singida. After the data from Water Point Mapping, 745.545 people are deemed to have access to functional water points in those regions. In the most probable scenario considering the quality of water delivered by each type of water point, 56% of the population served , e.g. 414.545 people, would be drinking unsafe water from improved water points. Even in the best scenario, 263,295 people, e.g. 35% of people having access to water would be affected by the poor quality delivered. The reduction obtained through uniform extrapolation (factor 0.67) would lead to a number of 246,030 people affected, thus underestimating severely these more probable figures.

Year round Functionality of water points was processed in the Enhanced Water Point Mapping campaign made in Same District. One water point is considered year round functional if the users state its functionality for at least 11 months per year. Despite being a subjective aspect, which can be affected by events occurred before the survey, it is proposed as a first indicator towards detecting vulnerability to droughts, conflicts in water uses and/or poor management. Figure 2 shows the expected coverage reduction grouped by Region. In the most probable scenario, coverage is reduced from 25.2% to 17.9% in Dodoma region, from 7.5% to

6.7% in Tabora and from 21.3% to 18.7% in Singida. After these estimations 158,045 people could be exposed to seasonal water sources meaning 21% of the population having access to functional water points, at minimum 117.545 in the most favourable scenario. This figure is not only important because of the amount of people itself, but as well to highlight the challenge of risk management against droughts.

Combining the information obtained about Quality and Seasonality, it is possible to estimate the coverage of people having access to safe and year round functional water points. Figure 3 shows the expected coverage reduction grouped by Region. Coverage is reduced around two thirds of initial coverage found by Standard Water Point Mapping in the most probable scenario. After this estimation, 64% of people having access to water points are affected either by poor quality or seasonality of the service, meaning 477,545 people or 11% of total rural population of the three regions. Thus, 1910 out of 2982 functional water points are deemed to be affected by quality and/or seasonality problems in the most probable scenario. Compared with a uniform reduction (factor 0.5), the effect of technology is more relevant in Tabora and Singida, where

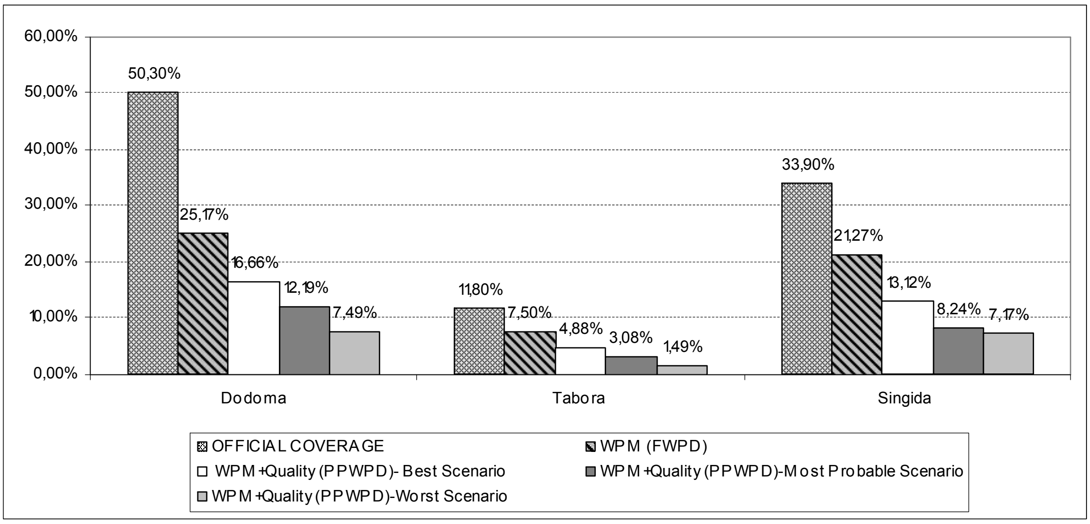

Figure 1. Access to water by region after different sources: GoT data, standard water point mapping (WPM) and estimated access when including quality of water delivered

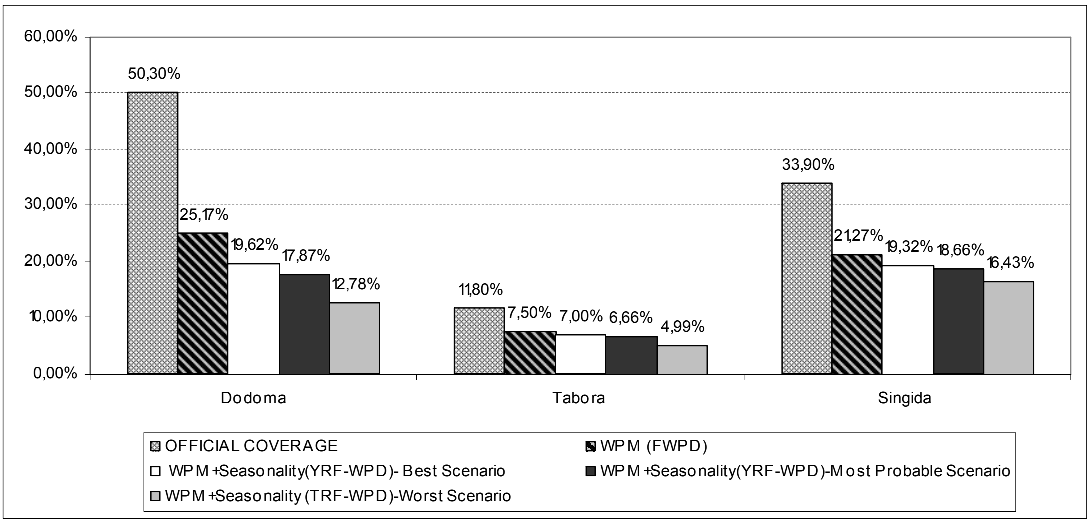

Figure 2. Access to water by region after different sources: GoT data, standard water point mapping (WPM) and estimated access when including seasonality of water delivered

access is cut by factor 0.34 when technology is considered. Even in the most optimistic situation, only 10.2% of rural inhabitants of these regions would have access to year round functional and presumably potable water, compared to the 17.5% estimated by the standard water point mapping, and the 31.7% of the official data. In order to improve the assessment more seasonality data from "motorised" and "others"-type WP is needed.

Conclusions

Water point mapping has been extensively used in Tanzania and other countries as a methodology to assess precisely the situation of water access in a certain territory using the GPS to locate improved water points. The coverage of one village is calculated multiplying the number of functional improved water points in the area by 250 people (according to the policy), and comparing it with the total population in that particular place. The possibility of displaying the information in maps is a powerful tool for planning at the decentralized level. Despite the progress made on the knowledge of the real situation of access to water offered by this methodology, it has still some limitations. Mainly, the indicator is measuring the access to water, but no information is given about the quality of the water delivered or about its performance along time.

The pilot project made by Ingeniería Sin Fronteras in Same District, gives a step further in this methodology, by including basic quality tests at the water points, and processing the seasonality questions included in the questionnaire. With these inputs, a new indicator can be defined including these concepts: the Presumably Potable and Year Round Functional Water Points Density, as explained above. Results in Same District (Jiménez and Pérez-Foguet, 2008) show a coverage reduction from 43.6% to 22%, almost halving the FCWP coverage. This paper aims to stress the importance that the inclusion of these aspects would have into the indicators used in the sector. To show that, it extrapolates the influence of Water Quality and Seasonality in access to water in three central regions of Tanzania: Dodoma, Tabora and Singida, covering a rural population of 4.5 million people, served by 6900 water points. Data used are extracted from the Water Point Mapping elaborated by Wateraid in 2005 and 2006. For this study all water points were grouped into four categories (handpumps, motorized water systems, gravity fed systems and others). Each of them includes type of water points with similar related factors affecting quality and seasonality aspects. Results are showed separating quality from seasonality, as well as both combined.

Extrapolation is done both with the most probably percentage of failure, and with the extreme values of the confidence interval with the 0.9 of significance level (best and worst statistical scenario).

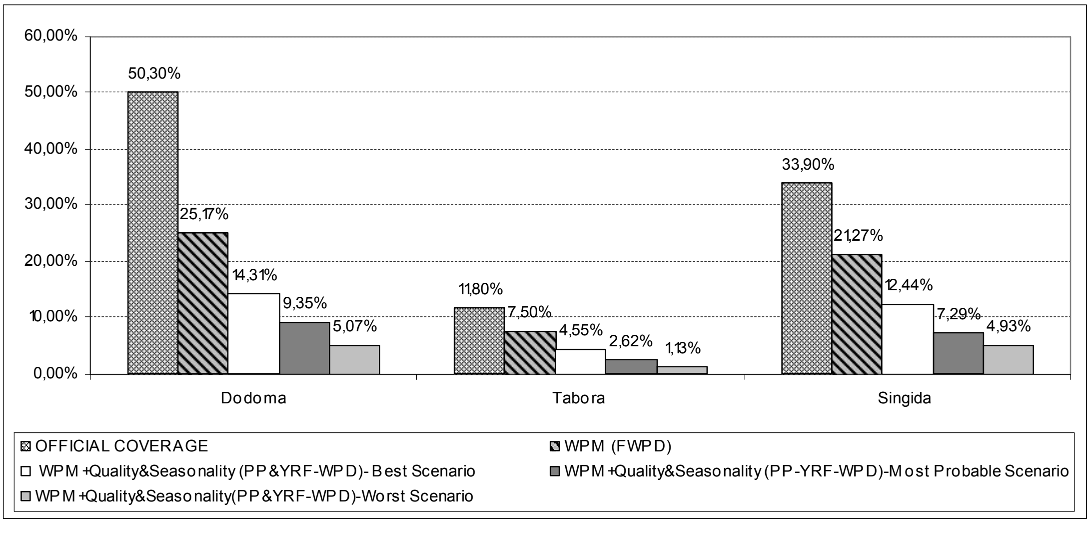

Figure 3. Access to water by region after different sources: GoT data, standard water point mapping (WPM) and estimated access when including quality and seasonality of water delivered

Extrapolation of quality data in the most probable scenario show that 56% of all rural population served by functional improved water points them, e.g. 414,545 people, would be drinking unsafe water from improved water points. Seasonality alone is less critical, affecting 21% of the population having access to functional water points with a minimum of 117,545 people. This figure aims to give a rough estimation of the number of people in a vulnerable situation in the event of droughts, highlighting the challenge ahead for managing this risk. If we combine both factors, looking for secure water access, we find that 64% of people having access to functional improved water points are presumed to be affected either by poor quality or seasonality of the service, meaning 477,545 people or 11% of total rural population of the three regions. Thus, 1910 out of 2982 functional water points are deemed to be affected by quality and/or seasonality problems in the most probable scenario.

Obviously, the fact of considering these aspects in the water access figures has enormous consequences. From one part, the “access to sustainable and safe water” might not be equivalent to the “access to improved water points”, as it has been adopted for international monitoring. In its latest report, the Joint Monitoring Programme is already differencing the piped water into a dwelling, plot or yard from other improved water points as another level of service (WHO, UNICEF 2008), but the access to water is still calculated trough the access to improved water points without further consideration. Secondly, our study in Tanzania show that it is reasonable to expect that around 50% of improved functional water points have either quality or seasonality problems. This fact is currently being ignored in all decision levels in the sector, simply because it is not being measured. No actions against it are being taken, with important effects on the health and well being of millions of people. In this sense, incremental approaches for improving water services have to be considered in national policies along with increased hygiene promotion campaigns focused on water handling. More research is needed in order to accurately assess to what extent we can believe that improved water points are providing safe water. And hopefully, more flexible and adapted service provision strategies will be taken afterwards.

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