Introducing the WASH Flows analytical tool

Integrating sanitation and watershed management for improved water governance and investments

SEI tool brief
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IMAGE (ABOVE): Stream of water pouring into children's hands, Burkina Faso

Watershed management and water, sanitation and hygiene (WASH) have been governed in silos. Efforts to connect these two areas require intentional technical work and interdisciplinary coordination.

This brief presents a new tool called WASH Flows, designed to link both aspects within one analysis framework, by connecting watershed-level flows to WASH actions.

The WASH Flows tool allows researchers to analyse rural WASH service baselines and to visualize and estimate WASH vulnerabilities at the household level. The tool can assess how WASH actions might lead to improved service quality, and it can model impacts of WASH actions on the water balance and water quality of downstream water bodies.

A case study of the Tupiza watershed in Bolivia illustrates the main characteristics and functioning of WASH Flows.

WASH and water security

The connection between WASH services and hydrological systems is relatively simple. The quality of a community's WASH services relies on its sources of water, and those water sources' quality will be impacted by a community's WASH services (Wetlands International, 2017).

This connection highlights the importance of integrating a WASH framework with the Integrated Water Resource Management (IWRM) framework. The IWRM framework is practiced by most Latin American countries to achieve water security and support water governance (Rahaman & Varis, 2005).

In many cases, watershed planning does not integrate WASH or WASH-related actions (Edmond et al., 2013; Hadwen et al., 2015; Vannucci, 2018; Wetlands International, 2017). Meanwhile, those investing in WASH solutions and changes seldom consider their impacts at the watershed scale. This reality leads to failure to meet targets under the UN Sustainable Development Goal (SDG) 6, Clean Water and Sanitation; these targets often require adequate frameworks that incorporate WASH approaches with IWRM frameworks (Vannucci, 2018).

An IWRM project typically includes water balance and hydrological modelling developed for a specific planning setting (Badham et al., 2019). A typical IWRM model integrates aggregated values of community-level demands; this approach makes it difficult to determine the household-level water supply situation at any given moment. Additionally, most models do not consider sanitation and hygiene, missing the connections between water, poverty and environment (Edmond et al., 2013).

An integrated or multi-sectoral project combining health interventions together with watershed management approaches, as well as water supply and sanitation, could reduce the impact of pollution within a watershed (Carrard & Willetts, 2017). It could also promote synergies across sectors, as well as better outcomes for conservation and human well-being.

Commonly, WASH analyses are based on data collected at the household level. Therefore, such analyses do not reflect broader aspects that involve, for instance, water resources at the watershed level (Wetlands International, 2017). Integrating understanding of the water cycle in WASH analyses can reduce the risk of water scarcity within a WASH system (Hadwen et al., 2015). Furthermore, an integrated assessment of WASH solutions at the watershed level, including aspects such as water availability, water quality, climate change impacts and other water uses, should lead to more sustainable and resilient WASH interventions.

Linking WASH and IWRM

Integrating WASH and IWRM frameworks by linking quantitative models can help address existing gaps in these two critical water security components. The two are explicitly linked in WASH Flows.

Currently, WASH Flows is being tested in a beta version as part of the Bolivia WATCH project. A generic version of the tool will be finalized that can be adapted to regions outside of our case study in Tupiza. WASH Flows is designed to be used by local water and sanitation utilities and government environmental organizations at all levels.

The tool was designed following the framework built by the Joint Monitoring Program (JMP) for Water Supply, Sanitation and Hygiene, developed by UNICEF and WHO, which estimates WASH service levels (i.e. access) through a series of specific indicators and from information collected at the household level (Cotton & Bartram, 2008). WASH Flows includes functionalities that can be used in the standalone tool or applied together with a watershed-scale modelling tool, such as WEAP (Water Evaluation and Planning) (Yates et al., 2005).

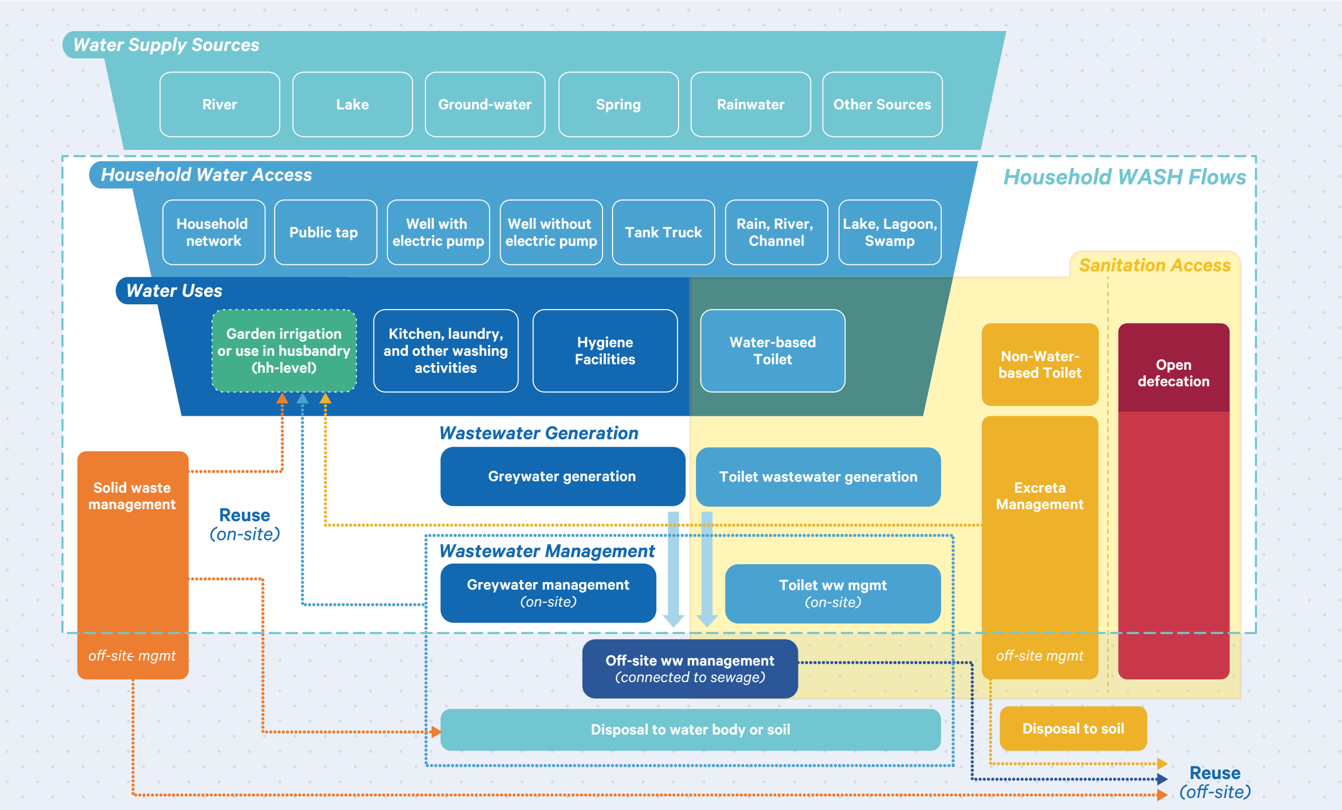
This tool operates in a Microsoft Excel interface. It comprehensively represents the simplified conditions of WASH services at the community level through quantitative analysis and graphical representations.

The WASH Flows tool can estimate WASH service levels, water demand and wastewater generation based on households' infrastructure. It can compare how different WASH interventions might influence the service level and can help users prioritize vulnerable communities where WASH interventions should be implemented. Additionally, it can estimate contamination loads resulting from inadequate or non-existent sanitation systems.

When coupled with a watershed modelling scale tool, WASH Flows solves the problem of connecting data at the household level and the watershed level. As shown in Figure 1, the basin model encompasses all existing water supplies, including household drinking water access, within WASH Flows. This interaction allows users to analyse the reliability of current or proposed water supply sources and potential impacts of these sources' use on a watershed's overall water availability.

Furthermore, WASH Flows includes an analysis of sanitation and wastewater produced at the household level (see Figure 1), estimating the quantity and quality of disposed water. When this quantification is integrated into the basin model, users can analyse potential effects of sanitation and wastewater production on downstream water uses and propose alternative wastewater management strategies.

Figure 1. Conceptualization of the WASH Flows tool and its interaction within the watershed modelling tool WEAP.



WASH Flows case study: Tupiza watershed

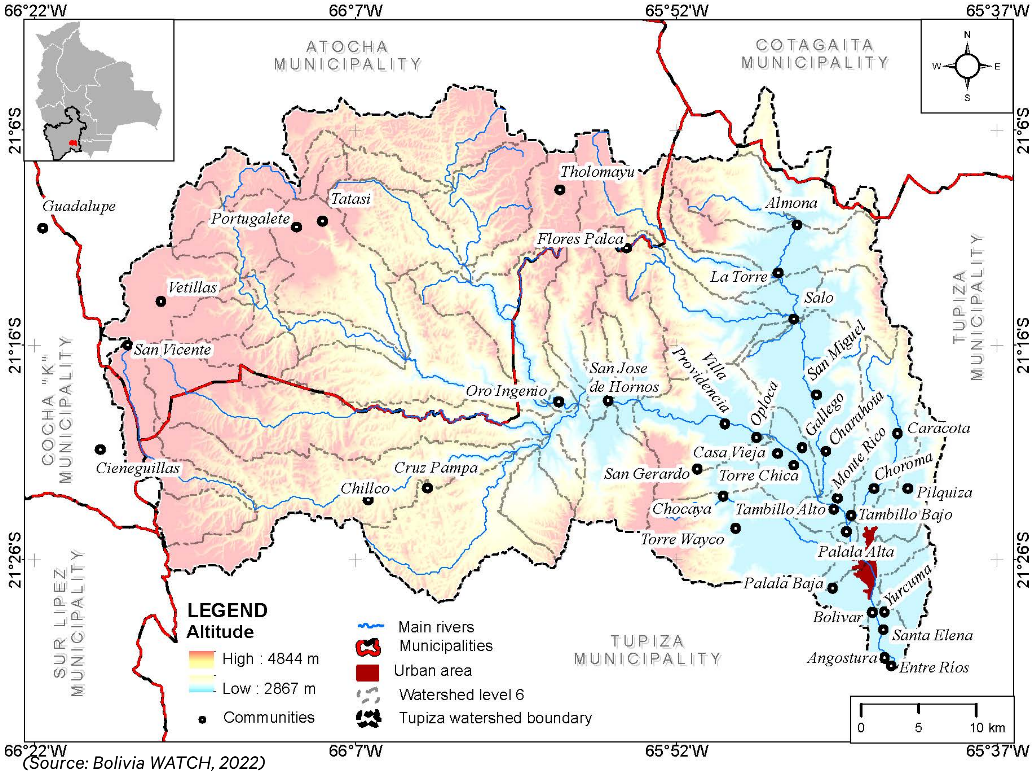
The Tupiza watershed is situated in Bolivia's Potosí Department. Bolivia has Latin America's highest rate of open defecation in rural areas; the country's rural inhabitants tend to have limited access to water and sanitation services.

The watershed covers an area of 2309 square kilometres and has a population of about 47 000, distributed among 38 communities settled near rivers and creeks (see Figure 2). A survey of 312 households provided qualitative WASH data to be used in the WASH Flows model for the Tupiza watershed plan; the data were supplemented with secondary sources to represent the conditions of WASH services.

The case study illustrates the two important characteristics of WASH Flows mentioned above: first, the tool aggregated household-level data to develop a WASH service baseline and estimate of WASH vulnerabilities at the community level using the JMP indicators. Second, it modelled the impact of WASH actions on service levels, watershed water balance, and water quality of receiving water bodies to support prioritization of appropriate actions.

Regarding the first aspect, WASH Flows generated outputs that allowed identification of the WASH service deficiencies at the community level in the Tupiza watershed. The baseline shows that in the watershed's rural areas, 25% of the households have access

Figure 2. Location of the Tupiza watershed, including its administrative division and communities.



(Source: Bolivia WATCH, 2022)

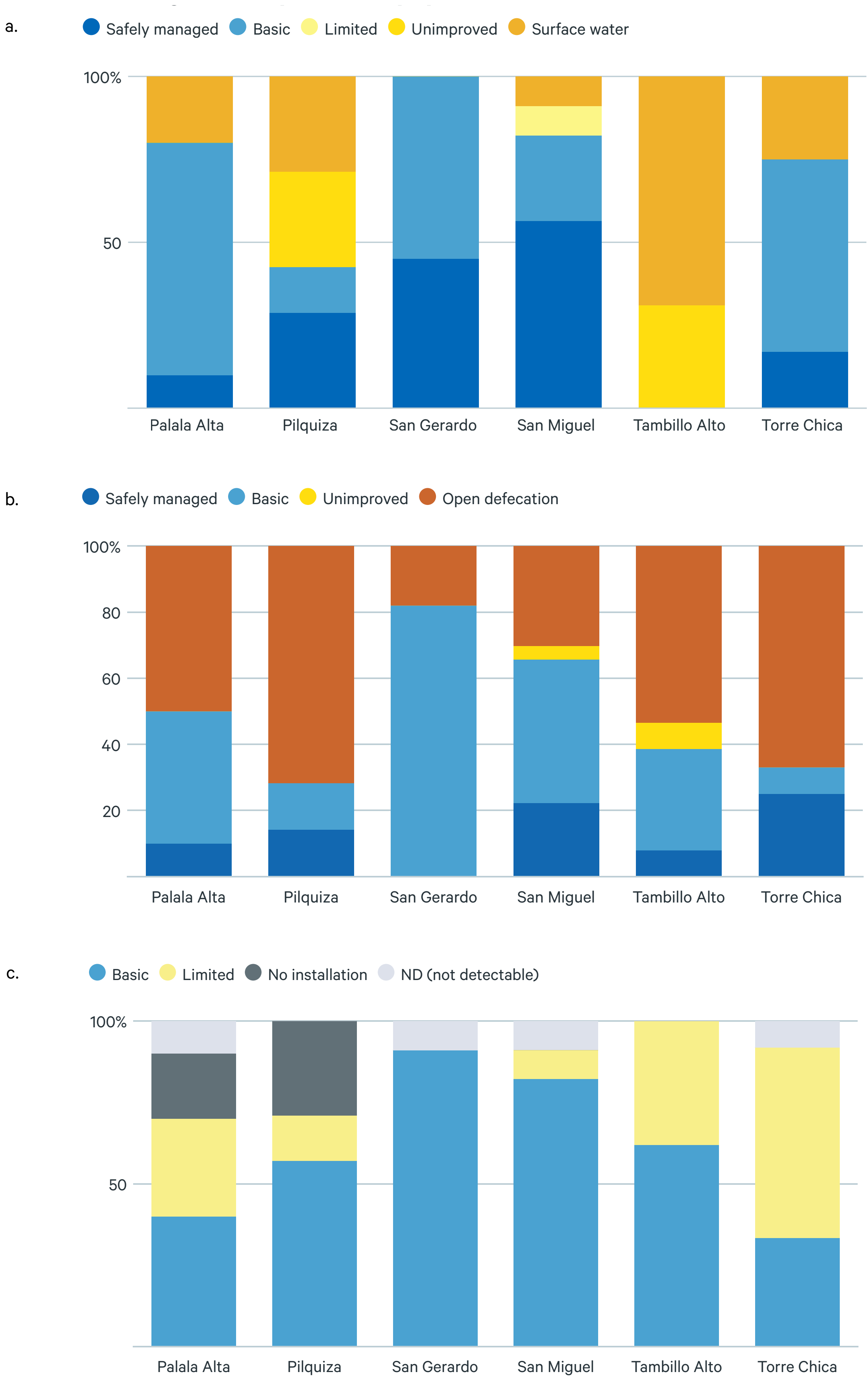
to a safely managed water service and only 4% of the rural population is connected to a safely managed sanitation service. Regarding hygiene, only 22% of rural communities in the watershed have access to basic hygiene services, such as infrastructure for handwashing. And the estimated biological oxygen demand (BOD) from these communities' wastewater discharge ranges from 10 to 15 kg BOD per inhabitant per day. An example of the visualization of these indicators for six communities in Tupiza's watershed is shown in Figure 3.

The WASH Flows model in Tupiza illustrated the impact of potential WASH solutions. As an example of the outputs, six communities could be identified where people lack water access during drought periods, as the analysis was coupled with the climatic data in WEAP's Tupiza model. The tool shows this outcome with visualizations, in this case, illustrated in Figure 4a.

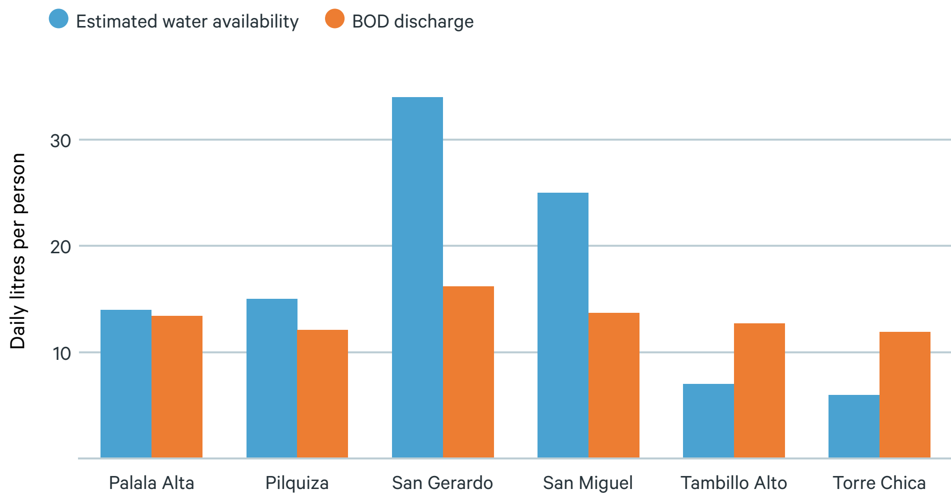
Based on these results, two categories of actions were selected for evaluation in the Tupiza watershed: building community drinking water systems and developing decentralized sanitation systems. Community drinking water systems include rainwater harvesting tanks, deep and semi-deep wells, and simplified and conventional distribution networks. Decentralized sanitation systems include simplified sewage networks plus a decentralized wastewater treatment plant, household artificial wetlands, and urine-diverting dry toilets.

According to the model analysis of various scenarios, these proposed WASH actions would allow three communities in the watershed to significantly reduce their water-access vulnerability in drought circumstances. Similarly, the selected sanitation actions would considerably reduce the number of people with no sanitation connections (see Figure 4b). The actions selected for the Tupiza watershed not only could increase WASH coverage, but also enhance communities' resilience to drought.

Figure 3. Sample of WASH Flows results for rural communities' baseline
a. drinking water, b. sanitation, c. hygiene and d. biological oxygen demand, or BOD, discharge.



d.



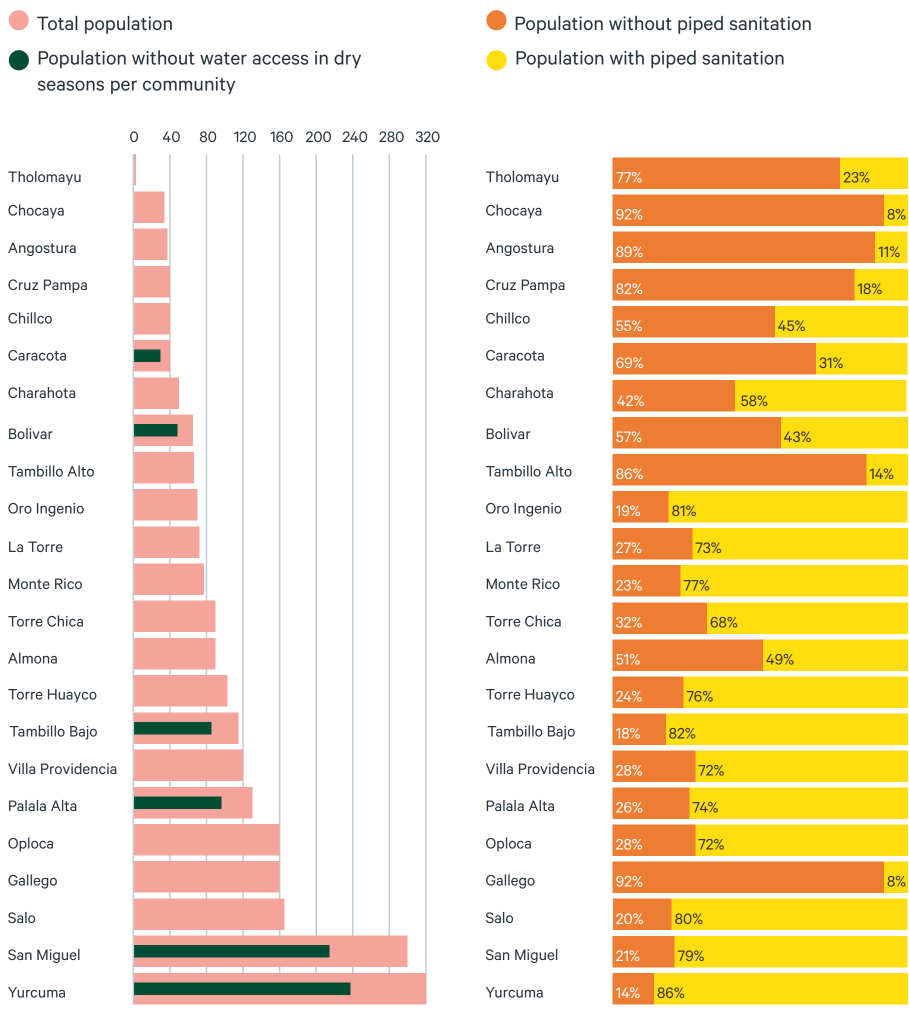
Note: supply goal 80 litres

Figure 4. Population without access to drinking water and piped sanitation per community in the Tupiza watershed (a. current and b. proposed WASH actions).

a.

Population without water access in dry seasons per community

Population with and without piped sanitation per community



b.

Population without water access in dry seasons per community

Total population

Population without water access in dry seasons per community

Population with and without piped sanitation per community

Population without piped sanitation

Population with piped sanitation

The model outputs were validated in two stages for the Tupiza case study: first when calculating the service baseline and again when proposing WASH actions for improving service levels. The first validation compared the calculated service baseline to national census data. The household surveys were qualitative and served as the primary source of information for WASH Flows; survey responses were converted into quantitative data for formulas that were designed to evaluate and define vulnerabilities in WASH services at the community level. WASH Flows could generate graphs and a threshold evaluation that compares the baseline outputs to national WASH service targets; to validate the results, the output could be crosschecked with WASH service coverage percentages registered in the last national census for each community.

The second validation was carried out when technical solutions were suggested for improving WASH service levels. After the baseline was verified, the communities with low service levels were visited to gather information about topography, spatial location of existing WASH infrastructure, socio-economic aspects, among other details. These data aided in evaluating potential technical or engineering actions that can improve access, quality or coverage of WASH services, or all three. This “ground truthing” also helps in validating WASH Flows models and comparisons of these proposed interventions in different WASH Flows scenarios.

Conclusion

The ultimate vision for WASH Flows is to support water security analyses that include:

- Assessing the current coverage of WASH services in comparison with national goals for drinking water, sanitation and hygiene coverage.
- Estimating contamination loads in the environment that result from inadequate sanitation at the household or community level.
- Prioritizing WASH interventions by comparing the WASH service levels of different communities through a vulnerability analysis and identifying communities in which WASH interventions should be implemented.
- Anticipating the benefits and impacts of WASH development interventions and comparing the effectiveness of various WASH interventions.

WASH Flows is a tool that connects two water security disciplines that have been traditionally disconnected: WASH and watershed management through IWRM. Information on water supplies, sanitation and health – WASH data – can illustrate the state of sanitation in rural communities and urban settlements; watershed conditions incorporated in IWRM show critical water availability thresholds that need to be achieved to maintain safe WASH systems in communities.

Connecting these two key areas helps identify opportunities for resilience and adaptation in novel ways, and WASH Flows helps visualize these connections and how to interlink them.

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