DEVELOPMENT
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Water Supply and Sanitation in Provincial Towns in Yemen

Impact Evaluation Report

November 2011

Courant Research Centre

'Poverty, Equity and Growth in Developing and Transition Countries: Statistical Methods and Empirical Analysis'

Georg-August-Universität Göttingen
(founded in 1737)

Discussion Papers

No. 102

Impact Evaluation Report: Water Supply and Sanitation in Provincial Towns in Yemen

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Nov. 2011

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Acknowledgments

This study has benefited from the generous contributions of many individuals. We would like to thank the Ministry of Water and Environment (MoWE), Yemen, which asked KfW Entwicklungsbank, the German development bank, to commission this study. We would also like to thank the German Federal Ministry for Economic Cooperation and Development (BMZ) which together with MoWE made the financing from a special study and advisory fund possible. The study was a cooperation project between the Development Economic Research Group, University of Göttingen and the Independent Evaluation Department of KfW Entwicklungsbank. We would like to thank KfW for the continuous support, helpful comments and discussions throughout the data collection and analysis process. Especially we would like to mention the contributions of Ali Kassim and Bernd Schönewald from KfW Office Sana'a, as well as Gunhild Berg, Eva Terberger and Herbert Voigt from the Independent Evaluation Department. Furthermore, Mohammad Al-Saidi, PhD student of the University of Mannheim, provided insight on the institutional setup of the water sector and assisted the preparation of the data collection. In addition, we want to thank Ramona Rischke, Hanne Roggemann and Elke Schaffland for excellent research support. We are extremely grateful to the research team at SOUL, Sana'a, led by Afrah Abdulaziz. Despite a very demanding timeline and unexpectedly tense security situation the team was able to successfully implement the data collection. Without their combined efforts, the completion of the study would not have been possible.

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Preface

Improving livelihoods in partner countries via an upgrading of drinking water supply, sanitation or waste-water systems has been one of the focal sectors of German DC for several decades. With funds provided by the German Ministry of Economic Cooperation and Development (BMZ), KfW Entwicklungsbank is currently implementing 270 FC projects in the water sector of more than 60 partner countries. Ex-post evaluations of whether these projects have achieved their development objectives belong to the standard FC project cycle; for reasons of accountability and – no less importantly – to learn on how to improve results in the future. These standard ex-post evaluations rely on a rapid appraisal approach, which is usually sufficient to give an overall assessment of development results. However, it is not suited to answering more in-depth questions about the impact of interventions on livelihoods. In order to answer these questions, rigorous impact evaluations can be applied. That is only done in selected cases given the costs in terms of time, money and research skills - cases that seem worthwhile in terms of the applied project design or because the context promises valuable insights.

Yemen certainly is such a case, for several reasons. First of all, the water sector is hugely relevant to the country because Yemen is one of the most water-scarce countries in the world. Secondly, German DC has supported the improvement of drinking water supply there, mainly in urban settings, since the 1960s. And thirdly, a rigorous impact evaluation of drinking water supply in rural areas was recently carried out, to which such an urban study is an excellent complement. When exploring the possibilities of such a rigorous impact study during one of the standard ex post evaluations in the Yemeni water sector we found the necessary support to go ahead with it.

After more than two years, including field visits and a detailed data processing, as well as discussions of interim results and preliminary findings, the final report is now complete. It contributes to the most rigorous evidence on the impact of urban water and sanitation supply which is available. Even though it cannot answer all our questions as unambiguously as we had hoped for, it certainly is making an impact already: In Yemen, it feeds into the ongoing discussion about competing uses of scarce water; in DC more generally, it helps to improve the design of urban water supply in water-scarce contexts that are currently underway; and finally, it provides new impulses to the academic discussion about methods of rigorous impact evaluation.

The report was prepared by the research team of Prof. Stephan Klasen. Research design, field work, analysis, and report writing was coordinated by Tobias Lechtenfeld based on experience with previous impact evaluations in rural water supply. Johannes Rieckmann supported the preparations and led the implementation of the field work in Yemen despite a volatile security situation. Most of the analysis was implemented by Kristina Meier who also contributed to the questionnaire design and data entry tool.

This study deserves to be called a milestone in the evaluation of Development Cooperation (DC) as it is the first attempt in German bilateral DC and one of the first attempts worldwide to rigorously measure the impact of Financial Cooperation (FC) interventions in the *urban* water and sanitation sector. FC E is very grateful to all of those who contributed to making this experience of Yemeni-German “academic-political-practical” cooperation a success.

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AI	Asset Index
BMZ	German Federal Ministry of Economic Cooperation and Development
DAC	Development Assistance Committee
DC	Development Cooperation
EC	Electrical Conductivity
EPA	United States Environmental Protection Agency
E.coli	Escherichia coli
FC E	Independent Evaluation Unit of KfW Entwicklungsbank
FC	Financial Cooperation
GDP	Gross Domestic Product
IOB	Policy and Operations Evaluation Department of the Dutch Foreign Ministry
IV	Instrumental Variable
KfW	KfW Entwicklungsbank, German development bank
LPCD	Liters per Capita per Day
MoWE	Ministry of Water and Environment, Republic of Yemen
MPN	Most Probable Number
ml	Milliliter
PSM	Propensity Score Matching
TDS	Total Dissolved Solids
YER	Yemeni Rial

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Executive Summary

The water and sanitation sector of the Republic of Yemen has been an important focus of German bilateral development cooperation (DC), which is ongoing for over four decades now. This report presents the findings of an impact evaluation of investments to improve water supply and sanitation for urban households in the provincial towns of Amran and Zabid in Yemen. These infrastructure investments, supported by German bilateral DC, took place between 1990 and 2004 and were implemented via the German KfW Entwicklungsbank (development bank). The overall goal of these interventions was to provide clean drinking water as well as to improve sanitary conditions in the program towns. The ultimate aim was to improve the health situation of the population by providing access to safe drinking water and effective sanitation infrastructure. Additional objectives were to generate positive secondary effects related to income, education, and livelihood.

The Development Economics Research Group at the University of Göttingen, Germany, has been commissioned by the Independent Evaluation Department of KfW Entwicklungsbank (FC E) to conduct this evaluation on behalf of the Ministry of Water and Environment of the Republic of Yemen. With water supply being a current and future focus of German DC, it is important to improve existing knowledge on how effective interventions in this sector are, how effectiveness can be improved, and to identify successful strategies and approaches that can facilitate the process of improvement. The main aim of the impact evaluation is to identify causal links between inputs, outcomes and impact using advanced statistical evaluation techniques. It has the aim to improve the understanding of the effectiveness of such interventions and to contribute to the design, implementation, and monitoring of future programs. The evaluation is based on a large household survey conducted in treatment and control towns, combined with water quality test results, baseline data, and additional secondary data sources from school and health facilities. The report conclusions on health impacts are exclusively drawn from survey data collected during household interviews. The possible limitations of the employed statistical approaches are discussed and addressed in the section on methods. Data from health facilities is only used for illustrative purposes.

The use of statistical impact evaluation methods allows conclusions about causality of the project impact. Most methods rely on cross-sectional data collected after project completion in towns with and without project activities. It is exactly the advantage of using such rigorous methods that allows making robust statements about causal effects that makes the use of such statistical methods useful.

It should be noted, however, that the evaluation and sampling design was not intended to study the impact and effectiveness of hygiene training supported by the German technical cooperation (TC). Second, using this micro data approach, it is not possible to evaluate the impact of TC activities on improving governance in the water and sanitation sector.

The main robust findings of the impact assessment regarding the development impacts included are as follows:

1) **Clean Water Supply**: the project was able to generate moderate to high levels of target achievement in terms of the provision of water and sanitation infrastructure in the two towns. However water scarcity and reliability problems in Amran leads more than 25% of households to continue to rely on water vendors as the main source of drinking water. In addition, substantial and lengthy water storage at the household level (mostly in roof tanks) is required to ensure continuous water supply. In Zabid water supply is reliable and no recourse to vendors is necessary, although about half of households continue to store water at the household level.

2) **Water quantity and costs:** the best estimate of water quantity consumed is around 19-26 liters per capita per day and not distinctly different from that of those with access to piped water. This is just about the lower bound for adequate water access, set at 20 liters per person per day

(WHO, 2008). For those with sanitation access, this appears too little for safe operation of flush toilets. Although the official price for piped water is significantly below the price charged by water vendors, the majority of connected households report higher costs for water use.

3) **Water quality:** while water quality of those connected to piped water is somewhat better than in the control towns, an alarmingly high share of connected households (20-50% in the case of pollution with e.coli, and 5-85% in the case of pollution with total dissolved solids, TDS) experience contamination above acceptable levels at the point of water consumption. The presence of sanitation access can have different effects on water quality, and the results show that under certain conditions sanitation contributes to deteriorating water quality. In contrast, subjective assessments of water quality are more positive.

4) **Pollution along the supply chain:** the study carefully investigates where along the supply chain (from the well used by the water corporation to the cup from which the water is drunk) the pollution is stemming from. While some of the evidence is circumstantial and further research is required to corroborate the findings, the report provides considerable evidence that five factors contribute to the observed pollution. First, after leaving the water works in clean condition, evidence is found in Zabid that water is already contaminated in some of the main feeder pipes. Second, evidence suggests that secondary feeder pipes are sometimes defect allowing contamination to occur. Third, evidence indicates that the mixing of water sources, necessitated by water supply unreliability, contributes to pollution. Fourth, it shows that storage in tanks that are not regularly cleaned or disinfected promotes pollution. Finally, water handling at the household level increases pollution levels between the storage container and the drinking cup.

5) **Water handling:** generally, only a minority of households purifies the water at the point of use, hardly anyone of the representatively surveyed

households participated in hygiene training, and water handling practices at the household level (esp. regarding the use of soap and treatment of water before drinking) are generally quite poor.

6) **Health impacts:** more households connected to water and sanitation subjectively report that disease incidence improved after water and sanitation access was provided than reported a deterioration in disease incidence; the majority reported no change. When examining actual reported disease incidence and comparing them - using statistical matching techniques, regression analyses, comparisons with the baseline, or comparisons with secondary health data - a different trend emerges rather robustly: In Amran, all of these indicators point to a statistically significant deterioration in disease incidence as a result of the water connection. The study suggests that reliable water supply and water quality issues are at the heart of these findings. Additional connection to sanitation has no further effect on health status, again probably related to low and unreliable water access in Amran. In Zabid, there is overall little robust evidence of a positive or negative effect of water connections on health, while there is some evidence of improvements in health conditions due to the additional access to sanitation services. At the same time, the study is unable to establish a clear link between the pollution levels in the water and the health impacts which can be due to a range of data issues; this requires further investigation.

7) **Other impacts:** the study finds little impact on school attendance in secondary data on schooling attainments. A minority of households report time savings which frees up both males and females from the burden of securing water access.

Based on these findings, the following policy conclusions are suggested:

1) Investments in providing piped access to water in regions affected by water scarcity should be prepared and considered with high caution when future availability and reliability of water supply is unstable or

unpredictable. A careful assessment of water rights, water availability, analysis of competing water uses (esp. for agriculture), and the installation of a water allocation system (e.g. via water permits, water charges, tradable water rights, etc.) that ensures sufficient availability and reliability of water supply to households should come before investments to extend a network.

2) Providing access to piped wastewater disposal (“sanitation access”) without reliable water access does not appear to have many beneficial health effects, since sufficient water access is required to operate the wastewater system effectively.

3) Extensive networks of piped water require high standards of maintenance and regular water quality testing to ensure that no pollution enters the network. Alternative solutions to extensive networks should be rigorously tested. Such alternatives might include programs for household level water treatment or smaller networks with standpipes. In smaller towns under water stress conditions drinking water supply via tanker trucks could be tested as a possible alternative to complement existing schemes.

4) Storage of water at the household level is a source of contamination. It is also an opportunity to purify the water. Thus if water storage at the household level is required or practiced, assisting households with purification at the household level (e.g. using chlorine tablets, filters, etc.) should be a priority intervention.

5) Effective training to improve water handling at the household level is critical to improve actual sanitary and hygiene conditions in households. Without such improvements, investments in extending water and sanitation services are unlikely to yield significant positive impacts.

6) To design programs for improved water storage and water handling at the household level, policy experiments (using ex ante randomized

designs) would be particularly useful to study the effects of different approaches to this difficult issue in different contexts.

7) When designing future interventions, ex-ante household-level analyses of water, sanitation and health needs should be designed to facilitate reliable and cost-effective ex-post impact evaluations.

Chapter 1: Background of the Evaluation and Project Context

1.1 Project Background and Context

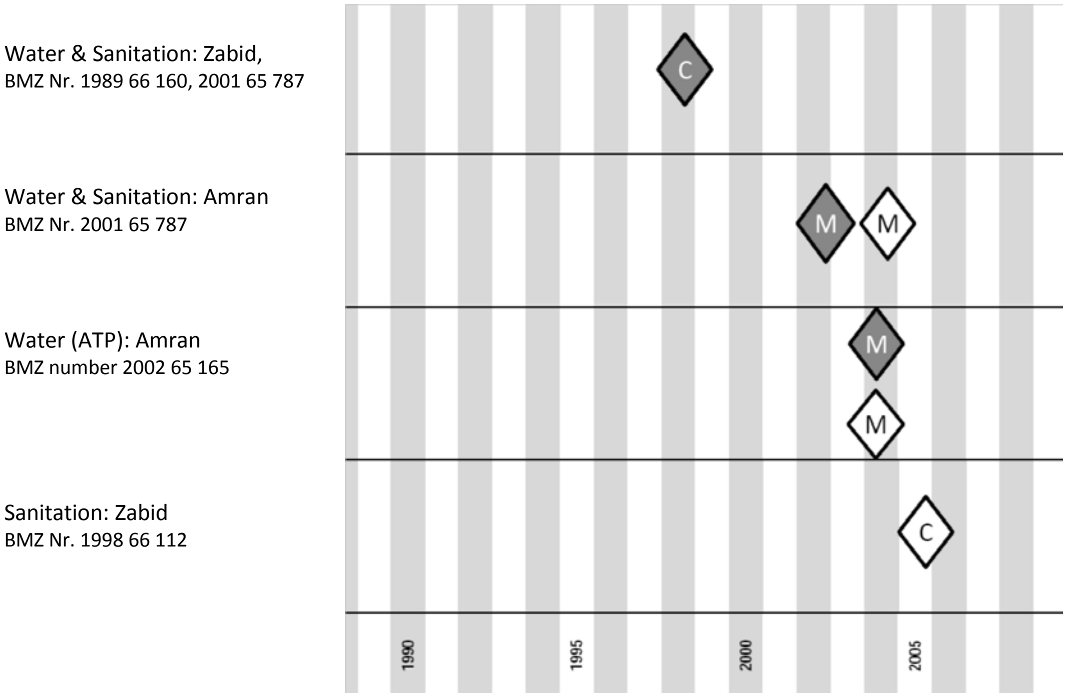
The water and sanitation sector of the Republic of Yemen has been an important focus of German bilateral development cooperation (DC), which is ongoing for over four decades now. The Republic of Yemen, ranking 134th in the world in terms of GDP per capita, is not only among the poorest countries in the world, but also suffers from severe water scarcity.[1] Estimates of total renewable water resources per inhabitant are between 100 m^3 and 150 m^3 per year, which makes interventions in the water and sanitation sector both necessary and challenging.[2] Access to clean drinking water in urban areas faces two main constraints, one being the tight resource situation – especially regarding ground water availability. The other is urban population growth, exacerbated by rural-urban migration. Thus providing safe water supply and sanitation services to a rising population under these conditions of scarcity is the central challenge for development policy to improve the urban water and sanitation situation.

This report presents the results of an impact evaluation of water and sanitation projects in the provincial towns of Amran and Zabid. These towns, alongside with the cities of Bajil, Bait al Faqih, Al Mansuriyya, Al Mukha, Yarim and Hajja, received rehabilitation and investments in the water and/or sanitation systems in the course of various BMZ projects, implemented through KfW Entwicklungsbank, the German development bank. The initial intervention was implemented as the Provincial Towns Program (PTP I) named "Water Supply and Sanitation in Provincial Towns" (BMZ number 1989 66 160 / 2001 65 787, Zabid, Amran), "Sanitation Zabid" (BMZ number 1998 66 112), "Sanitation Amran" (BMZ number 2001 65 787), and the labor-intensive infrastructural measures conducted in the context of supporting the local population in countering terrorism incentives (abbreviated ATP, BMZ number 2002 65 165, Amran). These

[1] The reference year is 2009, GDP per capita is measured in PPP USD. The total number of countries is 182 (UNDP, 2009).
[2] Estimation from 2005. (UN FAO 2008); 120 to 150 m^3 per person per year estimated in KfW Ex-Post Evaluation Report (KfW, 2008).

projects covered the rehabilitation, construction and extension of drinking water supply systems ("water") as well as the connection of households to piped sewerage systems ("sanitation"). A time flow chart displaying the intervention history can be seen below (Figure 1). Dark rhombi stand for water supply, white ones indicate sanitation. Letters C (Coast, Zabid) and M (Mountain, Amran) identify the region the treatment town is located in. The rhombi mark the approximate time the infrastructure became operational.

Figure 1: Intervention History in Water Supply and Sanitation



Note: Project phases not displayed here include planning, preparation and construction. The symbols stand for approximate uptake of operations. Source: KfW 2005, 2008, 2009.

Geographically the studied interventions cover two regions with very distinct ground water situations. Amran is located in an arid mountain region with cold winters, while Zabid is found in the coastal plain of the Red Sea, characterized by high temperatures and humidity. Ground water tables are low and decrease dramatically in the mountains around Amran due to unsustainably high extraction rates, although precipitation is higher than in the coastal plain. There are two main reasons for the large water extractions in Amran, including heavy industry (in particular a large cement factory constructed after project completion) and irrigation of local agriculture. To a smaller degree, migration driven population growth adds to the demand for drinking water supply (see also Annex 1).

The overall goal of these interventions was to provide clean drinking water and to improve sanitary conditions in the program towns.[3] The ultimate aim was to improve the health situation of the population through these interventions. Additional goals were to generate positive indirect effects related to income, education, and livelihood aspects.

The Independent Evaluation Department of KfW Entwicklungsbank (development bank), Germany, conducted a “rapid appraisal” ex-post evaluation in 2008.[4] The report finds that in the coastal town Zabid the degree of target achievements in terms of coverage, quality and reliability is “high” for water supply and “low to intermediate” for sanitation (about 4,200 households connected to pipe water supply in 2009; and 3820 connected to improved sewerage, see KfW 2009). In the mountain town Amran, the degree of target achievement is “intermediate” for water supply – amongst other factors due to the scarce resource situation – and “low to intermediate” for sanitation (2,700 households connected to pipe water supply in 2005, 1,730 to improved sewerage, see KfW 2005). Concerning the project impact, KfW finds based on information from local health authorities and health facilities that the general health situation – especially regarding bilharzias, typhus, and cholera – improved as the investments into the water supply and sanitation systems were made. However, no statements about causal relationships could be made and health effects were not quantified. The 2008 KfW evaluation report mentions that water cost reduced as a result of the intervention for households that were previously entirely depending on water trucks. Sanitation conditions (hygiene changes resulting from availability of piped sewerage systems) are reported to

[3] WHO and UNICEF in their “Joint Monitoring Programme” recommend a quantity of at least 20 liters per person per day (WHO, 2008), while the short-term minimum “survival” allocation is regarded to be seven liters per person per day, three to four of which for drinking (WHO 2005). Note that actual minimum need is likely to be higher in arid conditions as found in Yemen.

[4] Ex-Post Evaluierungsbericht (Schlussprüfungsbericht): Jemen – Wasserver- und Abwasserentsorgung in Provinzstädten.

have improved, with a positive impact on the ability of the towns to absorb the ongoing migration. Assumptions were made regarding a gender effect contributing to equalizing opportunities for women and men, especially through the reduction of household chores of women, including reduced care obligations for the sick (assuming that better drinking water quality leads to a reduction of water-borne disease incidence).

1.2 Reasons for and Purpose of the Rigorous Impact Evaluation

With water supply being a current and future focus of German development cooperation (DC), it is important to improve existing knowledge on how effective interventions in this sector are, how effectiveness can be improved, and to identify successful strategies and approaches that can facilitate the process of improvement. Previous evaluations of Financial Cooperation, carried out by KfW's Independent Evaluation Department (FC E), typically apply a "rapid appraisal" case study approach, based on a mix of qualitative and quantitative information, leading to an expert judgment regarding development success of a project or program according to the Development Assistance Committee (DAC) criteria of relevance, effectiveness, efficiency, impact and sustainability. However, causal links between inputs, outcomes and impact cannot be assessed with sufficient rigor. The evaluation methods typically applied are based on before-after comparisons and qualitative assessments. In-depth impact assessments which go further are useful to gain better insight into the causal links between inputs, outcomes and impact. They can help to provide an understanding of the causal chain that could feed into the design, implementation, and monitoring of future programs.

At the micro level, a relatively new development in evaluation methods is the employment of statistical techniques for the evaluation of effectiveness and impact of development projects and programs. These methods are applied in this study in order to determine to what extent project goals were achieved and through which channels. These methods are somewhat limited in the scope of questions they can address. Consequently, this study is not intended to draw conclusions on the impact or effectiveness of hygiene training activities in the project area as it would normally require a randomized design or at least a much larger sampling frame specifically designed to include treatment and control groups for these interventions. In addition, no direct robust conclusions can be drawn on the effect of the institutional quality since only two water utilities operate in the study areas.

In contrast to previous evaluations following the DAC principles and relying on expert judgments, such a rigorous quantitative impact analysis tries to quantify the impact by comparing the livelihood of the intervention's target group to a counterfactual situation without the intervention. The most important advantage of such an impact assessment is the explicit comparison of outcomes and impacts between a project town and a suitable control town that was not targeted by the project in order to identify *net intervention effects* separately from other factors which might influence the living conditions. The rigorous evaluation approach follows best practice in impact evaluations as they have been pioneered in recent years by the World Bank and other bilateral donors, notably the Netherlands Ministry of Foreign Affairs (MinBuza) through its evaluation unit IOB, in recent impact evaluations in rural areas of Tanzania, Yemen and Zambia.

Given the relevance and complementarities of the IOB study on Dutch-financed projects to extend water and sanitation services in rural Yemen, it is worth summarizing some of their key results for comparison. The IOB study evaluated extending water and sanitation supply in rural Yemen (IOB, 2007), which included providing piped drinking water to household compounds and some exemplary latrine building. While water connection rates are high, few households improved their latrines. Unexpectedly, the water analysis finds signs of E-coli pollution in more than half of the village wells, as well as excessive fluoride and calcium levels in more than 80 percent of these wells, the latter posing serious long-term health threats for children. Water pollution was found to deteriorate significantly when water is stored at household level. On average, connected households are slightly more aware of sound sanitation and hygiene practices, despite not recalling any hygiene training. Time savings from piped water supply are found in these rural areas, with boys benefitting most from the reallocation of household chores. However, there is some indication that school attendance improves in connected villages, including for girls when girl-schools are within proximity. While mid-term sustainability of the piped water projects was better than expected with close to 90 percent of all schemes still being operational more than 10 years after inauguration, most of these village schemes showed substantial need for investment which the households were not prepared to contribute to, endangering the long-term sustainability of their improved water supply. Excessive agricultural use of ground water is a second key factor causing erratic water supply and putting long term water availability in many communities at risk. Besides the necessary repairs of pipes and pumps, the study points to an urgent need to rehabilitate the water quality in the source wells and to improve hygiene awareness in order to reduce water pollution at household level.

Analytically speaking, the key idea of such evaluations is to identify the impact of treatment for the average household compared to a situation without the treatment. In the water sector "treatment" or "project participation" means that a household was connected to piped water supply. Analogously, for the sanitation sector "treatment" refers to the connection to a piped sewerage system. The evaluation question asked is: How would the individuals have fared had they not received the treatment?

Box 1: Control Group Design

Since it is impossible to observe an individual in both, the treated and the untreated state at the same time, a so-called *control group* is used for the comparison. The members of this control group are individuals who did not receive treatment, but who otherwise resemble the treated as closely as possible (with regard to key socio-economic indicators such as income, education, living area, etc.); and who are subject to the same external influences (e.g. geographic characteristics, awareness campaigns and other development projects, etc.). The advantage of this approach is that observed changes in indicator levels can be attributed to the program rather than to other external influences. This cannot be done using simple before-after comparisons.

To make this point clear consider the following example. The Yemeni town of Amran was supplied with water and sanitation systems. Independently, various organizations implemented awareness campaigns regarding personal hygiene, communicable diseases, and promoting safe water handling techniques, such as boiling and filtering water before use. If the international donor now wants to determine the impact of the intervention on the health situation of the target group, a simple comparison of water-related disease incidence in the town before and after the completion of the water and sanitation systems will most likely be biased (here: upwards) due to the fact that the awareness campaign is likely to contribute to a better state of health as well. Using this approach makes it impossible to isolate the effect of the campaigns from the effect of the donor's intervention. The solution to this problem is to find an adequate control town. This could be a second town which is similar to the project town (including in receiving the awareness campaigns) but did not receive water and sanitation systems. For Amran, the nearby town of Raydah was chosen as control town, since it is located in the same valley on the same aquifer as Amran and shares many of the water problems of Amran. It is scheduled to receive an improved water and sanitation system but residents had to rely on traditional sources during the study period.[5] Comparing water-related disease incidences of those two towns will yield the desired estimate of program impact. Besides external control towns, an in-town control group was chosen in Amran, consisting of households without access to pipe water supply.[6] An overview can be found below.

[5] It has to be noted that there might be campaigns conducted in the past both in treatment and control towns the authors have no knowledge about.

[6] This was not done in Zabid, as pipe water supply covers virtually the entire town, and the very few households in the sample found not to be connected had to be excluded from analysis due to their socio-economic characteristics differing widely from those of the treatment group.

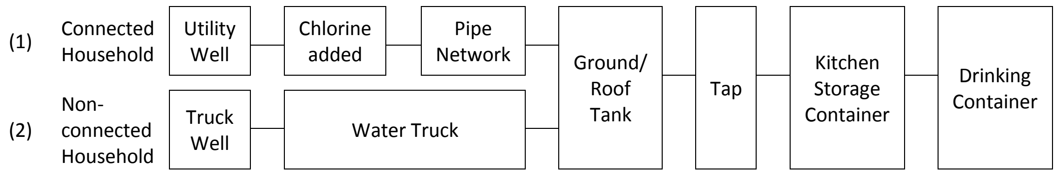
Location	Treatment Town	In-town Control Group	Control Town
Mountain	Amran	Yes	Raydah
Coastal	Zabid	No	Al-Jarrahi

Of course, the situation of the members of the control group cannot be more than a proxy for what the state of the treated would have been had they not received treatment. The gold standard to determine project impact would be to start with a baseline survey of comparable places that are potentially targeted for an intervention, then to randomly assign treatment to some of the places surveyed and finally to monitor impact by comparing the randomly assigned treatment and control locations. This was not possible in this context as such randomization would have to occur *ex ante*. The difference between the observed state of the comparison group and the unobservable situation of the treatment group, had they not received treatment, is referred to as bias. To keep this bias as low as possible by choosing an appropriate control group for the analysis, and controlling for as many potential differences between them and the treatment town, is a vital part of the impact evaluation and will be outlined in Chapter 2. A number of existing statistical methods to address bias are explained in more detail in Annex 2.

1.3 The Water Supply Chain for Connected and Unconnected Households

To provide an intuitive understanding of the water supply chain, Figure 2 outlines a schematic presentation of the water supply chain for the two predominant scenarios typical for urban Yemen. These include (1) improved water supply via a piped network, and (2) the traditional supply through water vendors who typically serve the urban population using tanker trucks.

Figure 2: Water Supply Chain



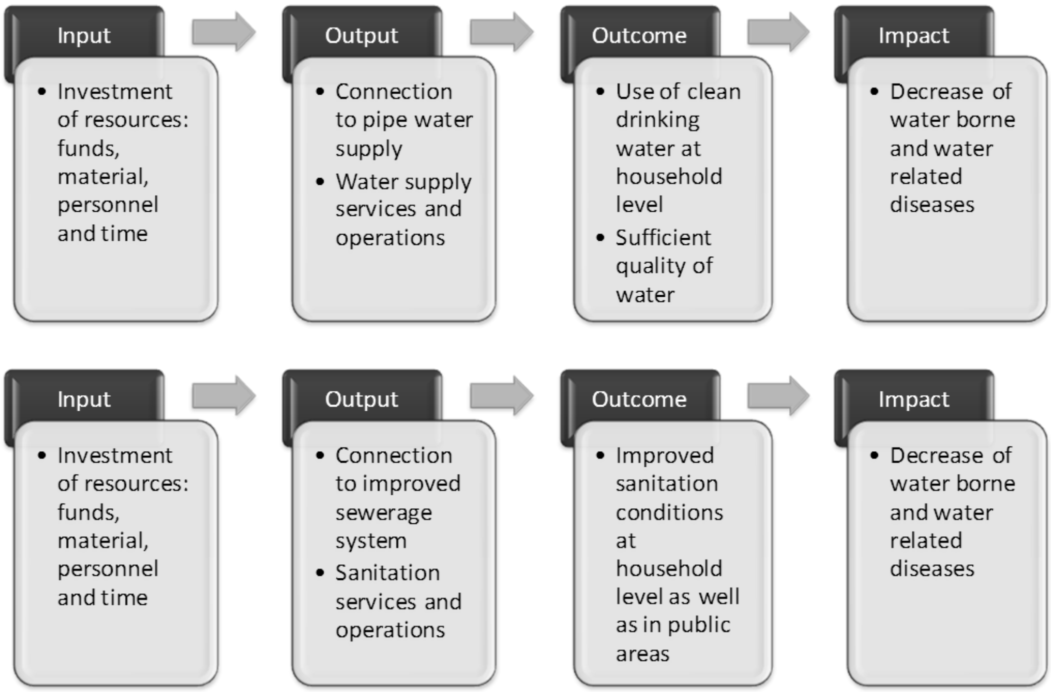
Note: Not all points in these water supply chains exist for all households for technical and other reasons.

Since water supply through water vendors requires storage of water at the household level, most families maintain a water storage tank in their compound or on the roof. These roof and ground tanks can contain water from the piped network and trucks, especially when piped water supply is irregular as in the mountainous area. This causes problems in identifying possible sources of pollution, which will be discussed further below. In Zabid, piped water supply was reportedly very regular. However, anecdotal evidence suggests that water supply has become more irregular and prone to rationing recently, as was reported during the water quality testing phase. Thus a large storage container is less necessary and also less common than in Amran. As discussed below, some 50% of households nevertheless have a large storage container, either a roof tank or a much smaller plastic jar (storing about 100 liters); some of these tanks date back to the time prior to water connections, and some (particularly the smaller plastic ones) appear to have been purchased to deal with occasional irregularities.

1.4 Impact Evaluation Questions

The study evaluates the impact of the Yemen-German development cooperation with respect to water supply and sanitation interventions in the two provincial towns of Amran and Zabid. The statistical part for the study draws upon existing secondary data including records from health facilities and schools, as well as data from a large household survey conducted specifically for this purpose. The household data was collected in the mountains (Amran and Raydah) during the hot and dry summer months and in the coastal plain (Zabid and Al-Jarrahi) during the mild and dry winter months in 2009. The main goal of the evaluation is to quantify the influence of project inputs - i.e. house connections to improved water supply and sanitation systems serviced by water utility providers - on selected impact indicator categories and levels, including health, education, income and livelihood of the beneficiary households. An exemplary selection of potential transmission channels from input to impact is depicted in Figure 3.

Figure 3: Potential Transmission Channels



Note: Spill-over effects are not shown. These might include a reduction of missed work and school days due to the decreased incidence of water related diseases.

Evaluating the impact of a project requires a theoretical model to outline the possible causal effects the project might have on particular outcomes and impact. These causal chains can then be tested empirically using the various data sources. The following hypotheses regarding impact are investigated:[7]

[7] In order to investigate these impacts, several outcomes that could lead to these impacts are considered.

Health Impact

Following the project proposal, a decrease in water borne diseases can be expected among households connected to improved drinking water systems. The same can be expected of households connected to a piped sewerage system and households who participate in hygiene training.

Hypothesis 1: ***The incidence of water-related diseases has decreased.***

Educational Impact

In addition, school performance may have improved due to less illness related absenteeism of students.[8]

Hypothesis 2: ***School performance has improved due to increased attendance.***

Livelihood Impact

Using livelihood as a collective term for welfare improvements on the household level, a series of effects are plausible. For example, cost-saving might occur when water supply becomes cheaper due to the connection, compared to alternative sources, such as water trucks. Second, a reduction in water related diseases might alleviate households of medical cost. Also, a reduced disease incidence should increase time available for productive use and thus is expected to have a positive effect on income generated by the household.

Hypothesis 3: ***Livelihood indicators, including available income, time, and wealth have improved for connected households.***

Gender Impact

In Yemen, where household chores are traditionally the responsibility of women and girls, time gains can be expected for female household members, concerning activities related to water and sanitation.

Hypothesis 4: ***Women and girls from connected households benefit from time gains.***

[8] Enrolment effects are not expected in an urban setting, since relatively little time was spent on fetching water prior to the project.

Chapter 2: Data Collection

The study focuses on two project towns which were purposefully selected based on several criteria that are crucial for this sort of evaluation of urban infrastructure projects.

2.1 Selection of Project Towns

a. Town size suitable for sample survey

Given the reliance on household survey data towns for evaluation very small towns were excluded to allow a sample size that would be meaningful for analysis and allow controlling for unobservable neighborhood effects.

b. In-Town control group available (water / sanitation)

Given the large amount of factors that might possibly affect the impact of water and sanitation a preference was given to towns with partial connections rated in order to have a sizable control group within each town that had no access to improved water and/or sanitation. In Amran, a sizable share of households is not connected to the water and sanitation networks. In Zabid many households are not connected to piped sanitation.

c. Representative for mountains and coastal setting

To allow some extrapolation of results to similar settings a preference was given to towns located in regions populated by the majority of the Yemeni population. In this regard, Amran and Zabid are located in regions where nearly 80% of the urban population lives.

d. Control town available in same aquifer

A methodological innovation of this urban evaluation is the use of control towns. To ensure comparability, preference was given to project towns close to other urban settlements which did not have any project activities. These control towns are important to draw conclusions about the alternative water sources available without piped networks. To allow meaningful comparisons, control towns were needed with similar ground water conditions, ideally located in the same aquifer or near the river bed. The controls towns Raydah (downstream from Amran) and Al Jarrahi (upstream from Zabid) fulfill these conditions.

e. Baseline data availability

The final advantage of Amran and Zabid over the other 6 project towns is the availability of household-level baseline data from the feasibility study commissioned by KfW during the planning process which could be retrieved. The baseline data allows the use of statistical methods that exploit changes over time and are intended to strengthen the robustness of the overall results. The questions from the baseline data were replicated in the endline survey to allow comparability. Although it was not possible to interview the households that participated in the baseline survey, information on the city neighborhood is available in the baseline data that facilitates the comparison. In future projects, baseline surveys should be designed to allow interviews with the same households after project completion, since such panel data can substantially improve the reliability of the results.

f. Effects of piped sanitation

In addition to the above mentioned hard selection criteria, the selected towns were particularly interesting for investigation since stakeholder interviews indicate that the sanitary conditions had been detrimental before the completion of the piped sanitation scheme. Traditional sewer systems (cesspits) were not able to handle the increased amounts of waste water and began overflowing. It was therefore suspected that health effects from sanitation should be readily detectable.

2.2 Household Survey

Data was collected in several ways. The most comprehensive part is based on a questionnaire-based household survey. It was conducted in all four survey towns in 2009, covering 2520 randomly selected households. These data were supplemented by secondary data from health and education institutions in the survey towns. Additionally, physical, chemical, and microbiological water tests were conducted at ground wells, water pipes, tanker trucks and donkey carts of water vendors, as well as at several points at the household level. Well owners, tanker truck drivers and members of 500 households were interviewed, using tailor-made questionnaires.

To acquire comprehensive data at the household level suited for an econometric impact evaluation with emphasis on health, income, education and livelihood, a household survey was conducted in both treatment towns as well as their respective control towns. This survey is based on a questionnaire developed by the Development Economics Research Group at the University of Göttingen, Germany. It includes lessons learned from a similar impact evaluation conducted earlier by IOB in rural Yemen. The survey was successfully implemented by the local research and development organization SOUL, whose team was in charge of training, supervision, data collection and data entry. The instrument contains modules covering the demographic composition of the household, water supply and water handling, time use, sanitation, health, education, livelihood, mortality, consumption, assets and housing. The full questionnaire is available in Annex 7.

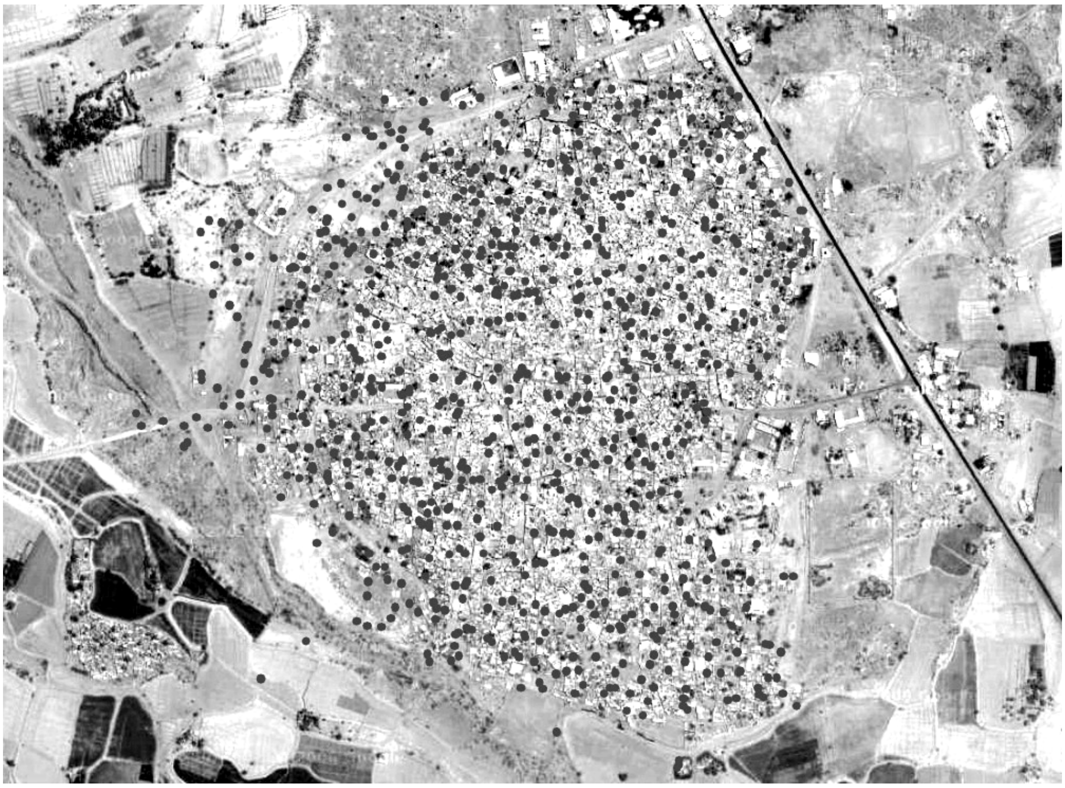
The questionnaire underwent several dry runs and rehearsals in a training environment before being tested under field conditions in two pilots and different environments (suburban and low-income households). This served two purposes effectively: the interviewer teams, supervisors and additional personnel involved familiarized themselves with the questions and possible difficulties, and were thus enabled to accumulate experience in implementing the survey effectively. Furthermore, the remaining flaws which inevitably find their way into draft questionnaires were identified and taken care of.

The sampling followed a two-stage clustered approach, combined with a stepwise random selection of households.[9] The sampling frame uses remote aerial mapping techniques, where the sample is drawn based on the roof tops of buildings in each town. While this method is very efficient it led to a number of

[9] Two-stage clustering implies that from each pre-defined cluster a random sub-sample is drawn. Since sampling was done with different intensity in the treatment and control clusters two steps were needed. Stepwise random selection means that after choosing a random starting point, every x^{th} house is chosen for interviews.

replacements of non-residential buildings during the field work, including business and administrative buildings, schools and religious facilities. Replacement procedures were therefore defined before starting field work. Figure 4 illustrates the spatial allocation of survey households for Zabid.

Figure 4: Household Sample in Zabid



Sample density is very high, covering up to 20% of the available buildings. This allows representative interpretation of the data even for rare subgroups while ensuring a narrow confidence band of the results.

The household survey was conducted in two phases. Following a thorough training covering procedures and the use of survey tools (e.g. GPS receivers), the first phase was conducted in August and September 2009 in the mountainous region of Yemen, both in Amran and Raydah. The deteriorating security situation led to travelling restrictions for Yemeni and German personnel involved. Data availability of secondary data caused significant delay, while these data were initially needed to support sampling and stratification and thus constituted a bottleneck. While it would have been preferred regarding cost and project duration to run the entire survey without interruption, this was not possible due to two holiday seasons (*Ramadan* and *Eid al Fitr)*. Although interviewer personnel were available even during the first week of Ramadan, this was not the case thereafter. More importantly, consumption and income patterns differ largely during the holiday seasons. To avoid that recall periods would cover these exceptional periods in order to preserve comparability of survey data between the four towns and for reasons of availability of staff and accessibility of households, the two remaining towns – Zabid and Al-Jarrahi – were surveyed four weeks after the holiday season was over. Consumption and income patterns have normalized by then. The second phase of the household survey was conducted in December and concluded by the end of the year 2009.

2.3 Secondary Health and Education Data

Data collected from health facilities and schools is used to verify the main results of the impact analysis with non-survey data. It is not used to directly draw conclusions about the impact. Data was collected from schools and health facilities in the four towns covered by this study. Data includes information about school attendance, educational attainment, as well as disease incidence rates over the past ten years. Education data was largely available and of reasonable quality. The data situation was less positive at health facilities. Some of the institutions appear to keep no disaggregate data. Others provided data with large gaps in the time line. Additionally, diseases were pooled to different aggregates. Therefore, data provided by health facilities are only of limited informational use for the main analysis.

In addition, few health facilities record the residential address of patients, which might confound causal identification. Rural patients often visit urban health facilities, while the urban population might be more inclined to choose hospital services in even larger towns. Households located in Amran, for instance, sometimes prefer to hospitalize family members in the capital Sana'a. Such cases can potentially bias the results when using secondary data sources. Data from education and health facilities were collected through standardized questionnaires Annex 8 and Annex 9.

Health Data

Secondary data were collected in health and education facilities in mountainous Yemen and the coastal plain, both in treatment and control towns. This was done in order to obtain further information regarding incidence of illnesses (to supplement the self-reported information about symptom incidence from the main household survey) as well as information about school attainment (to be compared with the findings from questions 6.14 and 6.15 from the main household survey, asking for subjective assessments of the influence of connection to pipe water supply and sanitation on school attainment).[10] Data collection teams from the local partner institute visited the health and education institutions to check availability of the data, and to copy the data records.

The health questionnaire focuses on seven water-related illnesses and groups of illnesses, including (1) bilharzias (intestinal and urinary) and schistosomiasis, (2) amoebic dysentery and giardia, (3) diarrhea, (4) hepatitis A, (5) typhoid, (6) malaria and (7) intestinal worms (including flukes, hookworm, pinworm, roundworm, tapeworms, whipworm, and others). It asks for incidence rates per month per age group per illness, in a time window from 1998 to 2009. The data filled into the questionnaires stem from health facility records from all four towns.

Education Data

The education questionnaire asks for the absolute number of both boys and girls passing respectively failing graduation to the next school year, per year for a time window from 1998 to 2009, and taking into consideration pupils from first to fifth grade included. The data filled into the questionnaires stem from school records from all four towns.

[10] Information about school enrolment was asked during the main household survey (See Table 2: Socioeconomic Comparisons of Treatment and Control).

2.4 Secondary Census and Survey Data

Secondary data was collected from two sources. First, the Central Statistical Organization (CSO), the Social Fund for Development (SFD) and several ministries provided access to nationally representative datasets, including a recent Household Budget Survey, parts of the last Census, and some maps for sampling purposes. These data served to support the choice of the control towns, and partially for sampling and stratification.

2.5 Water Quality Testing

In order to gain objective information on water quality – on top of the subjective assessments of households regarding color, smell and taste of their drinking water – water quality tests were conducted in March 2010 for a random subsample of 500 households. The subsample was drawn in a way to ensure spatial representativeness, covering all parts of town in the constant relative density of the household survey. Results from the water testing can hence be directly scaled up to the household sample. In all four towns water samples were taken at wells, from water tanker trucks and in households (from the ground[11] or roof tank, tap, kitchen container and drinking cup). In the treatment towns, samples were also taken at the water works (Local Corporations, LCs) and selected feed pipe test points. Physical (electrical conductivity, total solids dissolved, and pH value), chemical (hardness, calcium, chloride, total iron, fluoride, nitrate, sulphate), and biological (E.coli) tests were conducted at various links of the test chain. For the complete test chain, please consult Annex 10.

The water tests were conducted by a water quality expert from Yemen with previous experience from similar donor studies. Alongside the water tests, some additional questions were asked to respondents. Short questionnaires addressing the four different types of respondents (the water utilities, well owners, tanker truck drivers and household heads) were used to record answers, observations and test results (see **Annex** 11). This allowed addressing some questions arising

[11] Ground tanks are modern steel tanks situated in the compound of the household and typically hold two to six cubic meters.

from preliminary descriptive results, notably about water supply sources, supply volumes, and water prices.

Chapter 3: Descriptive Survey Results

This section gives an overview of the most important descriptive results of the household survey and provides an overview of the project outcomes and impacts. The survey was conducted in four towns, located in two separate governorates which are very distinct in terms of geography, hydrology and climate. The term *mountain area* refers to the project town Amran and its control town Raydah, while *coastal area* refers to the project town Zabid and its control town Al-Jarrahi.

3.1 Socio-demographic Characteristics of the Household Sample

The distribution of households with and without connections to water and sanitation among the four survey towns is shown in Table 1 (analysis sample).[12] In the coastal town Zabid all randomly sampled households are connected to piped water. In addition, the large majority of these households is also connected to sanitation (N=714). This is in stark contrast to the mountainous town of Amran, where the largest portion of sampled households is neither connected to water nor to sanitation (N=374). Some 270 households of the sample are connected to both services in the mountainous region, while the remainder (N=201) is connected to piped water only.

Table 1: Survey Population and Sample Size

		HHs	*Population*
Amran	Water	201	1777
	Water & Sanitation	270	2257
	None	374	2977
	Control Town	298	2508
Zabid	Water	127	859
	Water & Sanitation	714	4746
	Control Town	434	3101
Total		**2418**	**18225**

[12] The analysis sample shown in Table 1 was reduced by observations displaying implausible characteristics in the data. For the composition of the complete survey sample see Table 26 in the Appendix.

The different connection rates between the regions point to water scarcity problem limiting project implementation in the mountainous region, as it is also detailed in the KfW evaluation report of the project. Note that in contrast to Amran there is no in-town control group in Zabid, since all households are connected to the water network in Zabid.

Table 2 provides some key socio- economic characteristics of the sample population. Apparent differences exist between the treatment and control groups, both, for the in-town control group and for the out-of-town control groups. Most notably, education of the household head tends to be lower in the control towns. This cannot be attributed to possible treatment effects since the formal education of household heads has been mostly completed before the intervention started, and therefore constitutes a true systematic difference between treatment and control groups, which needs to be accounted for in the impact analysis. Also, school enrolment of children tends to be lower in the control groups. Here it can be argued that some of this difference might already be due to treatment benefits, implying a possible endogenous project effect. However, higher education among children in connected areas could also be due to reverse causality, since households with more educated family members might move to areas with piped water supply, rather than children having more time available to attend school because of cleaner water and lower disease prevalence.

For Zabid, households in the control town appear to be somewhat larger than in the treatment town. Income per capita is noticeably higher for the treatment group benefitting from sanitation than for both water-only and control town.

Table 2: Socioeconomic Comparisons of Treatment and Control

Indicator		HH Size	Children (<16 yrs)	Elderly (>64 yrs)	Dependency Ratio	Age Head	Headship	Yrs of Edu Head	School Enroll-ment Children	Income per capita per day	HHs
Unit		*Persons*	*Persons*	*Persons*	*Ratio*	*Yrs*	*% Male*	*Yrs*	*Percent of children*	*USD*	*N*
Mountain	Water	8.84	4.03	0.33	1.28	44.78	95.02	6.74	59.86	2.19	201
	Water Sanit	8.36	3.53	0.23	1.08	45.86	94.44	6.13	55.10	2.09	270
	None	7.96	3.87	0.20	1.33	41.74	95.99	6.12	60.09	2.11	374
	Control	8.42	3.96	0.16	1.27	44.03	92.28	5.36	47.92	1.94	298
Coastal	Water	6.76	2.81	0.19	1.03	45.74	85.83	5.76	78.77	1.91	127
	Water Sanit	6.65	2.36	0.24	0.88	46.17	88.80	7.85	85.82	2.55	714
	Control	7.15	3.19	0.26	1.24	45.74	91.47	4.64	72.00	1.87	434
Total		**7.54**	**3.23**	**0.23**	**1.12**	**44.97**	**91.81**	**6.31**	**67.20**	**2.17**	**2418**

The dependency ratio, defined as the ratio of household members too young or too old to contribute to household income to its working age members, is also lower than in the control town.[13]

Overall, the control areas are slightly worse off for most development indicators, with the in-town control households in the mountainous area being the most different from their treatment group. This underlines the importance to control for these covariates during the impact analysis, since results from simple descriptive comparisons of outcome indicators between connected and non-connected households might be driven by the systematic differences in these socio-economic indicators.

3.2 Outcomes: Access to Water Supply and Sanitation

This section presents the survey results regarding access to water and sanitation, the key intended project outcomes. Regarding water access, the descriptive analysis shows that piped water supply is very erratic in the mountainous areas, with scheduled and unscheduled interruptions. The scheduled interruptions imply that rationing is necessary because the overall ground water is not sufficient to support the entire piped network. The water corporation rotates water supply between urban neighborhoods. In addition, unscheduled

[13] More precisely, the dependency ratio equals the number of household members aged below 15 or above 60 divided by the number of household members between 15 and 60.

interruptions indicate that the network breaks down frequently, making it difficult for households to obtain water from the piped network with certainty.

Table 3 shows the primary water sources households use for obtaining drinking water. Unexpectedly, not even 75% of the connected households report to be using piped water as their main source of drinking water in the mountainous area. In addition, many of the households who use the piped water as main source rely intensively on water purchased from trucks as an additional water source. The situation is very different in the coastal plain, where piped water is the main water source for almost 100% of connected households.

Table 3: Main Source of Drinking Water

			Drinking Water	Sources
		Source	*Percent*	*N*
Mountain	Water	Pipe	74.6	449
		Tanker	20.2	124
		Other	5.2	36
		Total	**100.0**	**609**
	Not Connected	Tanker	91.7	386
		Other	8.3	40*
		Total	**100.0**	**426**
	Control Town	Tanker	95.7	261
		Other	4.3	12*
		Total	**100.0**	**273**
Coastal	Water	Pipe	99.2	849
		Other	0.8	11*
		Total	**100.0**	**860**
	Control Town	Tanker	40.9	150
		Other	59.1	245
		Total	**100.0**	**395**
Total				**2563**

* Category has a very small sample size, interpret with caution.

A possible explanation for connected households relying on water trucks in the mountains is the irregular supply of piped water. The average household in the mountains was without piped water during two out of three days (see Table 29 in Annex 3, which shows piped water being unavailable nearly 60% during the 3 months prior to the survey). This is most likely due to the overall water scarcity in the Amran groundwater basin, but might also indicate management problems within the local water corporation.

Water Rationing

Illustration 1 shows a typical tanker truck serving households with water for drinking and domestic use. Such trucks were found to operate in the mountainous area both in the treatment and control town. In the coastal treatment town almost no such trucks could be found for water quality testing reports indicate that since reliable piped water supply became available, the market for truck water disappeared. Both, tanker trucks as well as donkey tanker carts (displayed in Illustration 2) were found in the coastal control town, where no piped water exists.

Illustration 1: Water Tanker Truck

Illustration 2: Donkey Water Cart

In the coastal plain there are no signs of water rationing, with piped water being available during more than 99% of the time during the three months prior to the interview.[14]

Access to Sanitation

Sanitation comprises piped sewerage connections at household level. Sewage management is very important in urban areas, since limited space and high population density make hygienic waste disposal very difficult. However, setting up a piped sewerage network in a densely built city comes not without

[14] Note that during the water quality testing anecdotal evidence was collected indicating a recent deterioration in reliability of pipe water supply in Zabid. Nevertheless, piped water supply continued without much rationing in the coastal plain when compared to the mountainous area.

challenges, either. Sewerage pipes need to be installed in each household in a way that prevents blocking of pipes. In addition, the larger sewerage pipes in the streets can only function when sufficient water is used for flushing. These two factors play an important role when interpreting connection rates and the health impact of sanitation. Note that no hygiene training was provided for households as an integral part of the Financial Cooperation intervention.

Table 4 shows the connection rates for sanitation. In the mountain town of Amran, nearly a third of the households are connected to improved sanitation (32.0%). In the coastal town of Zabid connection rates are much higher, with 84.9% of households having access to piped sewerage. In comparison, none of the control towns has piped sewerage.

Table 4: Sanitation Access

		Connection Rate to Piped Sewerage	HHs
		Percent	*N*
Mountain	Sanitation	32.0	270
	No Sanitation	68.0	575
	Control Town	0.0	298
Coast	Sanitation	84.9	714
	No Sanitation	15.1	127
	Control Town	0.0	434
Total			**2418**

Note: Differences in sample size between tables in this chapter are due to survey non-response.

The relatively low connection rates in the mountainous area can lead to a problematic interaction between water access and missing sanitation access. When the rate of piped water connection is much higher than the rate of piped sewerage connection, a significant share of the urban population is forced to expose the waste water in the city, either openly in streets and drains or underground in septic tanks. Especially the former can pose extensive threats to public health, as the history of Amran shows. After the initial construction of the piped water system as part of this project, the inner city reportedly experienced severe problems (even leading households to leave the city center) because of sewage flowing in the streets. The construction of a sewerage treatment plant and piped connections after 2001 helped to revitalize central Amran (See KfW, 2008).[15]

With regard to households not connected to the public sewerage system, the survey data reveals that these households mainly use traditional underground cesspit tanks (see Table 38 in Annex 3). A small fraction of households, most likely situated on the outskirts of town, also reports using open canals.

3.3 Outcomes: Water Quantity and Cost

This section presents estimated water use and cost of drinking water in the different towns with and without water and sewerage connection. Measuring the quantity of consumed water turned out to be difficult, with large deviations between self-reported water use, water meter readings, and recall information on water purchases from trucks. Different measurement approaches were used to obtain a range of values.

Water Quantity Consumed

Calculations of consumed water quantity are based on self-reported amounts and on invoices from the water utility, using information on total water use, water used for various activities (drinking, cooking, etc.), and payments for water (see Table 5). Total water consumption ranges 11.4 to 25.9 liters per person per day for the average household connected to piped water (see columns 1 and 2). This is not much different from water use in the control areas (11.9 to 25.7 liters). Especially in the mountain area the amounts are below standard minimum levels of water consumption (20 liters per person per day, see WHO, 2008).

When only looking at water used from the piped scheme (columns 3 and 4), households in the mountain town only partly rely on piped water, which is indicated by significantly lower amounts in table 3 and 4 in comparison to tables 1 and 2.

[15] Episodes of sewage overflow have also been reported before the construction of the piped water scheme.

Columns 5 and 6 provide hope that actual water consumption is in fact much larger. These values are calculated on using information from the invoice of the water utility. Unfortunately few households had an invoice available, which means calculations are largely based on self-reported amounts and prices.

Table 5: Different Estimates of Water Quantity Consumed

Comparison of various water quantity measurements, in liters per capita per day

	(1)	(2)	(3)	(4)	(5)	(6)
	Total Water Use		**Only Piped Water**			
Calculation Method	Use by purpose	Total use	Use by purpose	Total use	Quantity bought	Price paid
Unit	*Liters*	*Liters*	*Liters*	*Liters*	*Liters*	*Liters*
Mountains						
Water	18.7	11.4	16.7	9.9	43.5	85.9
Sanitation	18.5	13.7	17.0	11.8	34.8	57.2
None	19.8	13.0	-	-	-	-
Control Town	18.4	11.9	-	-	-	-
Coastal						
Water	24.2	16.9	24.2	16.9	48.4	82.4
Sanitation	25.9	20.7	25.8	20.6	56.4	72.8
Control Town	25.7	20.5	-	-	-	-
Total	**22.6**	**16.7**	**23.4**	**17.7**	**48.2**	**74.5**
Households	2336	2303	1113	1115	115	197
Data source	Main Household Survey				Water Quality Survey	

Table calculated as follows:
(1) (Sum of water quantity used in last week) / (7 days * household size), see questionnaire q2.50 to q2.56.
(2) (Total water quantity used in last month) / (30 days * household size), see q2.58.
(3) (Sum of piped water quantity used in last week) / (7 days * household size), see q2.50 to q2.56.
(4) (Total piped water quantity charged in last invoice) / (30 days * household size), see q2.58.
(5) (Water quantity m^3 charged in last invoice * 1000 liters) / (Weeks covered by invoice * 7 days * household size), see q11.27 and q11.28
(6) (Value of pipe water charged in last invoice * 1000 liters) / (Weeks covered by invoice * 7 days * household size * official price per m^3) + sewerage fee; see q11.25 and q11.28. An additional sewerage fee is added as share of water cost: 80% in Amran, 60% in Zabid.
Note that the usable sample size of the household survey was much larger than that of the water quality survey (columns 5 and 6), and results are therefore more robust from the former.

In addition, more than half of the interviewed households were unable to answer the questions used for these calculations, because they didn't know any details of the last invoice. Such high non-response-rates can easily cause biased results, especially since the remaining sample is only 10% of that used in columns 4 and 5.

Alternative calculations from the GIZ supported PIIS Monitoring system indicate piped water consumption per person per day of 38.3 liters (mountain town) and 46.7 liters (coastal town) for 2008, which is within the range of these results (PIIS 2009). Overall, while consumed water quantity cannot be established accurately, it should be noted that most of the estimates are near or below the required minimum and that no differences seem to exist between treatment and control areas.

Water Cost

The subjective assessments of change in water cost since the connection are fairly clear. An increase in water cost is reported by 54.3% of households in the mountains and 81.3% in the coastal plain (see Table 37 in Annex 3). Upfront, a reduction of cost was expected because traditional sources were thought to be more expensive. Supply by tanker trucks – the main alternative to pipe water supply – comes along with cost of personnel, fuel, vehicles, mark-ups, etc. The findings of Table 37 are opposing hypothesis 3 (increased livelihood due to reduced water supply cost). Possible explanations for these increases in costs are the continued used of water vendors in addition to paying for piped water (in Amran), inflation and reporting errors.

Estimating the true cost of water is difficult because of large differences in water price reported by consumers, sellers, and previous reports. Table 6 displays the results for four calculation methods. The first two approach the cost from the consumer perspective. The third method is based on the information from a KfW report. The last method uses information from water vendors. Calculated results vary widely, with water cost reported by households by far exceeding that of external sources. While some difference is likely to be due to perception bias on the part of households, the difference seems larger than one would expect. The source of this discrepancy remains thus unclear. What remains clear, however, is that households by and large do not *perceive* cost-savings to have materialized as a result of water access.

Table 6: Water Cost

Cost comparison of different data sources (in YER per cubic meter)

Calculation Method	Piped water		Truck water		Other sources	
	Mountain	Coastal	Mountain	Coastal	Mountain	Coastal
Cost from total monthly water use (survey) [a]	1622.11	941.62	1346.00	1097.98	751.65	590.09
Cost directly reported by households (survey) [b]	2353.54	2185.93	1421.83	1452.94	2756.03	2054.88
Cost reported in KfW evaluation [c]	217.00	122.50	400.00	400.00		
Cost reported by water truck drivers [d]			346.15	490.00		

Notes: (a) Households are asked about the total water used during the past month and the total cost of that water. Data stem from the main household survey, indicated by "survey".
(b) Households are directly asked how much they pay per unit of water, measured in units of 20 liters (standard water unit, corresponding to the widely used yellow bucket).
(c) The average costs (YER/cubic m) for the Tihama (using water prices in Bajil) and the mountains (using water prices in Hajja) are taken from the internal evaluation (KfW, 2008). The internal evaluation also contains an estimate of cost of truck water, which is not specific by region. These values appear not more reliable than survey results.
(d) Water vendors were asked about the price charged per cubic meter. Coastal data is for Al-Jarrahi only, since no truck drivers were found in Zabid.

3.4 Outcomes: Water Quality

This section describes the results of water quality measured by microbiological and chemical analysis (objective measures). These results are contrasted against self-reported water quality results from the household survey (subjective measures).

Water Quality – Objective Results

Overall water quality at the point-of-use in treatment and control areas is very poor. Microbiological analysis of water samples taken at household levels indicates that contamination with E.coli is widespread (see Table 7).[16] Between

[16] Escherichia coli (E.coli) is a bacterium which found in the lower intestine of warm-blooded organisms and causes serious gastro-intestinal disorders. It can survive for some time outside the body, which makes it a suitable indicator for fecal residues in drinking water. E.coli provides evidence of recent fecal pollution and should not be found at all in drinking-water (WHO 2008). Values were measured with confidence between 2.2 MPN/100ml (MPN means 'Most Probable

20.7% and 46.4% percent of tested water storage tanks of connected households are contaminated. This is despite the fact that piped water at the source is free from pollution. Consequently, the pollution occurs somewhere between the water source and the water use at the household, as will be discussed below.

E.coli pollution of drinking containers is even higher, ranging from 20.0% to 46.4 % among households connected to piped water (see Table 7). E-coli pollution is similarly rampant in the control areas, where 20.3% to 61.4% of the point-of-use water tests are positive for E.coli.

The impact of sanitation is found to be of different nature. In the mountainous area, E.coli pollution is nearly double when households are connected to sewerage pipes. In the coastal plain, however, E-coli prevalence is lower by about 10 percentage points when households are connected to sewerage pipes.

A chemical indicator of water quality that can be used to identify more general water pollution is the amount of Total Dissolved Solids (TDS).[17] TDS captures a variety of dissolvable pollutants that may originate from sewage, urban and agricultural run-off, industrial wastewater and salt (WHO, 2003). TDS is thus a proxy indicator for broad water pollution, which must not necessarily include E-coli pollution. However, when E.coli and TDS are correlated, water pollution is likely to be widespread, which can provide important clues regarding the source of pollution.

TDS pollution is found in lower concentrations in the mountainous area, ranging from 5.5% to 10.0% among connected households. In the coastal area, TDS pollution is more than 8 times higher, ranging from 75.4% to 84.5% among connected households. Given the proximity to the coast (about 12 km), this might be an indicator that salt water intrusion is currently polluting the aquifer below Zabid. Salt water intrusion can happen when ground water is extracted at unsustainable rates, allowing salt water to move in from the coast. In a hydro-geological study from neighboring Oman, Kacimov et al (2009) show how large-

Number' of E.coli traces) and 16 MPN/100ml. Water samples with test results of 2.2 MPN and above are considered polluted.

[17] TDS-values above 500 mg/L can be considered as polluted (WHO, 1996).

scale sea-water intrusion, reaching several kilometers inland, can be caused by excessive urban water use.

Regarding sewerage connection, the TDS test results are equally ambiguous and contrary to E.coli. Improved sewerage is associated with cleaner drinking water in the mountains in terms of TDS.

Table 7: Objective Water Quality

			Households		Sample Size
		Water Source	Drinking Cup Polluted E.coli	TDS	HH
			percent	*percent*	*N*
Mountain	Water	Pipe	20.0	10.0	70
	Water & Sanit		38.4	5.5	73
	None	Truck	20.3	12.5	64
	Control Town	Truck	40.0	0.0	65
Coastal	Water	Piped	46.4	75.4	69
	Water & Sanit		36.6	84.5	71
	Control Town	Truck	61.4	29.5	88
Total			38.6	31.4	**500**

Notably for the coastal area, TDS pollution in the control towns is substantially lower than in the treatment town, despite evidence that donkey carts are used to supply drinking water. Given that the control town is located further inland, this provides additional evidence for possible sea water intrusion.

Water Quality –Subjective Results

Besides the laboratory tests, households were asked to report their subjective perception of water quality. Not surprisingly, respondents seem to have become used to the poor drinking water quality and appear unaware of any pollution. Nevertheless, the fact that more than half of the connected and unconnected households report the water quality as *very good* is surprising (see Table 8), given that high TDS concentrations can adversely affect the taste of water (WHO, 2003).

In relative terms, subjective water quality is worse in the mountainous area, where many more households report the water quality of piped water as *bad* or *very bad* compared to the coastal plain.

Table 8: Subjective Water Quality

Overall quality of main drinking water source (self-reported)

			Very Good	*Good or Acceptable*	*Bad or Very Bad*	*Sources*
		Source	*Percent*	*Percent*	*Percent*	*N*
Mountain	Water	Pipe	68.6	28.2	3.2	277
		Truck	56.5	39.1	4.3	207
	None	Truck	66.7	32.1	1.3	318
	Control Town	Truck	71.2	28.0	0.8	243
Coastal	Water	Pipe	71.3	28.1	0.6	818
		Truck	80.0	20.0	0.0	5*
	Control Town	Truck	77.0	22.3	0.7	139
Total Sample			**69.1**	**29.4**	**1.5**	**2007**

Note: Households were allowed to identify more than one main source in the questionnaire.
* Few households, interpret with caution.

Additionally, the survey contains detailed questions about smell, color and taste of the water, which are shown in Table 33, Table 34 and Table 35 in Annex 3. These indicate some contamination problems in Amran. The detailed subjective quality indicators contain *chlorine* among taste indicators. A slight chlorine taste is a good sign, since it indicates that the drinking water was treated. Since chlorine particles break up when they react with pollutants in the water, a slight chlorine taste indicates that chlorination is sufficient (Arnold and Colford, 2007). In Amran, about 13.2% of connected households report a taste of chlorine in the water (see Table 33: Subjective Water Quality). Households seem to be aware of the beneficial effects of chlorine since virtually all households with chlorine taste report the overall water quality as *good* or *very good*.

Combining Subjective and Objective Water Quality Measures

When comparing subjective and objective drinking water quality, it turns out that households are either not aware of the high share of contamination in their storage tanks and containers or – less likely – do not perceive the contamination as a serious problem (see Table 30 and Table 31 in Annex 3). Especially in the coastal plain the disparity between subjective quality assessment by households and objective measurements of E.coli and total dissolved solids are striking.

In principle the disparities might also results from the timing of measurement as described in Section 2.3. For logistical reasons the water quality testing took place later than the interviews of the main household survey. However, the differences appear too large to be caused by seasonal variations in water quality only.

A direct comparison of contamination levels between mountainous Yemen and the coastal plain do not allow clear statements about differences in project success in improving water quality in the two regions due to differences in climate. However, contamination levels are unacceptably high, in both the treatment and control towns. A detailed discussion of the possible sources of pollution can be found further below (Chapter 4).

3.5 Outcomes: Health

Table 39 in Annex 3 contains the households' subjective assessment of disease frequency after connection to water and/or sanitation.[18] When interpreting this table it has to be noted that the question of how disease frequency changed after receiving treatment was preceded by a filter question, asking whether household members (both adults and children) had actually suffered from the symptom in question prior to the connection to water and sanitation. Although this seems somewhat implausible, in the majority of cases households claimed to have never fallen ill from these symptoms, which led to the question inquiring about change after receiving treatment to be skipped. It is not impossible that

[18] Although the questionnaire included 18 water-related symptoms, diarrhea, abdominal pain and vomiting are presented since they are most directly related to water-borne diseases.

these questions were somewhat misunderstood by those households during the survey, and most likely the correct interpretation is to assume no change in disease incidence after the connection to water and sanitation in these cases.

Keeping this in mind, perceived effects concerning disease frequency are somewhat small, with the majority of connected households reporting no change. Some improvement, however, seems to be visible in the coastal area.

Turning from the subjective health effects in the subsample of connected households to the comparison of reported symptoms incidence during the last four weeks for treated and control households, the picture somewhat changes. Table 9 below shows that although overall prevalence of water-borne diseases is fairly low, the data indicate that diarrhea, abdominal pain and vomiting occurred more frequently in the project areas, compared to the control areas. This can be observed for both coastal and mountain areas. In the coastal plain, incidence rates are lower when sanitation is present, while the contrary is true for the mountainous region.[19]

When controlling for water source, a higher rate of incidence of diarrhea is found among households using piped water (compared to trucked water) in the mountains. In Zabid all households use piped water, so that a comparison by source is not possible there.

In principal it is possible that diarrheal diseases come from unwashed food or other non-water related sources. The epidemiological literature shows that at least 80-90% of all cases of diarrhea in developing countries come from drinking water. To exclude the possibility that food (e.g. unwashed vegetables) or food preparation (e.g. cooking without prior hand washing) is the source of diarrhea households were interviewed on these issues. Neither of these factors is able to explain a significant share of reported diarrhea incidence.

[19] Part of the higher disease incidence in treatment towns could be due to perception bias partly linked to the fact that the treatment group has higher socioeconomic status. This effect will be taken into account during the statistical analysis.

Table 9: Health

Reported Symptoms during past 30 days

		Diarrhea	**Abdominal Pain / Vomiting**	**Fever**	**People in subsample**
		Percent	*Percent*	*Percent*	*N*
Amran	Water	4.47	4.24	4.87	1744
	Water & Sanit.	5.38	4.66	6.14	2361
	None	3.32	3.72	4.70	2981
	Control Town	2.90	3.07	2.38	2479
Zabid	Water	4.77	4.54	6.52	859
	Water & Sanit.	3.29	2.70	3.52	4746
	Control Town	2.71	2.61	3.87	3100
Total		**3.60**	**2.98**	**3.76**	**18270**

Table 10 provides evidence on the reported (subjective) change in disease incidence and actually reported individual disease incidence. In particular, the table shows actual reported individual disease incidence by perceived subjective change in disease incidence. Since the question about subjective change was not asked in the control towns, only average disease incidence for the control towns is reported.[20]

Two trends can be observed. First, for both regions it can be seen that average disease incidence among the control groups is always lower even than in the treatment group, regardless of whether the treated reported improvements, no change, or deterioration. Second, health data from treated households reporting a subjective increase in disease incidence show a higher reported disease incidence than households reporting no change or a decline.

[20] We place this in the 'same' row as no change in connections took place; but it is simply the rate reported for the control town. It also needs to be noted that treatment households claiming not to have suffered from the investigated symptoms prior to connection are now included in the group reporting no change ('same' row) (see discussion about table 27).

Table 10: Subjective change in disease incidence and reported disease incidence

Abdominal pain

Subjective	Mountains			Coastal			Total		
Change	Treated	N	control	treated	N	Control	treated	N	control
Less	0.053	18		0.040	117		0.042	135	
Same	0.035	434	0.025	0.020	715	0.015	0.026	1149	0.021
More	na[21]	9		na	9		0.048	18	

Vomiting

Subjective	Mountains			Coastal			Total		
Change	Treated	N	Control	treated	N	Control	treated	N	control
Less	0.027	17		0.026	103		0.026	120	
Same	0.020	437	0.019	0.016	729	0.021	0.018	1166	0.020
More	na	7		na	9		0.062	16	

Diarrhea

Subjective	Mountains			Coastal			Total		
Change	Treated	N	Control	treated	N	Control	treated	N	control
Less	0.054	21		0.064	119		0.062	140	
Same	0.054	429	0.036	0.033	712	0.033	0.041	1141	0.035
More	na	11		na	10		0.094	21	

In this sense, subjective assessments of the intervention on disease incidence and reported disease incidence are in line. In contrast, there is no clear difference in the reported disease incidence between those households reporting the same or lower disease incidence as a result of the connection to piped water. In fact, it appears that households who report subjective improvements tend to have higher rates of disease incidence which appears odd at first sight.

But this approach of comparing averages has three limitations. First, the comparison is between a subjective assessment of change over a prolonged time period (i.e. the time since connection), which varies across households, to a snapshot of disease incidence during the four weeks prior to the survey. Second, subjectively reported changes over time to differences in health across individuals are compared. It remains unknown whether those who report a

[21] Note: for very small subgroups with N<15 means are misleading and are not displayed.

higher disease incidence already had higher incidence in the past than others in the treatment group; if that is the case, it may be perfectly consistent that they still have a higher disease incidence yet report a decline from even higher levels earlier. Third, since this is a purely descriptive analysis, possible selection bias is not yet sufficiently controlled for (this will be done in Chapter 5).

In addition, the possibility exists that connected households have stopped using clean bottled water in response to piped water supply. The investigation of possible causes of increase of diarrheal diseases bottled water have not been found to play any role, since consumption of bottled water is virtually inexistent among households in any of the treatment and control groups. Consequently, the number of water bottles does not correlate with access to piped water. This is quite plausible in the Yemeni setting, since it is primarily men who drink bottled water during the traditional Qat sessions.

Table 11 looks at the differences between reported symptoms and the perceived trend in health burden and reported days missed in school and work because of illness.

Mixed effects are observed for days missed due to diarrhea, abdominal pain and vomiting. Again, the number of days missed in school or at the work place is higher in the treatment areas (with the exception of sanitation in the coastal town), which correlates positively with the reported days missed (see Table 41 in Annex 3). This contradicts hypotheses 2 and 3 (increases in education and livelihood, due to less water-related sick leaves). However, the same caveats apply as with Table 10; additionally, the analysis is based on relative low reported rates of illness-related absenteeism.

Table 11: Subjective Change in Disease Incidence and Days missed in School/Work

Abdominal pain

Subjective	Mountains			Coastal			Total		
Change	Treated	N	control	Treated	N	Control	treated	N	control
Less	Na	10		0.033	102		0.036	112	
Same	0.037	250	0.027	0.015	603	0.024	0.021	853	0.026
More	na	5		na	9		na	14	

Vomiting

Subjective	Mountains			Coastal			Total		
Change	Treated	N	Control	Treated	N	Control	treated	N	control
Less	na	7		0.029	91		0.032	98	
Same	0.018	254	0.020	0.017	615	0.020	0.017	869	0.020
More	na	4		na	8		na	12	

Diarrhea

Subjective	Mountains			Coastal			Total		
Change	Treated	N	Control	treated	N	Control	treated	N	control
Less	na	11		0.055	104		0.054	115	
Same	0.059	265	0.039	0.031	601	0.037	0.040	866	0.038
More	na	7		na	9		0.054	16	

3.6 Outcomes: Hygiene Practices

To further analyze and explain the health status of the sampled households, this section looks at hygiene practices. As can be seen in Table 12 below, most households in the sample do not treat water before drinking. The only exception being households in the mountain town of Amran, where water filters are used in nearly one out of five households connected to pipe water (18%) and an additional 4.9% boils their water before drinking; thus it appears that there is awareness of the water quality problems mentioned above among a minority of households in Amran. This is in contrast to the coastal area, where water purification is not done by more than 3% of all households.

Table 12: Water Treatment before Drinking

		Boil	*Water filter*	*Other*	*No Treatment*	*HHs*
		%	*%*	*%*	*%*	*N*
Mountain	Water	4.9	18.0	2.0	74.3	490
	None	2.4	7.2	1.9	87.2	374
	Control Town	2.3	4.7	0.7	91.6	299
Coastal	Water	1.9	0.4	0.7	97.0	841
	Control Town	0.9	0.5	1.2	97.5	434
Total		**2.5**	**5.4**	**1.3**	**90.4**	**2476**

The overall low level of purification could be due to the very low participation rates in hygiene trainings (see Table 42 in Annex 3) and lower awareness of the necessity and benefits of drinking water purification.

Water filters attached to the water tap can be a cost-effective method to reduce E.coli pollution of drinking water at the point-of-use (see Sobsey et al, 2008, for an evaluation of various technologies; and Clasen et al 2004, 2005 for applied randomized control trials in Bolivia and Colombia). Depending on the type of the filter, bacteria can effectively be withheld or eliminated from drinking water. Different models are found on the Yemeni market. An alternative method of household water purification is chlorination of storage tanks (an extensive review can be found in Handzel et al, 2003).

When asked about hand washing behavior, almost all household members claim to wash their hands after using the toilet and before eating or serving food. However, soap (or laundry detergent, a common soap substitute in Yemen) is not always used or available. On average, soap and detergent use is higher in the areas with piped water supply (see Table 43 in Annex 3).

3.7 Outcomes: Gender Effects and Time Use

Since it is usually not necessary to cover long distances in order to fetch water in urban areas, it was not expected to find large time savings due to the water project compared to households not connected to a pipe system. However, a small share of households did report that family members had to fetch water prior to the connection, as can be seen in Table 13. While in mountainous Yemen more female household members used to fetch water, this was a predominately male activity in the coastal plain prior to project implementation. Almost all of the households where water had to be fetched also report that the connection resulted in a noticeable increase of time thereafter available for other activities (see Table 44 in Annex 3). Also, a reduction of the domestic work burden was reported by a proportion of 45% of connected households in Amran, and 56.8% in Zabid, thus supporting hypothesis 4 (reduction of work burden regarding household chores).

Table 13: Time Saving

Water fetching prior to connection

		Was fetching water	*Was not fetching water*	*Households*
		Percent	*Percent*	*N*
Mountain	Boys	6.0	94.0	469
	Girls	9.6	90.4	469
	Men	5.1	94.9	469
	Women	14.7	85.3	469
Coastal	Boys	10.9	89.1	841
	Girls	5.7	94.3	841
	Men	14.0	86.0	841
	Women	6.4	93.6	841
Total		**9.0**	**91.0**	**1310**

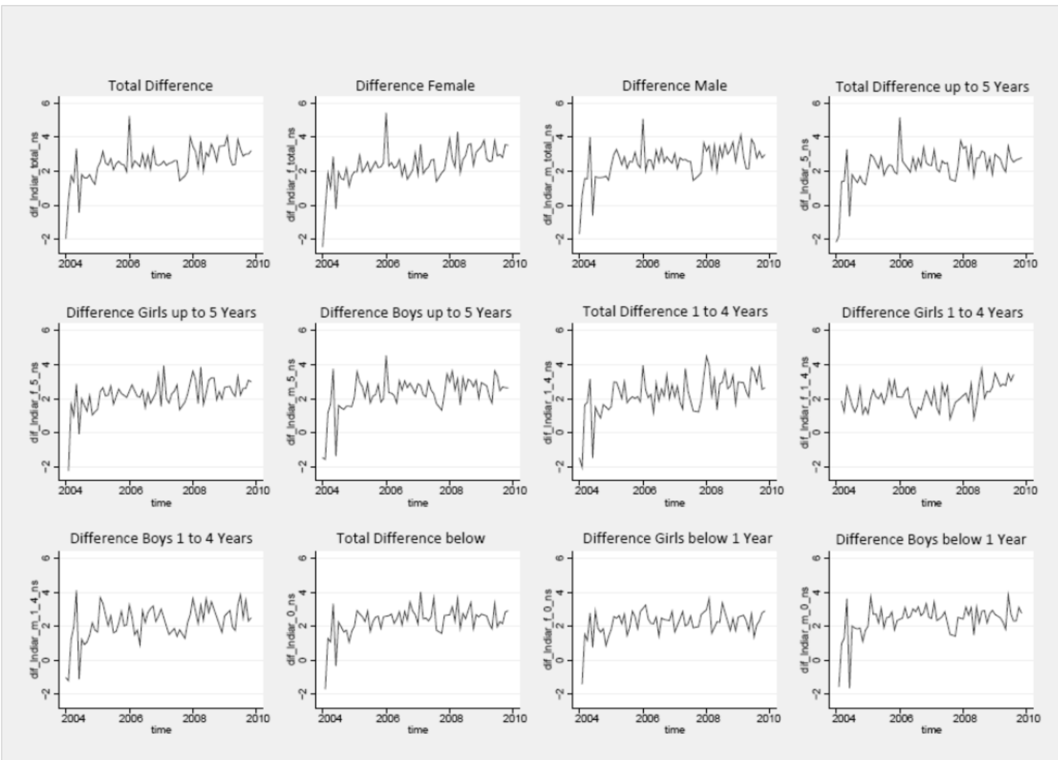
At the same time, the often criticized negative effect of piped water on socializing opportunities for women in the region cannot be observed in either of the two cities. In Zabid, 21.1% of connected households actually report an increase of opportunities (see Table 45 in Annex 3). Thus overall these results point to some positive effects in terms of time-savings of the intervention.

3.8 Outcomes: Time trends in Health and Education

Health Outcomes

Out of all collected symptoms, only the information on diarrhea incidence was used, since this was the most complete data for all health facilities. In addition to this it can be argued that diarrhea is the symptom most directly associated with the use of contaminated water. The health facility data contains the absolute incidence of diarrhea in the facility for each month, i.e. a headcount of patients with diarrhea. Since the record books of the health facilities do not record the full address of the patient, but only the town he is from, the in-town-control group for the mountainous region cannot be used (as mentioned earlier, in the coastal region there was no in-town-control group) for the analysis of the health facility data. Instead, for both regions health facility data from the control towns is used. For the mountainous region (Amran/Raydah) comparable data is available from the beginning of 2004 up to the end of 2009. For the coastal plain, diarrhea incidence can only be compared from the beginning of 2007 up to the end of 2009. The Figure 5 below shows the difference in diarrhea incidence between treatment and control groups in the mountainous area.

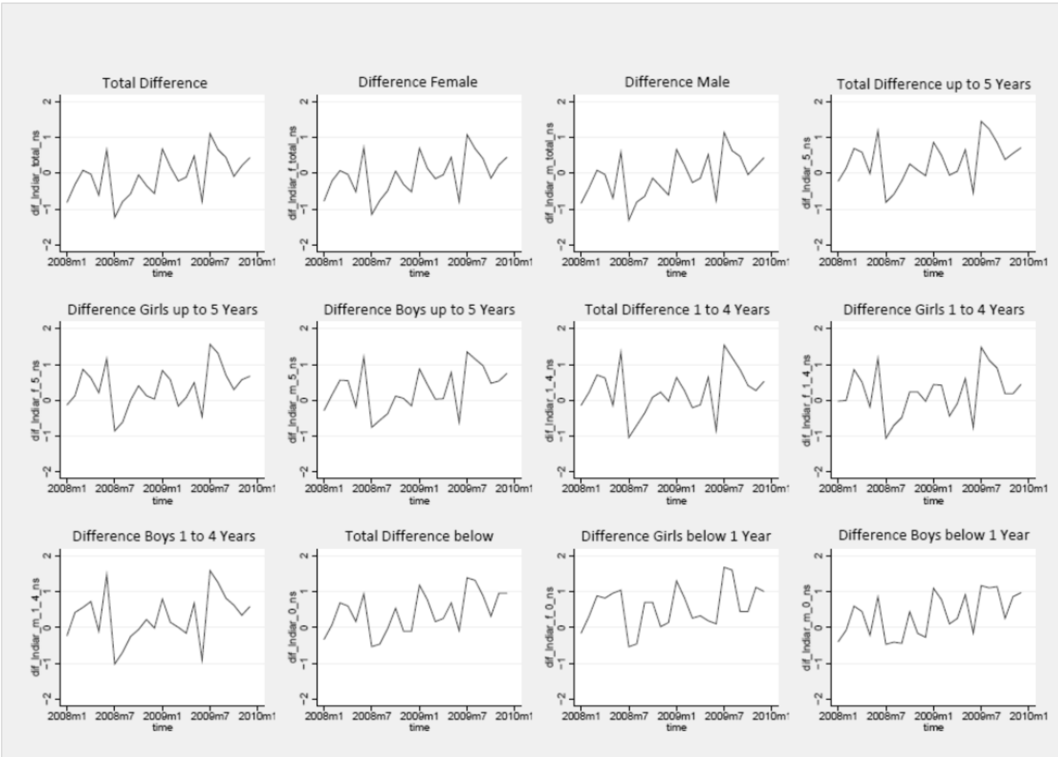
Figure 5: Difference in Diarrhea Incidence (Mountains)



The data is in monthly format with incidence presented in logs and without seasonal effects to ensure comparability. The difference in incidence (treatment town less control town) is plotted for totals, as well as individually by gender and age groups (5 years and younger, age 1-4 and younger than 1 year). All graphs show a slight, yet noticeable upward trend, suggesting an increase in diarrhea incidence for Amran compared to Raydah over the years; they appear consistent with the results on the reported disease incidence from the household survey that in the treatment group, a negative impact on health outcomes is observed.

A similar impression arises when looking at the data for the coastal plain (Figure 6), which – while displaying a more positive picture than the mountainous region – also looks somewhat worse as far as health outcomes are concerned than the results from the household survey.

Figure 6: Difference in Diarrhea Incidence (Coastal)



Although these descriptive findings are largely consistent with the results of the descriptive analysis above (and the iv-regression and the propensity score matching below, at least for Amran and the mountainous region), they need to be interpreted with caution. First of all it needs to be noted that data availability in health facilities – and therefore coverage of these – was not complete in all towns (i.e., data are not available for all illnesses and age groups). This problem might be more pronounced for the treatment towns Amran and Zabid than for the control towns Raydah and Al-Jarrahi. It was exacerbated by the fact that some of the visited health facilities only had incomplete data over the years, making it necessary to further reduce the comparable group of facilities. Besides this, not all patients from the treated towns actually have access to water and sanitation, so the distinction between "treated" and "control" is less clear for those towns. Two scenarios are possible here: Either the graphs understate the true negative effect of access to water and sanitation, since an unknown percentage of the patients labeled as "treated" did not receive treatment, or the unconnected patients from the treatment town are significantly worse off than the untreated patients from the control towns, thus driving the negative results. However, Table 2 does not support the latter possibility. Keeping these problems in mind it can be said that although the descriptive analysis of the health facility data gives some interesting insights, the results seem somewhat less reliable than those obtained using instrumental variable regression and propensity score matching with the survey data which is presented below.

Education Outcomes

The education data collected from the schools of the four towns consist of the absolute numbers of boys and girls passing and failing the school year (taking into account grades one to five) each year. Figure 7: Education Failure Rate (Mountain and Figure 8: Education Failure Rate (Coastal) below display the percentage of failing students (totals and divided by gender) for treatment and control towns in both regions.

The data suggest a substantially higher failing rate in the control towns compared to the treatment towns, which is supported by the descriptive statistics on demographic factors in Table 2. One could claim that this descriptively supports the hypothesis 3 of better school performance due to less sick leaves. However, the problems found for the health facility data apply to the education data, namely lack of completeness and differences in aggregation.

More sophisticated methods, such as propensity score matching and instrumental variable regression analysis do not detect any indication of a reduction in missed days due to water and sanitation. Consequently, no differences in trend are found between treatment and control groups. The trends in both groups are similarly irregular and no impact on educational attainment can be established.

Figure 7: Education Failure Rate (Mountain)

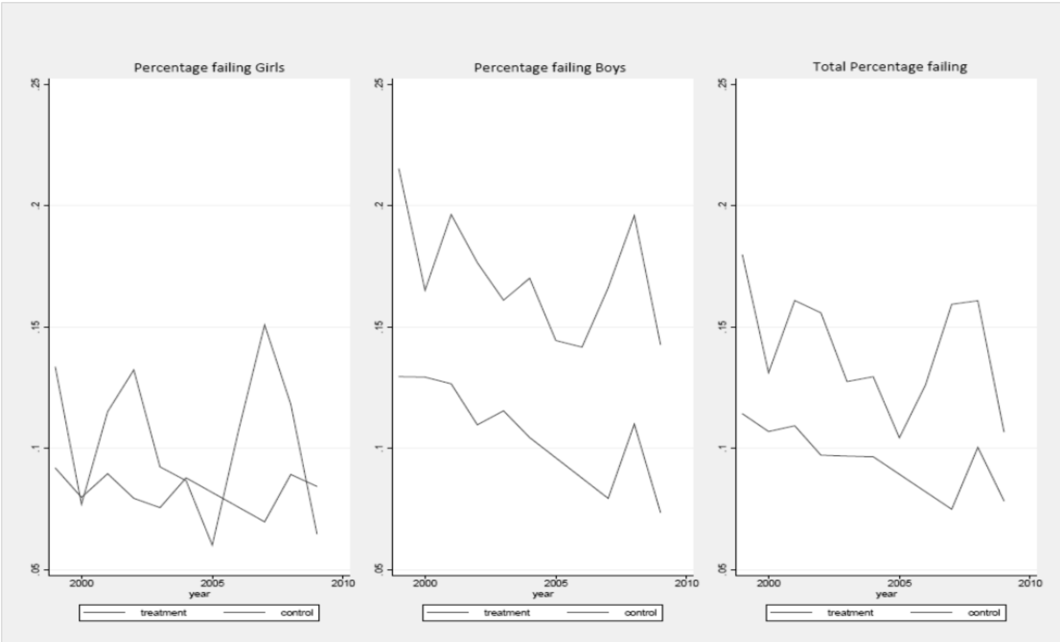
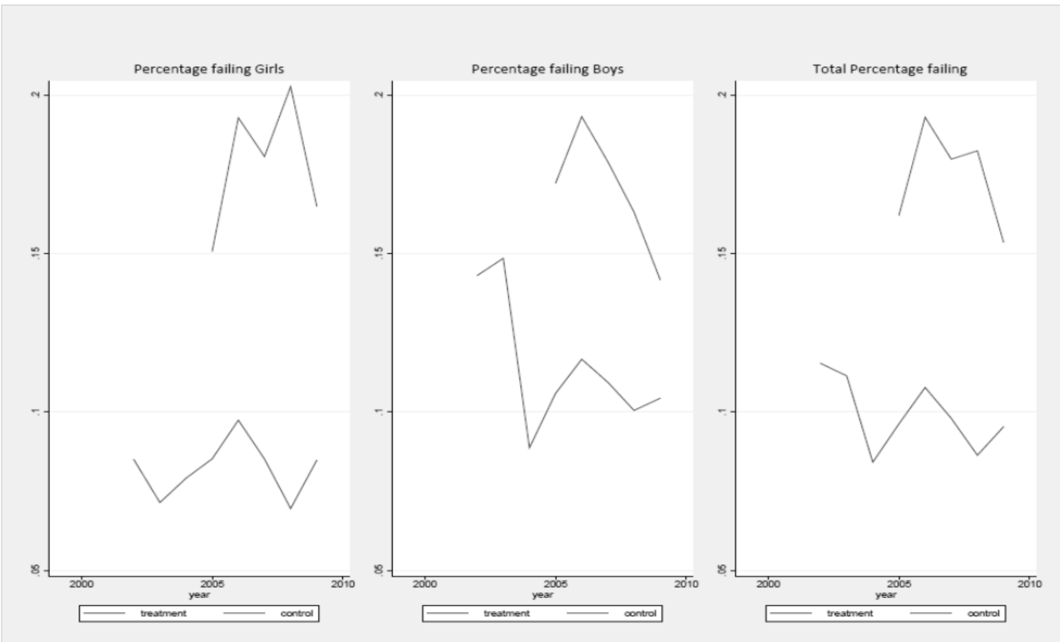


Figure 8: Education Failure Rate (Coastal)



3.9 Outcomes: Health Comparisons between Baseline and Endline Data

The comparison of illness incidence rates between baseline data from 2004 (made available by KfW) and data from the 2009 household survey allow calculating first and second differences. First differences refer to the change in illness over time in the project areas, while the second difference refers to the difference of these first differences for treated and untreated households in the project area. The second difference can only be calculated for the in-town control groups (and thus only for the mountain area) since the baseline survey did not cover the control towns. The comparison with the baseline suggests a substantial increase in diarrhea incidence for both treatment towns where the project was implemented.

However, this finding should be treated with caution as it could be due to differences in survey design. In any case, the result does suggest that the problem of water-borne diseases remains important and may have increased. [22]

More reliable would be the second-difference comparison between treatment and in-town control group, which would be free of differences in survey design. Table 14 compares households connected to piped water supply prior to the intervention with the in-town control group. The second difference of diarrhea incidence indicates a deterioration of health due to the project by 1.22 percentage points (see boxed number in Table 14).

[22] It should also be pointed out that disease incidence is reported to be very low in the baseline survey, in fact it appears implausibly low for a situation with poor water access and quality. While this may be the case, it would only cause a problem if there was not just a general underestimation, but a differential underreporting that affected the control areas more than the treatment areas. There is no evidence that this was the case.

Table 14: Baseline Comparison Health - Symptoms during past 30 Days

		Diarrhea			Individuals	
		Baseline	Endline	*Difference*	Baseline	Endline
		Percent	*Percent*	*Percentage points*	*N*	*N*
Amran	Water	0.93	4.39	*3.46*	1744	1777
	Water & Sanit.	-	5.30	-		2265
	None	1.08	3.32	*2.24*	1118	2986
	Control Town	-	2.86	-		2516
First Difference	In Town Water		1.07	***1.22***		
	Out Town Water		1.53			
Zabid	Water	2.28	4.77	*2.49*	1185	859
	Water & Sanit.	-	3.29	-		4746
	None	-	1.28	-		234
	Control Town	-	2.71	-		3100
First Difference	Out Town Water		2.06			
Total		**1.37**	**3.55**	**2.18**	**4047**	**18618**

The diarrhea incidence for connected households increases even stronger when controlling for differences over space and time. This is consistent with an increase of water-borne diseases in the treatment group and points once more to a negation of hypothesis 1 (improved health). No difference-in-difference can be calculated for the coastal area, since all households were already connected to some sort of water scheme during the baseline survey.

Chapter 4: Sources of Water Pollution

4.1 Introduction to Pollution Measurement

The pollution of the drinking water raises some important questions. Since the microbiological analysis does not detect any traces of E.coli pollution in the wells used by the water corporations the source of pollution must occur somewhere between the pipes and the point-of-use. Following the flow of water, several pollution channels are epidemiologically possible, all of which are discussed in detail below (Wright et al, 2004).

In principal, the pollution can occur in the water pipe network, for instance through broken pipes or erratic water supply. Alternatively, household behavior might be responsible for the pollution through poor hygiene practices and water handling at the household level. To narrow down these possible channels field work included a series of water quality tests that were conducted at multiple points along the water chain. They comprised tests of the pipe wells (test point 1), the main feed pipe which serves large neighborhoods (test point 2), the large water storage tank at each sampled household (test point 3), the water tap connected to the water tank (test point 4), in many households another small kitchen container (test point 5) and lastly the actual drinking cup used by household members (test point 6 and point-of-use).

Because of lack of access it was not possible to test the water quality in the small pipes (between test points 2 and 3) which connect individual households to the main feed pipe of their neighborhood. Also, chlorine content in the water was not conducted due to the related cost. As explained above, very low (or absent) chlorine residuals in pipes and tanks can indicate that intrusion of pathogenic micro-organisms is very high in the affected pipes and tanks (Semenza et al, 1998).

4.2 Hypotheses on Drinking Water Pollution

Despite these limitations it is possible to narrow down the source of pollution, which is done by proposing a number of hypotheses that are subsequently tested against the data and backed by results from various epidemiological studies where necessary.

<u>Hypothesis 1</u>: The source well is polluted.

As evident from Table 15 below, E.coli is not found in any of the source wells feeding the piped water systems. In the mountain town of Amran, five wells are connected to the water pipe network, all of which are E.coli clean. Note however, that one of the Amran pipe wells contains high TDS levels, possibly due to the high mineral content in the deep ground layers that have been drilled into in order to find any ground water.[23]

The situation in the coastal control town is worrying: six of seven wells used by the town are polluted by E.coli. In the short term, chlorination of these wells by the water authorities seems urgently necessary. Using randomized control trials, well cleaning and chlorination has been shown very effective (for a summary see Kremer and Zwane, 2007 and Kremer et al, 2009).

In the coastal town of Zabid, all pipe wells are TDS polluted, possibly due to salt water intrusion as described above. Because TDS pollution can result also from mineral content in the aquifer, this section primarily focuses on E.coli, which is directly attributed to human and animal waste (WHO, 1996). Water quality tests reveal that E.coli pollution occurs only after the water has left the water utility. Hypothesis 1 is rejected.

[23] Interviews with the water corporation indicate that two of the five wells are permanently not providing sufficient water to be pumped into the pipe network.

Table 15: Objective Water Quality

			Source Well Polluted		Sample Size
		Water Source	E.coli *percent*	TDS *percent*	Wells *N*
Mountain	Water Water & Sanit	Pipewells	0.0	20.0	5
	None	Truckwells	0.0	66.7	3
	ControlTown	Truckwells	0.0	0.0	3
Coast	Water Water & Sanit	Pipewells	0.0	100.0	3
	ControlTown	Truckwells	85.7	57.1	7
Total			**28.6**	**47.6**	**21**

<u>Hypothesis 2</u>: The main feed pipes are polluted.

Water samples were taken at the first junction of the main pipes that connect the pump station with the town. This control point is used by the water corporation to cut the water supply to selected neighborhoods for controlled water rationing. The water quality was thus tested at a point of permanent positive water pressure which implies the pipes are not affected by the effects of water rationing.

In the mountainous region, the water samples taken from the four main feed pipes were E.coli clean. In the coastal region, one of the two main feed pipes shows E.coli pollution, as shown in Table 16.[24] This is alarming, since the feed pipe delivers water to about half of the urban population in the city of Zabid. While the E.coli test should be re-done for validation it is already confirmed by the results of the *Total Coliform* test, which indicates that all feed pipes in the coastal area are polluted.[25]

[24] The data on which this table is based was electronically received from the water engineer conducting the tests. To verify the pollution at this crucial point in the piped water network in Zabid additional tests are recommended.

[25] The feed pipe affected by E.coli was tested at the following location: N 14.19494, E 43.31605

Table 16: Pollution of Main Water Feed Pipes

	Water pipe polluted			Sample Size
	E.coli	Total Coliform	TDS	Pipes
	percent	*percent*	*percent*	*N*
Mountain	0.00	0.00	0.00	4
Coastal	50.00	100.00	100.00	2
Total	**16.66**	**33.32**	**0.00**	**6**

The test result is also in line with the unexpected widespread prevalence of E.coli pollution among households in the affected town. In fact, E.coli affects up to 53.6% of the coastal households with a water connection at the point-of-use, which is not statistically different from the E.coli prevalence in the control town, where drinking water is obtained from donkey carts and highly polluted wells.[26] Hypothesis 2 is rejected for the mountain region, but cannot be rejected for the coastal region.

***Hypothesis 3**: Household members cause the pollution of the water storage tanks.*

The water from the small feed pipes runs directly into large steal storage tanks located on the roofs of the buildings. Some households maintain their water tanks in the building compound, but in urban areas there is rarely enough space to do so. In fact, 91.5% of the surveyed households keep their tanks on the roof, where gravitation provides natural water pressure within the house and – more importantly here – where tanks remain out of reach from playing children and other unintended manipulation (see Table 17). Because tanks are out of reach, households with their water tank located on the roof can be excluded from having accidentally polluted the tank water and can be used for comparisons below.

Note that all storage tanks are fully closed. A metal lid covers a bucket-wide opening which can be used for cleaning the tank. However, only 7.9% of the surveyed households report to having been accessing their storage tank for

[26] Result is based on the standard 5% confidence intervals around the mean of the coastal E.coli prevalence. The mean prevalence [and its confidence bands] for the 140 connected households is 41.4% [31.5% - 53.6%] and 65.9% [50.1% - 85.2%] for the 88 coastal control households, that were randomly tested. The Poisson distributed confidence intervals overlap, hence no statistical difference exists.

cleaning in the four weeks prior to the survey.[27] Overall, households do not seem to pay much attention to the tanks. Also recall that E.coli can be directly attributed to waste of humans and some large animals (donkeys being the most relevant animal for Yemen), but not to excreta from smaller animals such as birds. Taken together, this makes it highly unlikely that E.coli enters the storage tanks from direct household activity or animals.

This can be shown by comparing the pollution between tanks located on the roof and tanks in the courtyards. Since roof tanks are not accessible to household members, they serve as control group. Table 17 shows that in the mountainous area E.coli prevalence in compound tanks (26.1%) is indeed slightly higher than in roof tanks (25.0%). However, the difference is only marginal and statistically not significant. In the coastal area, however, roof tanks appear much more polluted, although not significant.[28]

Table 17: Pollution of Water Storage Tanks - by Tank Location

		Storage Tank Pollution			
	Tank Location	E.coli *percent*	Total Coliform *percent*	TDS *percent*	Households *N*
Mountain	Roof	25.0	64.6	7.1	240
	Compound	26.1	56.5	4.3	23
Coast	Roof	42.4	84.8	75.8	33
	Compound	16.7	77.8	88.9	18
Total		**26.9**	**67.1**	**19.3**	**316**

Note: Sample only includes connected households. Differences in sample size between tables in this section result from missing testing data and/or survey non-response.

Similarly, Total Coliform and TDS values are ambiguous, (again, differences are not significant), showing no clear pattern of increased pollution in the more accessible tanks. In conclusion, water quality tests show no sign of direct household pollution of the tanks. Hypothesis 3 is rejected.

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[27] Interestingly, non-connected households clean their tanks much more often (16.0% in the four weeks prior to the survey), possibly because they do not trust the truck water quality.

[28] This is possibly due to higher temperatures in the roof tanks but unrelated to water handling by connected households.

<u>Hypothesis 4</u>: Storage tanks cause water pollution.

Rationing implies that piped water is available irregularly, forcing households to manage water availability at household level. This is done via steel storage tanks as described above. Recall that in the coastal area, where water supply is very regular, large storage tanks (or smaller plastic containers containing some 100 liters) are only encountered in about half of the households (49.6%). In line with epidemiologic literature, the very existence of storage tanks might promote water pollution as it is difficult to keep such tanks free from pollutants (see for example, Bastable and Clasen, 2003; and Chartier et al, 2001). This is supported by the data shown above that pollution in the storage tanks is very high even when water in the pipes was clean.

Unfortunately, the effect of the mere existence of storage tanks on pollution levels cannot be tested in the mountains where everyone has such tanks. As a partial test, it can be differentiated among households in the coastal areas with and without storage tanks. Table 18 shows E.coli prevalence in the point-of-use (drinking cup) for households with and without storage tanks. In the coastal area it appears that E.coli pollution at the point-of-use is a lot higher when households do not use a large water tank; but since this does not control for other covariates, it is unclear whether this is driven by other factors that affect water handling at the household level. The difference is not statistically significant at conventional confidence levels. Differences in Total Coliform and TDS are inconclusive. All in all, the pollution results indicate no clear role of the water storage containers in increasing pollution levels. Thus this hypothesis cannot be fully resolved at this stage. It is noted that pollution levels in tanks are high and unlikely to be caused by households or the tanker or piped water that went into them, but it does not appear that households without tanks have cleaner water at the point of use.

Table 18: Pollution of Drinking Cups - by Use of Water Storage Tank

		Drinking Cup Pollution			
		E.coli	Total Coliform	TDS	Households
		percent	*percent*	*percent*	*N*
Mountain	Storage Tank	30.4	78.6	8.0	112
	No Tank	na	na	na	0
Coast	Storage Tank	31.8	93.2	79.5	44
	No Tank	47.8	97.1	78.3	69
Total		**36.0**	**87.1**	**43.6**	**225**

Note: Sample only includes connected households. Differences in sample size between tables in this section result from missing testing data at the point-of-use and survey non-response.

<u>Hypothesis 5</u>: Extensive storage time causes the pollution of the water storage tanks.

Storage time of water can adversely affect the water quality. In a randomized control trial from rural Kenya, Kremer et al (2008) show how extended storage and lack of chlorination have detrimental health effects. If connected households maintain larger tanks and store their water for longer periods than unconnected households that might explain some of the E.coli in the tanks.

Table 19 shows the average water storage time for households. The results indicate for the mountainous area that E.coli prevalence is lower in tanks with longer storage time. The apparent negative relationship between pollution and storage time is confirmed by the Total Coliform test results. However, TDS pollution appears to be rising with storage time. None of the differences between prevalence rates are statistically different, though, and these tests can only be done for the mountains while on the cost storage times are very low.

Table 19: Pollution of Water Storage Tanks – by Storage Time

		Storage Tank Pollution			
	Storage Time	E.coli	Total Coliform	TDS	Households
		percent	*Percent*	*percent*	*N*
Mountain	max 1 week	27.3	63.6	9.1	11
	max 2 weeks	22.4	60.5	6.6	76
	above 2 weeks	22.2	55.6	11.1	36
Coast	max 1 week	25.0	83.3	100.0	12
	max 2 weeks	na	Na	na	0
	above 2 weeks	na	Na	na	0
Total		**23.0**	**61.5**	**16.3**	**135**

Note: Storage time categories are exclusive. The sample only includes connected households and is restricted to large tanks to ensure comparability. Differences in sample size between tables in this section result from missing testing data and survey non-response.

Differences in storage time of tank water do not seem to be a cause of E.coli pollution in the tanks. Hypothesis 5 is rejected.

***Hypothesis 6*: Rationing of piped water causes storage tank pollution by mixing.**

Mixing of truck and pipe water in storage tanks can cause E.coli pollution. When pipe water has been cut off for several days and storage tanks run empty, households are forced to obtain water from traditional sources such as water trucks. If mixing of truck water with piped water in the storage tanks is a source of pollution then larger E.coli prevalence among mixing households should be observed.

Table 20 shows E.coli prevalence in tanks of connected households which mixed pipe and truck water in the tank filling tested for pollution. E.coli prevalence increases from 15.8% (unmixed) to 34.9% (mixed) in the mountain areas, which is equivalent to a 54.7% increase (statistically significant at 90% confidence). Coastal households do not mix their tank water, limiting the analysis to the mountainous areas.

Table 20: Pollution of Water storage Tanks – by Mix of Water sources

		Storage Tank Polluted			
	Water Source	E.coli *percent*	Total Coliform *percent*	TDS *percent*	Households *N*
Mountain	Pipe	15.8	61.1	2.1	95
	Mixed	34.9	65.1	18.6	43
Coast	Pipe	36.7	88.5	98.6	139
	Mixed	na	na	na	0
Total		**29.2**	**75.5**	**53.1**	**277**

Note: Sample only includes connected households. Differences in sample size between tables in this section result from missing testing data and survey non-response.

However, while mixing of water sources can explain the doubling of E.coli prevalence in the mountain storage tanks it is not sufficient to explain the E.coli prevalence among households that do not mix their drinking water. Especially for the coastal area, the alarmingly high level of E.coli prevalence remains unexplained. Hypothesis 6 cannot be rejected.

***Hypothesis 7**: Rationing of piped water causes storage tank pollution by pipe flushing.*

The very process of water rationing can be a source of pollution. The epidemiological literature shows that water rationing in pipes increases the risk of E.coli pollution. In a randomized trial in urban Uzbekistan Semenza et al (1998) find that diarrhea is directly attributed to leaky pipes and lack of water pressure. The causal relation between water pressure and pollution is also underlined by Vairavamoorthy et al (2007).

Under normal operation, water pipes develop a biofilm coating which provides a habitat for pathogenic micro-organisms (Barry and Hughes, 2008; Flemming, 2002). During water rationing the pipes become empty and the biofilm begins to bloom. When water supply is reactivated, the micro-organisms are partially flushed out and should not be consumed. In the case of the mountainous area, however, the polluted flush water ends up in the storage tanks and pollutes the drinking water. Pipes are permanently connected to the storage tanks and cannot be disconnected when the polluted flush water arrives. This problem has been observed in other cities with regular water rationing (see Potter et al, 2010, on the effects of water rationing in Amman, Jordan).

Although pollution through pipe flushing cannot be shown using the available survey or laboratory data, flushing remains a potential source of pollution for the mountainous area that cannot be discarded. Hypothesis 7 is not rejected.

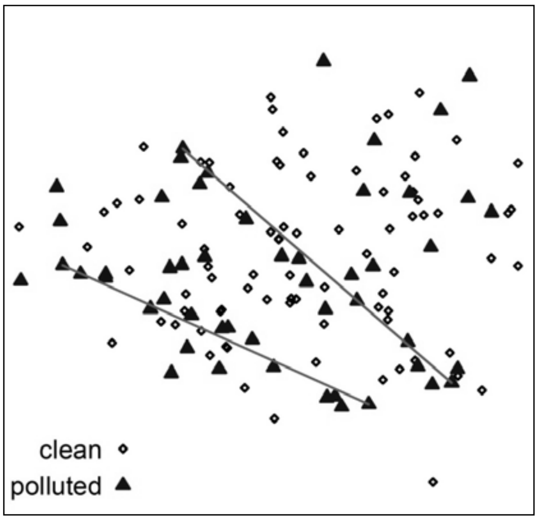
<u>Hypothesis 8</u>: Leaks in the small feed pipes cause pollution of the drinking water.

Irrespective of water rationing and flushing, leaks in the small feed pipes connecting individual households to the main water lines might be an important source of pollution (for an overview on the transmission channels see for example Friedman et al, 2003; and Gadgil, 1998). This is especially relevant for the coastal area, where average E.coli pollution in storage tanks (33.3%) and drinking cups (41.4%) is very high (see Table 21).

Small pipes were not directly tested for E.coli, but spatial analysis of the households with polluted drinking water can provide evidence. When pollution is due to leaking pipes, household pollution should be observed along these pipes. If pollution has other sources, no clear spatial pattern of pollution should be observed. Figure 9 provides the graphical image of the coastal town of Zabid. The graph clearly shows a pattern of pollution along two roads (parallel lines) which correspond to the drinking water pipes in the south-western part of town. Especially when comparing the area at the bottom of the graph with the upper half of the graph it becomes clear that pollution is above average along these roads.

A similar spatial distribution for the mountain town of Amran does not show any spatially obvious pattern (see Annex 5). This provides some evidence that E.coli pollution results from the piped network. This is most likely due to leaks in the pipes, since rationing is rare in the coastal area. Leaks allow waste water, animal residuals and other pollutants to enter the drinking water.

Figure 9: Spatial distribution of E.coli polluted storage tanks (Coastal)



Note: The figure shows spatial distribution of households with E.coli polluted storage tank using GPS coordinates. While some pollution appears random, a clear pattern is visible in the lower half, which is marked by 2 straight lines which correspond to the roads used for water pipe construction.

This comes as a surprise, since sewerage coverage is quite extensive in the coastal town, with 84.9% of all households connected to the piped sewerage system, implying that sewage is safely removed from the city (see Table 4 in section 3.2). However, the urban streets are not sealed in the coastal area which makes it easy for animal waste to seep into the ground. Since the groundwater table is very shallow, sewage does not seep in very deep. In addition, post-project extensions of the piped network are predominantly carried out above ground and are very prone to damage and leaks. Hypothesis 8 cannot be rejected.

<u>Hypothesis 9</u>: Household members cause the water pollution at the point-of-use.

From the storage tanks the water runs to a tap. Rather than drinking directly from the tap, most households (90.3%) fill up kitchen containers with a capacity of 5-10 liters for daily drinking use. These small kitchen containers are traditionally made from clay to keep the drinking water cold, since water from the pipes and storage tanks heats up during the day time. Nowadays, most households use insulated kitchen containers made from plastic (74.2%) or metal (24.5%). Such kitchen containers can be a potential source of E.coli pollution in the drinking water (for a comprehensive overview, see Gundry et al, 2004). Unfortunately, only a small proportion (8.8%) of kitchen containers could be tested for pollution, making it impossible to draw meaningful conclusions from any comparisons.

However, water quality tests of the final point-of-use – the drinking cup – provide sufficient observations for analysis. As in many poor countries, household members typically share a single drinking cup, thereby facilitating the spread of water borne diseases. Given the limited degree of water purification (e.g. boiling, filter use, etc) it can be expected that E.coli prevalence increases between the water tank and the point-of-use.

Table 21 shows that E.coli prevalence between water storage tank and drinking cup indeed increases among connected households - on average by 23.3% (mountains) and 25.6% (coast). The change in the control households is somewhat lower in the mountain area, but even higher in the coastal area.

Table 21: Change in Pollution between Storage Tank and Drinking Cup

		Changes in Pollution Prevalence			
		E.coli	Total Coliform	TDS	HH
		percentage points	*percentage points*	*percentage points*	*N*
Mountain	Water	23.3	17.2	0.9	116
	No Connection	16.0	10.0	0.0	50
	Control Town	22.0	36.0	0.0	50
Coast	Water	25.6	7.7	-20.5	117
	Control Town	31.0	4.2	-35.2	71
Total		**24.1**	**13.5**	**-11.8**	**407**

Note: Table reports changes. Differences in sample size between tables in this section result from missing testing data and survey non-response.

The changes in Total Coliform confirm the increase at household level, although to a lower scale. Changes in TDS are virtually absent in the mountainous area, and strongly negative in the coastal area. This clearly points to an improvement of TDS pollution in the coastal area towards the point-of-use.[29]

Overall, the results imply that about a quarter of the E.coli prevalence at point-of-use can be attributed to unhygienic water handling at household level. Hypothesis 9 cannot be rejected.

4.3 Conclusion on the Causes of Drinking Water Pollution

In conclusion, water pollution appears to occur at various stages between the well and the point of use. Although project wells and main feed pipes are clean of E.coli in the mountainous area, water rationing appears to cause pollution in the small feed pipes which deliver water to the connected households. In addition, the coastal area shows signs of E.coli pollution in at least one of the main feed pipes, endangering water quality for a large share of the urban population. In addition, spatial analysis shows evidence that leaks in the small pipes are causing pollution in the coastal area.

Surprisingly, household members do not seem to be polluting the water in the storage tanks. Unfortunately, there is only limited proof of chlorine use or any other additional water purification at household level.

Storage tanks are primarily polluted because of excessive water rationing in the mountainous areas, forcing households to obtain untreated water from traditional sources and causes pathogenic micro-organisms to be flushed into the tanks. Tank pollution in the coastal area – where rationing is rare – is most likely due to problems in the pipes. Notably, the duration of water storage does not seem to have any direct impact on E.coli prevalence in the water storage tanks.

Lack of hygienic water handling and lack of purification (e.g. boiling, filters, etc) adds to further pollution when filled into the kitchen container for daily use. Lastly, sharing of a single drinking cup among all household members causes yet another increase of E.coli prevalence at this point-of-use.

[29] Given the lack of water purification, the improvement of TDS values is puzzling and would require further investigation.

Water pollution through household members is an important factor in the overall pollution. These results imply that the project had no beneficial impact in terms of improved water handling. The central role of drinking water storage and handling has long been shown (see for example, Mahfouz et al, 1995, on household water handling in Saudi Arabia). The missing program focus on chlorination and household level water handling appears to be a key problem and is directly related to the limited health impact of the overall intervention.

Conversely, one can also say opportunities to reduce pollution levels at the household level have not been used. Given that water is stored in households (sometimes in roof tanks and then smaller jars), there would be great need to use water storage for water purification (e.g. by chlorinating it). This approach is a great opportunity for future attention.

Chapter 5: Multivariate Impact Analysis

Building on the descriptive screening of the data in the previous chapter, the following presents the results of the econometric analysis, employing advanced quantitative evaluation techniques including propensity score matching and instrumental variable regression to control for selection bias.

The focus of the statistical analysis lies on testing hypothesis no. 1, namely the effect of water and sanitation on health, using variables on disease incidence and severity both in adults and children.[30]

5.1 Overview of the Variables

The following impact variables are available for the various hypotheses.

Health-related variables

For the analysis of water-borne diseases five key symptoms were measured. In absence of reliable medical diagnostics it is recommended to measure symptoms rather than diseases, since respondents are able to report symptoms with a lower degree of error. The measured symptoms are watery diarrhea, bloody diarrhea, abdominal pain, vomiting, and fever. The analysis takes place at household level, meaning that within-household percentages are used.

To illustrate this method, consider the variable *Disease*. A household member is considered ill when at least one symptom is reported to have occurred during the past four weeks before the interview. The number of ill household members is then divided by the total household size, resulting in a measure of morbidity within each household. The measure ranges from zero, meaning that no household member reported any symptom to one, meaning that everybody

[30] Due to limitations in the data it is not possible to statistically test all hypotheses introduced in chapter 1.3. The effect on livelihood and education via days missed at work and in school is analyzed using propensity score matching, however it has to be noted that due to the very low reporting of days missed (less than 45 households in both regions claim to have taken sick leaves due to water related symptoms), the reliability of the results is doubtful. For the same reason, those two impact indicators were not included in the instrumental variable regressions. Variables on gender related impact (hypothesis 4) could only be measured for treated households, which limits analysis using the treatment-control group framework applied elsewhere in this chapter. The investigation of these hypotheses therefore takes place on the descriptive level (see above in chapter 3).

reported at least one symptom during the reference period. Since disease incidence among small children is a crucial impact indicator, the variables *Disease*, *Diarrhea* and *Severity* are included for the subgroup of children up to the age of five.

Health-related variables

Disease	Household incidence of water-borne symptoms (at least 1 out of 5 symptoms)
Diarrhea	Household incidence of diarrhea (bloody and watery)
Severity	Household incidence of water-related symptoms, which were classified as severe by the respondent
Disease (child)	Same as Disease, limited to children 5 years and younger
Diarrhea (child)	Same as Diarrhea limited to children 5 years and younger
Severity (child)	Same as Severity limited to children 5 years and younger
Workdays missed	Number of work days missed due to water-related symptoms limited to working age household members
Schooldays missed	Number of school days missed due to water-related symptoms limited to household members enrolled in school.

Control variables

The following control variables are used in the econometric analysis in an attempt to control for the majority of observable factors that could influence the impact of the program.

Socio-economic characteristics

Education (hh head)	A set of binary variables indicating the educational level of the household head. The categories are „no education“, „primary” (including religious madrasa schools and vocational training which presumably provide reading and writing skills), „middle“, „secondary“ and „tertiary“. The reference category used in the regressions is „none“
Knowledge (disease)	A binary variable on household level, which takes the value 1 if the respondent correctly reports that all 5 symptoms can be related to water
Dependency ratio	A variable typically used to measure household composition. The ratio is calculated by dividing the number of household members younger than 15 or older than 60 by the total number of household members
Own house	A binary variable indicating whether the house/apartment is owned by the household
Asset	An aggregate index of wealth based on reported housing characteristics.[31]
Household size	The total number of household members

Housing characteristics

Distance (centre)	The distance of the dwelling from the city centre in meters (calculated using GPS data)
Age (house)	The reported age of the dwelling
Rocky ground	A binary variable taking the value 1 if the dwelling is built on rocky ground which presumably makes the connection to piped networks more difficult

[31] See Annex 4 for the construction of this index.

Hygiene-related variables

Soap	A binary variable indicating whether soap and/or detergent is used for hand washing
Purify (water)	A binary variable indicating whether water is purified by the household before drinking

Water-quality-related variables

Unreliable	A binary variable indicating whether the respondent claimed that the most substantial problem of the main source for drinking water is unreliability
Poor quality	A binary variable indicating whether the respondent claimed that the quality of the water from the main source for drinking is „bad“ or „very bad“
Sewerage breakdown	Number of times the toilet of the household was unusable during the past three months
Truck	Binary variable indicating whether household uses trucked water for drinking
E.coli	Binary variable indicating pollution with E.coli (measurements above 2.2 MPN/100ml) at the level of the drinking container
TDS	Measurement of total dissolved solids (mg/L)

5.2 Impact Estimates from the Propensity Score Matching

As described in, propensity score matching is a useful statistical technique to reduce selection bias by matching similar households from the treatment and control groups using the so-called propensity score, which is defined as the estimated probability of receiving treatment. When estimating the propensity score, a number of factors need to be taken into account. Covariates used for the estimation should satisfy two vital conditions. First, they should influence both the probability of receiving treatment as well as the impact. Second, they should not be changed by the treatment itself. In line with these requirements, the propensity score below is based on the household knowledge of water-related diseases (*Knowledge (disease)*), the education level of the household head

(*Education (hh head)*), the household composition (*Dependency ratio*), the household size (*HHsize*) and the ownership of the dwelling (Own house).[32]

Box 2: Matching Techniques

To match the treated and untreated observations, three well established algorithms were employed, namely kernel matching, radius matching and nearest neighbor one-to-one matching. When applying kernel matching, each treated observation is matched with an artificial control, which is constructed from all control observations, receiving different weights, depending on the distance of their propensity score from the score of the treated observation. Contrary to this approach, nearest neighbor matching matches only one control (the one with the propensity score that is closest to that of the treated observation) to each treated observation. Radius matching can be seen as a method lying somewhere in between. Here, the non-weighted mean of all controls within a defined distance (referred to as caliper) from the propensity score of the treated observation are combined to form a control observation.

The tables below only show the results of the radius matching, since kernel and nearest neighbor matching yielded very similar figures. The Average Treatment Effect on the Treated (ATT) is calculated as the difference of means of treatment and control groups of the impact variables after matching. Hence, a negative result can be interpreted as a decrease in the impact variable due to the treatment and vice versa. Table 22 below displays the matching results when treatment is defined as “connection to water only”. Here, all households which are connected to a water pipe but do not have access to a sanitation system are classified as treated. For the sake of consistency, the in-town control groups (i.e. unconnected households in the treatment towns) are excluded for the regional

[32] A number of different models were compared for the estimation of the propensity score. The model used was chosen based on the kernel density estimate of the propensity score distribution for both the treated and the controls. Sufficient overlap of both densities is vital for successful propensity score matching, since it guarantees that for each treated observation, control observations with similar propensity scores are available.

comparisons between the mountainous area and the coastal plain. The control groups are the households in the control towns Raydah and Al-Jarrahi.

Impact of Water

Table 22: Propensity Score Matching – Impact of Water

Outcome	Mountain			Coastal			Amran		
	ATT	t-value	N	ATT	t-value	N	ATT	t-value	N
Disease	0.0455***	2.76	488	0.0399**	1.98	560	0.0268*	1.72	567
Diarrhea	0.0193	1.53	488	0.0111	0.73	560	0.0195*	1.75	567
Severity	0.0329**	2.25	488	0.0184	1.21	560	0.0239*	1.76	567
Workdays missed	-0.0076	-0.6	496	-0.0074	-0.59	560	-0.0030	-0.19	573
Schooldays missed	0.0018	0.84	496	0.0441*	1.81	560	0.0018	0.57	573
Disease (child)	0.1078*	1.71	361	0.1328	1.36	338	0.0631	1.17	409
Diarrhea (child)	0.0954***	3.19	361	0.0151	0.38	338	0.0412	1.3	409
Severity (child)	0.1347*	1.87	361	0.1879	1.62	338	0.1041	1.63	409

The table shows the impact (also called Average Treatment Effect for the Treated, ATT) of water on each investigated outcome. The impact is reported for the mountain area, for the coastal plain, and separately for the mountain town Amran, using the in-town control group not yet connected to any piped network.

In line with the descriptive results, the findings for the mountain region suggest a significant increase in disease incidence for households connected to the water pipe system. For the coastal plain the results are less clear, with only few impact variables being affected by being connected to the water pipes.[33] For Amran the analysis is repeated at the town level by excluding the control town.

The findings for Amran are similar to those for the mountainous region as a whole, however the negative effect of piped water on health seems less

[33] Statistical significance implies that results are not due to coincidence. This is important, since surveys represent the total population with a certain degree of error. Hence results are always reported with the probability of error, where lower probabilities of error are desired. . Significance is expressed using asterisks *, with one asterisk * indicating a probability of error of up to ten percent, two asterisks ** of up to five percent and three asterisks *** indicating a probability of not more than one percent. Significance levels can be calculated using t-values. The cut-offs for the various levels of significance are *=1.64, **=1.96, and ***=2.58.

pronounced in terms of both size (e.g. for disease about half as high), and significance. Possible explanations for these effects are presented below.

A possible explanation for these unexpected negative health impacts could be the unreliable piped water supply in the mountainous areas leading to water quality problems, which are discussed extensively above. This can cause bacterial contamination in the pipes. The pollution might also be due to the water trucks, which are used whenever the pipes do not deliver any water. Some evidence for both hypotheses is available in Table 27 in Annex 3, which shows that the use of alternative water sources (mainly tanker trucks) is very common for connected households in the mountain town Amran.[34] As discussed above, problems with water tanks, mixing of water sources and some problems with feeder pipes plus poor water handling at the household level appear to contribute to these water quality problems.

The slight differences in results between the mountainous region (Amran and Raydah) and the town of Amran alone (Treatment Group and In-Town Control Group) can be explained by similarities in behavior. Water-handling practices and water sources are more similar between treated and un-treated households in Amran than between treated in Amran and un-treated households in the control town.

Impact of Sanitation

Table 23 below displays the matching results for the impact of sanitation. Here the control groups are all households without sanitation, but with connection to the water pipe system. Since no households with water pipe connections exist in the control towns this analysis is restricted to the treatment towns, using the in-town-control groups. Results need to be interpreted relative to the impact of water. Insignificant results imply that the impact of a joint connection to water

[34] Annex 6: Impact Results
Table 48 in Annex 5 shows the results of the propensity score matching coding only those households as treated that only use piped water for drinking. The strong, positive correlation between water and disease incidence cannot be observed here, suggesting a contaminating effect of alternative water sources. However, due to the small size of the subsamples, these results should be interpreted with great caution.

and sanitation pipes is no different from the impact of water pipes alone. Positive (negative) results suggest that the impact of a joint water and sanitation treatment is stronger (weaker) relative to being connected to only piped water.

Table 23: Propensity Score matching - Impact of Sanitation

Impact	Mountain			Coastal		
	Impact (ATT)	t-value	N	Impact (ATT)	t-value	N
Disease	0.0187	0.99	458	-0.0373*	-1.79	841
Diarrhea	0.0087	0.62	458	-0.0207	-1.3	841
Severity	0.0077	0.48	458	-0.0244	-1.53	841
Workdays missed	0.0567*	1.87	469	0.0086	0.78	841
Schooldays missed	0.0097*	1.75	469	-0.0346	-1.32	841
Disease (child)	0.1382*	1.73	327	-0.1172	-1.03	418
Diarrhea (child)	0.0150	0.4	327	-0.0223	-0.51	418
Severity (child)	0.0684	0.84	327	-0.0899	-0.64	418

For the mountains, the strong positive effect on disease incidence found for water is not changed by the results for sanitation. Especially the increase of sick leaves for work and school, as well as diseases among small children seems to be exacerbated by access to sanitation.[35] This implies that the disease burden and its consequences are more pronounced when households are connected to sanitation in addition to the water connection. The limitation to these results is the reduced sample size given that some 30 % of the households do not have young children. For the coastal town, the results suggest that sanitation might decrease the disease incidence. However, except for the overall per capita disease incidence, estimates are insignificant.

The differences between the study areas provide some hints of why sanitation can have both a negative and a positive impact on health and related impact indicators. The main suspect is the widespread water rationing, which is likely to prevent households from using flush toilets. Instead, traditional water buckets

[35] Results might appear unstable due to the small number of reported sick leaves in the sample.

are used in the bathrooms, which can quickly become a source of contamination. Consequently, the increased availability of water (at least on some days) might create a habitat for bacteria and other pollutants in the sanitary facilities. In contrast, where water supply is regular, sanitation access appears to indeed reduce disease incidence.

5.3 Impact Estimates from the Instrumental Variable (IV) Regressions

As described in more detail in Annex 2, instrumental variables provide another possibility of dealing with selection bias among project participants.

Box 3: Instrumental Variable Regression

Instrumental variables allow the estimation of impact in case the explanatory variables are correlated with the error term. This is likely in three cases. First, in case of reverse causality, for instance when the dependent variable influences one or more of the covariates; second, if relevant explanatory variables are omitted from the model that are correlated with both the dependent as well as the independent variables; or third, in case of measurement error. Instrumental variables are not part of the explanatory model. Rather, the idea is to replace the endogenous covariates which correlate with the error term with such that do not do so (which is the so-called criterion of exogeneity), but still correlate with the replaced covariates (which makes them relevant).

Instrumental variables are especially helpful if the source of the bias is likely to change over time. In such a case it cannot be fully controlled for using propensity score matching. Instruments need to fulfill two conditions, however. First, they need to be relevant, meaning that they need to be strong predictors of treatment.[36] Secondly, instruments must be exogenous, meaning that they should not be correlated with the impact indicator.[37] For example, the distance a household lives from the centre should predict connection, without having any

[36] The criterion used for relevance here is the F-test of the first stage regression, which, according to Cragg, J.G. and S.G. Donald, 1993, should have a value of at least 10.

[37] Instrument exogeneity can never be fully tested. For this report, the Hansen test is used (as is common practice). The null hypothesis of exogenous instruments can always be accepted (see Table 24 and Table 25), suggesting valid instruments.

influence on the health effects of the connection. While relevance can be shown statistically, instrument exogeneity cannot be fully tested.

Interviews of local stakeholders and the project progress reports suggest that construction typically began in the city centre. The distance a household lives from the centre might hence be a useful instrument that determines connection status. Similarly, the material of the ground (rock or sand) around the building reportedly affected whether a household was connected early. This is because the initial program emphasis was on connecting many households in little time, a goal which was partially achieved in digging through sand rather than rock. Especially in the mountain town the ground material seems to have played a crucial role in who was connected first. Lastly, the age of the building provides another possible instrument, since very young houses did not exist when the projects were rolled out.

The suggested instruments for water and sanitation (distance to city centre; age of house; and rocky ground*)* can be shown to have affected the treatment decision, while not having a direct influence on the various impact indicators scrutinized in this study. This makes the instruments both relevant and exogenous as required.

Impact of Water

Following the logic of the set up for the propensity score matching, a distinction between the town and the regional level, as well as between the two treatments „water“ and „sanitation“ is made. However, for the analysis of the effect of water, a binary variable *Sanitation*, indicating whether the household also has access to a sewerage system, is included in the analysis, rather than running the regression on the subsample of households connected to water, but not to sanitation, as well as households not connected at all. Analogously, whether or not a household belongs to the in-town-control group of a treated city is controlled for by a binary variable indicating the city.[38] The variables used to

[38] Note that only a city variable for Amran is needed, since there is no in-town-control group for water in Zabid. All households in Zabid are connected to the water pipe system.

explain the impact are the same for both treatments and all investigated impact categories (with similar results regarding the significance and magnitude of the coefficients of the explanatory variables), the results are summarized in Table 24 and Table 25, which show only the coefficients of the treatment variables for each impact variable.

Table 24: Instrumental Variable Analysis - Impact of Water

Impact	Mountains				Coastal			
	Impact Water	F-test first stage	Hansen p-value	N	Impact Water	F-test first stage	Hansen p-value	N
Disease	0.088**	44.29	0.436	1,072	0.061	54.35	0.646	1,253
Diarrhea	0.060**	44.29	0.422	1,072	0.046	54.35	0.420	1,253
Severity	0.101**	44.29	0.432	1,072	0.011	54.35	0.764	1,253
Disease (child)	0.288*	32.50	0.781	784	0.102	30.92	0.374	671
Diarrhea (child)	0.112	32.50	0.607	784	0.068	30.92	0.422	671
Severity (child)	0.377**	32.50	0.416	784	0.179	30.92	0.289	671

In general, the impact of piped water using the instrumental variable regression is very similar to the results obtained using propensity score matching. It shows that having access to water supply in the mountain town causes a deterioration of health. The results are significant for all impact indicators with the exception of diarrhea among children.

A series of control variables were included in the regressions above, which contain interesting information that helps to identify the cause of the unintended impact.[39] The binary variable *Sanitation*, controlling for the additional access to sanitation, is insignificant in all cases, suggesting that sanitation does not reduce the adverse health effects of water in any of the study areas. The positive and significant coefficient of the variable *Truck*, indicating that households use water from tanker trucks for drinking, supports

[39] The full regression results for all impact indicators can be found in Table 49 - Table 69 in annex 5.

the hypothesis that the direct impact of water on disease incidence might actually be caused by contaminated water from sources other than the pipe system.[40] In line with the results of the propensity score matching, no significant increase of disease incidence can be observed in the coastal plain.

As expected, the effect of water purification is negative, although the coefficients are insignificant, possibly due to the very small number of households treating their water before drinking. Among the socio-economic factors, the most influential variables are house ownership (reducing disease incidence) and the share of children and elderly living in the household (increasing disease incidence). This effect is fairly consistent for both regions (with the exception of regressions with very few reported positive impact, such as disease incidence and severity among children). There is some evidence for reporting bias[41], since higher education and good knowledge of the transmission of water-related diseases sometimes have a significant positive effect. Self-reported diarrhea incidence might be biased for three reasons. Respondents may not be aware of the diarrhea incidence among other household members, although it can be assumed that mothers are fairly well informed about the health of their younger children. Second, poorer people tend to underreport their health burden when certain illnesses are very common, which can make rich households look worse off. Third, health knowledge may be limited and hence symptoms misreported. While all these sources of reporting bias are relevant they will not affect the relative comparison between treatment and control groups before and after the intervention, since the reporting bias will affect both groups in a similar way. As long as the intervention does not affect the reporting bias, these relative comparisons are valid.

The effect of household wealth, measured by the asset index variable *assets* is somewhat unclear. Wealth appears to be reducing the disease burden in the

[40] Note that the variable „*truck*“ is not used in the model for the coastal plain, since there almost no household connected to the water pipe system uses additional drinking water from tanker trucks.

[41] The term *reporting bias* in this case refers to the phenomenon of richer, more educated people claiming to be sick more often, due to a heightened awareness of diseases and their own well-being.

mountains, suggesting that poorer households suffer more, even when controlling for education. In the coastal area, poorer households appear to be benefitting most from the project, since wealth and disease burden are negatively correlated.

In line with the results of the matching analysis, frequent water rationing in the mountains and a lack of hygienic water handling at household level appear to be behind the adverse impact water seems to have on the disease burden of households. Some of the control variables reveal a more nuanced picture between the study areas. House ownership reduces disease incidence, perhaps because storage tanks and bathroom are kept in better conditions when the dwelling is owned rather than rented. The share of children and elderly living in the household increases the disease burden, possible because of their weaker immune systems and – regarding children – their lower consideration of hygiene aspects. Household wealth creates some puzzle, since wealth is correlated with a lower disease burden in the mountains and a higher disease burden in the coastal area.

Impact of Sanitation

With regard to sanitation, the results of the propensity score matching are only indicatively confirmed by the instrumental variable regressions, since the results are never significant. Also, the results for the coastal plain cannot be interpreted, since the relevance of the instruments is not given in this specification.[42] The results are nevertheless qualitatively in line with the magnitude and sign of the coefficients of the propensity score analysis, suggesting that sanitation increases disease incidence in the mountains and decreases it in the coastal region. Both propensity score matching as well as IV regressions generate fairly consistent findings. Water access appears to have increased health problems in the mountains, while in the coastal plain some evidence of reduced health problems associated with access to sanitation is found.

[42] Values of the F-test are well below 10.

Table 25: Instrumental Variable Analysis - Impact of Sanitation

Variable	Mountains				Coastal			
	Coef. of Sanitation	F-test first stage	Hansen p-value	N	Coef. of Sanitation	F-test first stage	Hansen p-value	N
Disease	0.008	46.91	0.887	436	-0.152	3.160	0.330	826
Diarrhea	0.011	46.91	0.335	436	-0.071	3.160	0.420	826
Severity	0.024	46.91	0.518	436	-0.079	3.160	0.792	826
Disease (child)	0.103	34.38	0.907	311	-0.552	4.938	0.703	411
Diarrhea (child)	0.001	34.38	0.632	311	-0.187	4.938	0.496	411
Severity (child)	0.158	34.38	0.667	311	-0.626	4.938	0.793	411

The IV regressions were repeated including E.coli contamination and high levels of total dissolved solids (TDS) as explanatory variables. However, the coefficients are virtually never significant and always close to zero (see Table 49 to Table 69).[43] This suggests that for the subsample for which laboratory tests were conducted a contamination with E.coli and TDS does not have a measurable influence on the investigated health impact. While this might be expected for TDS[44], it is less clear why E.coli pollution does not have a significant effect on reported illnesses. This is something that deserves further investigation.

To rule out the possibility of increased E.coli tolerance, the analysis was repeated using higher cut-off values for E.coli pollution (5.1 MPN/100ml and 9.2 MPN/100ml compared to the standard threshold of 2.1 MBN/100ml). The findings remain unchanged.

Besides possible errors in the E.coli measurements, the reason for the missing effect of E.coli on health could also lie in the nature of the dependent health

[43] The coefficients for water and sanitation somewhat change in the regressions including E.coli and TDS, compared to the full sample specification. This is probably rooted in the small subsample sizes. The smaller samples can lead to spurious changes of significance.

[44] Illnesses caused by total dissolved solids tend to be long-term (such as kidney stones or clogging of arteries) and might not always cause immediate symptoms of the gastro-intestinal tract.

variables used. Being asked about symptoms experienced during the past four weeks, some people might not precisely remember all symptoms, or might be unwilling to openly admit them, thus leading to underreporting. Reduction of the sample size to the one fifth of its initial size for which water test measurements were available might also be responsible for the lack of significant results. Lastly, there was a time gap between the measurement of reported health symptoms and the water tests and this might reduce the statistical relationship.

Water and Sanitation Access and Water Pollution

In principle, E.coli and TDS has been shown to negatively affect the digestive system and lead to gastro-intestinal problems. The level of pollution with E.coli and other pollutants is hence an important link between water and sanitation systems and adverse health impact. Hence the effect of water and sanitation on the contamination of water with E.coli and TDS is also investigated. E.coli measurements at two different points in the test chain are used. The water typically arrives at the household at a storage tank and the first sample is taken here. The second sample is taken from the drinking cup used by household members. The difference in E.coli between those two testing points can be associated to household level pollution (see Table 67 and Table 68).

In Amran, the pollution in the tank is not different between treatment and control areas, suggesting that the pipes do not deliver exceptionally bad water quality. In the coastal plain, where water arrives directly at a tap over half the households and only 50% of households use storage containers (and store for much shorter time periods), the connection to water and sanitation has a decreasing effect on contamination. This is relative to the control town, where water is provided through vendors who take their water from polluted wells (see Table 7).

Regarding the pollution through the household, it appears that E.coli contamination is higher in the drinking cups when households are connected to sanitation in the mountain region.

These findings might help to explain the results on disease incidence reported above. The reason behind the increase in disease burden is likely to be associated with an absence of hand-washing[45] in combination to the way how toilets are flushed using a single bucket. The fact that sanitation in the treatment towns is not comparable to western-style flush toilets, but usually means manually flushed (and possibly quite often blocked) indoor toilets, may be the key to the puzzle of why households in the mountainous area without connection to a piped sewerage system are faring better in terms of E.coli pollution (see Table 7). The investigation of impact of water and sanitation access on TDS (see Table 69) shows that water access is associated with higher TDS in the mountains, suggesting that the interruptions in supply are indeed a factor in accounting for the poor water quality in the mountains using this indicator.

Rural and Urban Results

In comparison with the impact evaluation of rural water and sanitation in Yemen this analysis points to some interesting similarities (IOB, 2007). Most importantly, water quality is strongly affected by storage facilities at household level in the rural areas. In addition, broken pipes and erratic water supply were found to reduce the quality of piped water.

Similar to the urban study, impacts of hygiene awareness campaigns could not be detected due to a virtual lack of such activities. As a result, handling of water at household level was found to be very poor, very much in line with what can be seen in urban areas.

Despite these problems, the study finds for several health indicators a significant reduction of prevalence of 4-5 percent. For diarrhea, prevalence among household members in control villages is on average 75 percent compared to 71 percent in villages with a piped water scheme. While this change in prevalence goes in the right direction, the magnitude of the change is not very great and

[45] Although the vast majority of household members claims to wash their hands after using the bathroom, it could be assumed that this answer was given due to moral obligations rather than reflecting common practice.

points to the fact that 95 percent of the population affected by water borne diseases such as diarrhea does not benefit from piped water in terms of health. To reduce the disease burden for the large share of the population more efforts are needed.

While in rural areas also many source wells were polluted, this does not seem to be a problem for the wells feeding the urban piped network. However, erratic water supply, lack of water pressure and falling ground water tables are endangering the sustainability of the piped networks.

Chapter 6: Conclusions

This report analyses the impact of access to piped water and sanitation on health, and, to a lesser extent, on livelihood, education and gender. Probably the most disconcerting finding of this analysis is an increase in disease burden and disease severity associated with access to piped water in the mountain city of Amran while no significant positive or negative results can be detected for Zabid. These results are robust throughout the various methods used in the descriptive and econometric analysis of the household data. They are also supported by the baseline data and by secondary health facility data.

A possible explanation of the deterioration in health indicators in Amran is the very erratic water supply in Amran, which causes severe rationing and hence forces households to obtain water from unsafe sources such as trucks. Moreover, water rationing is likely to cause a pollution of the pipes and mixing of water sources, as indicated by subjective data collected in the survey. The econometric results of the propensity score matching and instrumental variable regressions support the hypothesis that water rationing is causing the deterioration in health.

With regard to livelihood effects that are regularly used in appraisal reports no clear impact was found. The assumed transmission channel asserts a positive effect on livelihood via increased productivity and reduced sick leaves based on an improvement in health. Given the lack of positive health impacts time or productivity gains can only be expected due to the need to fetch water by hand ceasing to exist; and are not found. In general, very few households reported sick days due to water-related symptoms in both treatment and control towns which is needed to employ regression techniques to analyze the relative livelihood effects between treatment and control groups. Overall, the hypothesis on water and sanitation having livelihood effects is rejected for this project. Minor effects might occur in settings with more successful health outcomes. Gender issues are analyzed on the descriptive level. While time savings are typically stronger in rural areas, it seems that the connection to a water pipe system did indeed lead to some increases in leisure time, not only for girls and women, but also for boys and men in the coastal plain where they had been involved in fetching water before the project.

The effect of sanitation in the mountains is less clear. The results of the propensity score matching show almost no significant effect in addition to the effect of water. However, the sign of the effects suggests a slight worsening of health caused by sanitation. Results from the instrumental variable regressions point in the same direction, however, they too are mostly insignificant and should not be overstated. For the coastal city of Zabid the impact of water supply on disease burden is somewhat harder to quantify than for the mountains. Neither the descriptive nor the econometric analysis yields robust results in either direction. The subjective impression of the households connected to the water pipe system is hard to determine, with most of the treated households reporting no change in disease incidence after connection. However, some small, tentative evidence for perceived improvement exists. Results regarding effects on livelihood, education and gender are very limited, similar to those in the mountain town of Amran.

Some positive impact on health may be caused by sanitation in the coastal plain. Although most results are not significant, some specification of the propensity score matching and IV regression suggest a slight decrease in disease incidence and severity due to sanitation.

Comparing the households' subjective assessment of health changes after connection to water or sanitation with disease incidence reported during the past four weeks (see Table 10 and Table 11) yields some discrepancies. On average, disease incidence in households from the treatment group which reported a reduction in sickness after the connection is still higher than in the respective control town. However, perceptions of no change, as well as a deterioration of health after receiving treatment more or less coincide with the reported disease incidence.

Extending the analysis by using laboratory measurements of E.coli and total dissolved solids in a subsample of 500 households (20 percent of the total sample) yields surprising results: In general, E.coli contamination is far above acceptable levels in all towns for truck water as well as the water in household tanks (which for connected households – depending on the recent supply situation – can be pipe water only, a mixture of pipe and truck water, or pure truck water). Regarding the polluted tanks, it remains unclear and recommended subject to further investigation whether the pipe water arrives already contaminated, or if its quality deteriorates while stored within the tank. It could also be that contamination increases both within the feed pipes and the tanks. In fact, given the severe e-coli pollution it is surprising that not a much higher disease burden was found in the survey data. However, the data show no significant influence of E.coli pollution (or TDS) on health indicators in our analysis. Small sample size, as well as a general difficulty associated with recall data from households could be the reason for these findings. The sanitation component seems to increase E.coli contamination of water at the point of use (drinking cup) in the mountain region, where water rationing is frequent. This could be from the increased exposure to feces when sewerage pipes are clogged due to a lack of water in the sewerage system. .Piped water access in the mountains increases TDS pollution, likely linked to unreliable supplies. Contrary to the objective water quality data, the descriptive analysis of the subjective judgments of the households is typically rather positive, particularly in the coastal areas.

Policy Implications and Further Research

One important goal of a quantitative impact analysis is to determine not only the effectiveness of a program but to also shed some light on causal links that might condition the success or failure of a project. One clear message from the current evaluation is that success depends on a number of conditions which can differ dramatically between locations. A clear policy implication for the case of Amran is to tackle issues of water resource management and availability prior to expanding the water pipe and sewerage system any further. Evidence from this study suggests that access to piped water might not have the desired health effects due to frequent water rationing. Increasing the reliability of piped water supply is likely to cause a reduction of storage time of water in household tanks, and a decrease of bacteria growth.

Piped networks might not be the best choice for localities where ground water is severely limited and rationing of piped water not avoidable. In fact, it might be worth testing alternatives systems of water supply, such as public standpipes with higher water reliability. A market based system of trucked water supply in combination with regulation and supervision of truck water quality might be another preferred solution for extremely water scarce localities, as trucks are able to tap more distant wells. Regardless of the method of water supply, water quality at point-of-use needs more attention. For example, water storage tanks at household level might be useful for additional water purification.

This finding on the impact of water and sanitation services on health prompts a range of further questions. In particular, it is critical to investigate to what extent water quality at source versus contamination of water en route – especially within the different sections of the pipe network and the main household storage tank – are responsible for these results. Moreover, the role of water handling and hygiene practices at the household level need to be examined in greater detail. For example, it is only possible to speculate on how connection to a piped sewerage system causes an increase in disease burden. In particular, randomized control trials should be used to identify to what extent hygiene training and water purification at household level can help to improve water quality at the point of use and avert these negative health effects. Similarly, it is important to investigate the reasons for reduced and irregular water supply and decreased water quality. Here technical and institutional issues are likely to play a crucial role. These points could contribute to clearer policy implications to reduce the incidence of water-borne diseases.

It appears quite clear that a focus on engineering aspects of water supply and sanitation is unlikely to yield the expected health effects, unless it is accompanied by greater attention to all links of the supply chain. Additional emphasis should be put on water quality at point-of-use, handling of water and sewage, and hygiene practices. What packages of interventions yield the best impact should be the focus of future analyses.

Annex 1: Description of Survey Towns

Four towns are selected for the impact evaluation. The two treatment towns represent two distinct topographic environments, and therefore allow some conclusions for other provincial towns in Yemen within the same environment respectively. Amran is located in the mountainous region of Yemen, while Zabid is a coastal plain town, sited in the west of the country.

As already mentioned above, the households of the control group should be as similar as possible to those of the treatment group. For purposes of this evaluation, two types of control groups were selected: in-town and out-of-town control groups. The in-town control group comprises households in the project town of Amran (no in-town control group could be used in the town of Zabid, as the few households there not yet connected to pipe water supply turned out to be too different in socio-economic terms from the others), which – although located in or near the treatment areas – have not yet been connected to water and/or sanitation. Out-of-town control groups consist of unconnected households in non-project towns similar to the treatment towns in terms of socioeconomic, topographic and other aspects. For each of the two treatment towns, a control town was selected in spatial vicinity, namely Raydah for Amran, and Al-Jarrahi for Zabid. As can be seen from the descriptive results in Chapter 3, there seem to be systematic differences to exist between the households in the control and the treatment groups, which made adjustments of the grouping necessary. More details on how this is achieved will be given in Annex 2.

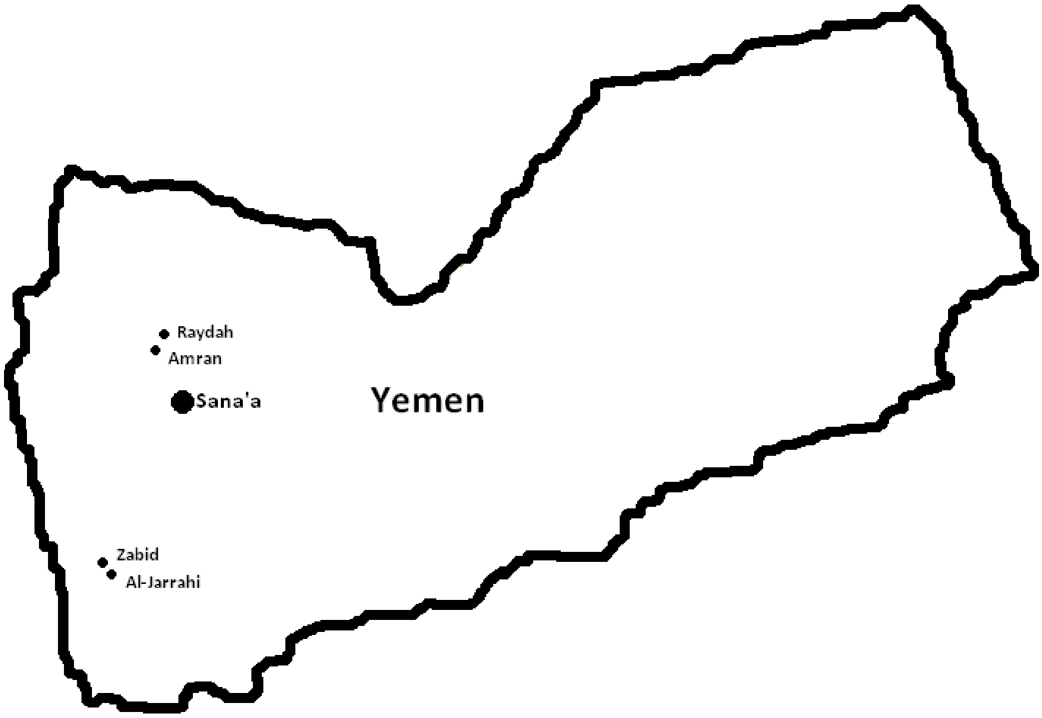
Figure 10 provides any overview of the locations of the four survey towns. Amran is located about 50 kilometers northwest of the capital Sana'a, in a mountainous area at about 2260 meters above sea level (15° 39' 45N; 43° 56' 39E). The town is growing fast due to rural exodus and already had a size of about 78,000 inhabitants back in 2004.[46] Raydah is located about 30 kilometers further to the northeast, with very similar topography at a height of about 2160 m and about

[46]Source: CSO, 2010. The recent inflow of civil war refugees did not affect the main household survey, as it gained momentum only after the survey.

14,000 inhabitants (15° 49' 24N; 44° 2' 19E). Zabid is located in the coastal plain at only 85 meters above sea level and is smaller than Amran with about 22,000 inhabitants (14° 11' 42N; 43° 18' 55E), while Al-Jarrahi is situated at a height of 147 meters just about ten kilometers to its southeast with about 19,000 inhabitants (14° 7' 57N; 43° 23' 18E).

Topographic conditions resemble those in Zabid closely. Climate conditions differ between mountains and the coastal plain, the latter being characterized by sub-tropic (while still relatively dry) conditions, extremely high temperatures topping 40°C and high degree of air humidity of around 90%. Annual rainfall in Amran and Raydah ranges in average around 400 and 500 mm per year, while Zabid and Al-Jarrahi receive only around 130 mm (rainfall increases with height, as rain clouds usually enter the country from the west and rain off upon reaching higher areas).

Figure 10: Location of Survey Towns



Groundwater situations differ widely between the mountainous region and the coastal plain, with ground water table in Amran and Raydah sinking distinctly while water scarcity is less of a problem in Zabid and Al-Jarrahi. In Amran resource conflicts about water can be observed, where agriculture (here especially the water-intensive growing of Qat[47]) and cement production compete for the same ground water as households.

This is not the case in the coastal plain, where ground water table depletion is not a pressing matter, and societal structures differ from the traditional system in the highlands. The population in the coastal plain is not structured along tribal lines as in the mountainous areas, but composed of a higher proportion of descendents of former migrants from African countries.

Zabid and Al-Jarrahi are largely unaffected by tensions between government and tribal groups. The contrary can be said for Amran (and to a lesser extent Raydah), which was also affected by refugee inflow after civil unrest in northern Yemen in 2009. Refugees settled mostly outside of town in organized camps, thus causing little distortion during the survey.

[47] Quat is a tropical evergreen plant. Its leaves are used as a mild chewing drug and play a central role in Yemeni daily social life from early afternoon to evening hours.

Annex 2: Methodology

Identifying the project impact on the outcome variables

In the following, methodologies used for evaluating the program impact on the key indicators are presented.

As already mentioned, a crucial point in any impact analysis is coping with selection bias, which arises due to systematic differences between households receiving treatment and those without. If, for example, households in the treatment group are on average more educated and wealthier than those in the control group, the effect of connection to water and/or sanitation might be biased upwards, since education and income also have a (most likely positive) impact on the investigated outcomes variables, such as health. To control for selection bias, a number of methodologies is available. Note that for the sake of robustness it is always desirable to calculate the same impact using various approaches and comparing the results. The more similar the results achieved using different methods of calculation, the more robust one can assume them to be. This section is divided into methods used for data from multiple time periods and those used for cross-sectional data.

Methods used for data from multiple time periods

Difference-in difference

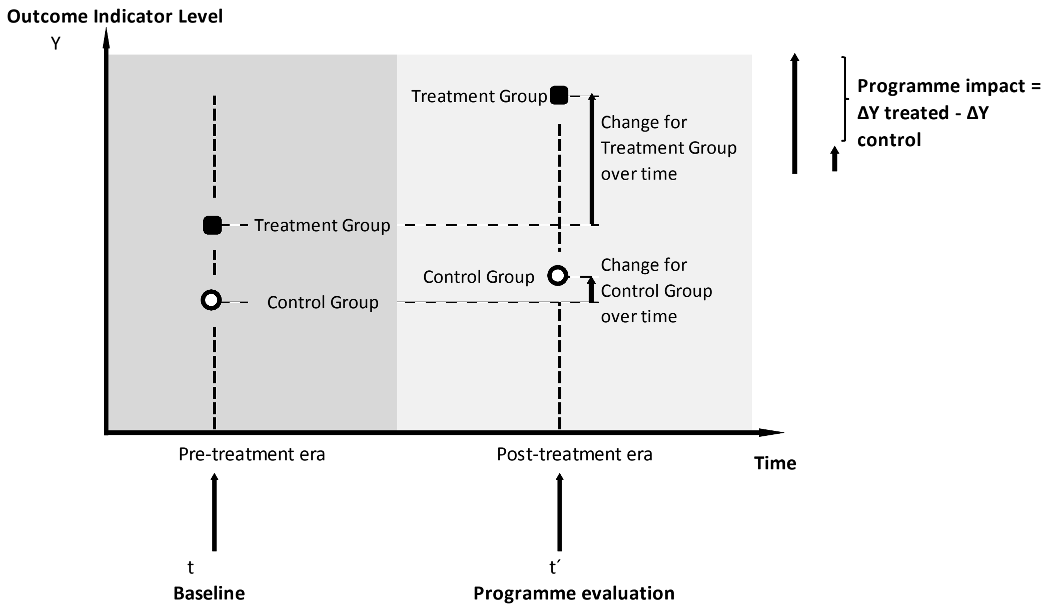
The method of difference-in-difference is a powerful, yet data intensive way of getting rid of the unobserved heterogeneity causing selection bias, as long as this heterogeneity can be assumed to be invariant over time. The form of difference-in-difference used in this study involves the comparison of averaged before-after outcome levels for the treatment and the control group. The impact *I* of the treatment is estimated as follows:

$$I = \frac{1}{n}\sum_{k=1}^{n} (O_k^{after} - O_k^{before}) - \frac{1}{m}\sum_{l=1}^{m} (O_l^{after} - O_l^{before})$$

with *n* being the number of individuals in the treatment group, *m* being the number of individuals in the control group, and *O* denoting the outcome investigated.

Figure 11 enhances an intuitive understanding of the measurements.

Figure 11: Difference-in-Difference Measurement



Methods used for cross-sectional data

Here, differences in impact indicator levels are not calculated over time, but a one-time ex-post comparison between the treatment and the control group is made. Therefore no pre-intervention data is needed.

The most obvious drawback of this option is that it lacks the comparison over time. One noticeable advantage of the one-time cross-section analysis, however, is the possibility to use regression analysis in order to investigate the influence of control variables, such as water handling practice, education etc. on the various impact indicators.

Improving the control group with propensity score matching

As the descriptive results in Chapter 3 have shown, there seem to be systematic differences between the households in the control and the treatment groups.

Therefore it is advisable to construct more appropriate control groups, using so-called propensity score matching. The basic idea of a matching procedure is to find, for each household in the treatment group, a household without treatment which resembles the treated one as closely as possible with regard to a chosen set of important socio-economic indicators (such as age, education, income level, etc.). An obvious problem here is the multidimensionality of the matching problem, as the set of indicators grows large. A solution to this is the so-called propensity score matching, which reduces the problem to one dimension, namely the so-called propensity score (Rosenbaum and Rubin, 1983).

The propensity score PS_i can be interpreted as an estimate of individual *i*'s probability of receiving treatment. It is estimated here using a probit model of the form:

$$PS_i = \Phi(\mathbf{x_i}'\boldsymbol{\beta})$$

with x_i denoting a vector of covariates deemed to determine the probability of receiving treatment, and Φ the cumulated density function of the normal distribution. In a second step, untreated individuals are matched to the treated ones on the basis of the estimated propensity score. A noticeable drawback of propensity score matching is its reliance on the so-called assumption of unconfoundedness, meaning that

$$O \perp P \,|\, X$$

or, in other words, it is assumed that all relevant differences between treated and non-treated individuals are captured by the covariates X, and that therefore assignment to treatment, *P*, is not influenced by further, unaccounted for covariates. Of course this is a rather strong assumption.

Instrumental variables

Instrumental variables are the classical approach for dealing with the endogeneity problem arising in the presence of bias. In a linear regression framework of the form

$$O_i = \alpha + \boldsymbol{\beta}'\boldsymbol{x_i} + \gamma P_i + \epsilon_i$$

with P_i being the treatment status of individual *i* (e.g. $P_i = 0$ if no treatment occurred, and $P_i = 1$ if treatment was received), the presence of bias manifests itself in a correlation between the treatment status P_i and the error term ϵ_i. This means that the program influence γ cannot be reliably estimated.

The instrumental variable approach now tries to overcome this problem by using an estimate P_i, rather than P_i in the linear regression model. The estimate $\widehat{P_i}$ has been constructed in such a way that it only contains those components of the original treatment status P_i, which are not influenced by the outcome O_i , and are therefore not correlated with the error term.

To successfully implement this method, it must be possible to find determinants of program placement (i.e. connection to water or sewerage) that are not influenced by impact categories (i.e. health, education and livelihood factors). These determinants are referred to as instruments. Good candidates for this are distance of the household from the town centre, altitude of the household, ground consistency and age of the district the household is located in.

The vector of instruments, ***IV***, is used to estimate $\widehat{P_i}$:

$$\widehat{P_i} = \delta + \boldsymbol{\theta}'\boldsymbol{IV}_i + \varepsilon_i$$

The unbiased program impact on the chosen outcome O_i is then estimated by:

$$O_i = \alpha + \boldsymbol{\beta}'\boldsymbol{x_i} + \gamma \widehat{P}_i + \epsilon_i$$

It has to be kept in mind that the validity of this approach depends crucially on the quality of the chosen instruments. The instruments have to fulfill the following criteria:

1) Relevance: The instruments must have a strong influence on the variable causing the endogeneity problem (in this case the treatment variable P_i).

2) Exogeneity: The instruments must not be correlated with the error term of the linear regression model.

While it is easy to test for relevance, exogeneity is not fully testable; therefore one has to rely on plausibility assumptions.

x

Annex 3: Descriptive Results

Table 26: Sample Population

Sample Size: Unrestricted

		HHs	*Population*	*For Analysis*
Mountain	Water	201	1777	x
	Water & Sanit.	289	2401	x
	None	375	2986	x
	Subtotal	**865**	**7164**	
Control Town	None	344	2928	x
	Subtotal	**344**	**2928**	
Coastal	Water	127	859	x
	Water & Sanit.	714	4746	x
	None	36	234	
	Subtotal	**877**	**5839**	
Control Town	None	434	3100	x
	Subtotal	**434**	**3100**	
Total		**2520**	**19031**	

Results for the towns of Amran (Mountains) and Zabid (Coastal)

Table 27: Relative Water Use

Water Use, by Piped and Tanker Water

			Drinking Water	*Non-Drinking*	*Sources*
		Source	*Percent*	*Percent*	*N*
Mountain	Water	Pipe	71.6	70.7	449
		Tanker	22.4	21.1	138
		Other	6.0	8.2	43*
		Total	**100.0**	**100.0**	**630**
	None	Tanker	91.7	85.9	387
		Other	8.3	14.1	40
		Total	**100.0**	**100.0**	**427**
	Control Town	Tanker	95.7	95.5	264
		Other	4.3	4.5	12*
		Total	**100.0**	**100.0**	**276**
Coastal	Water	Pipe	99.0	81.3	849
		Tanker	0.1	6.3	3*
		Other	0.8	12.5	11*
		Total	**100.0**	**100.0**	**863**
	Control Town	Tanker	40.9	18.0	150
		Other	59.1	82.0	245
		Total	**100.0**	**100.0**	**395**
Total			**2209**	**419**	**2628**

* Few households

Results for the towns of Amran (Mountains) and Zabid (Coastal)

Slightly less than 3/4 of connected Amran population uses piped water for drinking. 99% of Households in Zabid use Piped Water for drinking.

Table 28: Problems of Water Source

Problems with Piped and Tanker Water

			Unreliable Supply	*Poor Quality*	*Too expensive*	*No Problems*	*Sources*
		Source	*Percent*	*Percent*	*Percent*	*Percent*	*N*
Mountain	Water	Pipe	26.0	9.3	21.3	43.4	389
		Tanker	16.0	8.0	29.6	46.5	213
	None	Tanker	3.1	8.8	40.1	48.0	354
	Control Town	Tanker	3.2	5.5	43.9	47.4	253
Coastal	Water	Pipe	8.7	2.5	29.3	59.5	827
		Tanker	0.0	0.0	33.3	66.7	6*
	Control Town	Tanker	8.7	9.4	35.6	46.3	149
Sample			**10.9**	**6.1**	**31.8**	**51.3**	**2191**

Note: Households use multiple drinking water sources

* Few households

Results for the towns of Amran (Mountains) and Zabid (Coastal)

Reliability is a problem in Amran. Price of piped water is a problem in both towns.

Table 29: Water Rationing

Percent of days no water was available during past 3 month (by Main Water Source)

		No Water available	*Sources*
	Source	*Percent*	*N*
Mountain	Pipe	59.9	479
	Tanker	29.9	790
	Other	17.8	96
Coastal	Pipe	0.9	940
	Tanker	3.8	153
	Other	2.5	293
Total		**14.3**	**2751**

Note: Households use multiple main sources

Control Town included in Tanker and Other Sources

Results for the towns of Amran (Mountains) and Zabid (Coastal)

In Amran there is no water available on 60% of the days.

Table 30: Water quality - Subjective and objective Measurement

			Subjective Grading			Objective Measurement				
						E.coli*		TDS		
		Water *Source*	Accept able or better	Bad or Very Bad	Sub-sample Size	Clean	Pollu-ted	Clean	Pollu-ted	HH
			%	*%*	*N*	*%*	*%*	*%*	*%*	*N*
Mountain	Water	Pipe	96.8	3.2	277	71	29	92.3	7.7	143
	None	Tanker	98.7	1.3	318	79.7	20.3	87.5	12.5	64
	ControlTown	Tanker	99.2	0.8	243	59.4	40.6	100	0	65
Coastal	Water	Pipe	99.4	0.6	818	58.7	41.3	20.2	79.8	140
	ControlTown	Tanker	99.3	0.7	139	38.6	61.4	70.5	29.5	88
Total			**98.8**	**1.2**	**1795**	61.4	38.6	68.6	31.4	**500**

* Sampling Point: Cup[48]
Results for the towns of Amran (Mountains) and Zabid (Coastal)

Table 31: Water quality – Relative Comparison of subjective and objective Measurement

Subjective Quality:		***Clean***		***Clean***		***Polluted***		***Polluted***		***HH***
Objective Quality:		***Clean***		***Polluted***		***Clean***		***Polluted***		
Objective Indicator		*Percent*		*Percent*		*Percent*		*Percent*		*N*
		E.coli	*TDS*	*E.coli*	*TDS*	*E.coli*	*TDS*	*E.coli*	*TDS*	
Mountain	Water	78.57	90.00	20.00	8.57	1.43	0.00	0.00	1.43	70
	Water & Sanit.	60.27	89.04	34.25	5.48	1.37	5.48	4.11	0.00	73
	None	73.44	81.25	18.75	10.94	1.56	0.00	0.00	1.56	64
	Control Town	53.85	95.38	40.00	0.00	0.00	0.00	0.00	0.00	65
Coastal	Water	53.62	24.64	46.38	75.36	0.00	0.00	0.00	0.00	69
	Water & Sanit.	61.97	15.49	36.62	84.51	0.00	0.00	0.00	0.00	71
	Control Town	37.50	69.32	61.36	29.55	1.14	1.14	0.00	0.00	88
Total Sample		**59.00**	**66.20**	**37.80**	**31.00**	**0.80**	**1.00**	**0.60**	**0.40**	**500**

Results for the towns of Amran (Mountains) and Zabid (Coastal)

[48] Here a cup - respectively any other kind of drinking container at hand - from the kitchen was used for water quality testing, which of course may not be representative for all such containers in the household. Still, it is assumed that if there is any noteworthy bias, it will probably lead to a lower estimate of pollution. Probably most household members will give one of their cleaner cups to the tester.

Table 32: Subjective Water Quality – Overall Quality

		Very Good	*Good or Acceptable*	*Bad or Very Bad*	*Sources*
		Percent	*Percent*	*Percent*	*N*
Mountain	Water	58.6	34.8	3.6	814
	None	63.2	32.0	3.2	465
	Control Town	68.2	25.2	2.3	305
Coastal	Water	70.0	28.3	0.9	877
	Control Town	76.4	22.8	0.2	508
Total Sample		**67.0**	**29.2**	**2.0**	**2969**

Note: Households use multiple main sources

Results for the towns of Amran (Mountains) and Zabid (Coastal)

Drinking water is rated less good by connected households.

Table 33: Subjective Water Quality - Taste

			Clean	***Salty***	***Bitter***	***Chlorine***	***Sources***
		Source	*Percent*	*Percent*	*Percent*	*Percent*	*N*
Mountain	Water	Pipe	77.8	3.7	3.4	13.2	378
		Tanker	86.6	6.7	3.6	0.9	659
	Control Town	Tanker	91.2	1.9	1.5	0.8	262
Coastal	Water	Pipe	82.6	0.1	0.3	16.5	793
		Tanker	100.0	0.0	0.0	0.0	5*
	Control Town	Tanker	90.0	2.0	4.0	2.0	50
Total Sample			**84.2**	**3.0**	**2.1**	**8.8**	**2149**

Note: Households use multiple main sources

* Few households

Results for the towns of Amran (Mountains) and Zabid (Coastal)

Piped water appears to be less clean. This subjective result might come from chlorination at the water plant and deterioration of taste.

Table 34: Subjective Water Quality - Color

			Clear	*White Milky*	*Green*	*Muddy*	*Sources*
		Source	*Percent*	*Percent*	*Percent*	*Percent*	*N*
Mountain	Water	Pipe	82.0	9.0	0.5	1.3	378
		Tanker	90.1	2.4	0.6	1.5	659
	Control Town	Tanker	86.6	0.8	0.0	1.9	262
Coastal	Water	Pipe	91.9	5.9	0.1	0.8	793
		Tanker	100.0	0.0	0.0	0.0	5*
	Control Town	Tanker	94.0	2.0	0.0	1.2	50
Total Sample			**89.0**	**4.7**	**0.3**	**1.2**	**2149**

Note: Households use multiple main sources

* Few households
Results for the towns of Amran (Mountains) and Zabid (Coastal)

Piped water in Amran shows sign of pollution. There is almost no indication of algae intrusion.

Table 35: Subjective Water Quality - Odor

			Smell	*No Smell*	*Sources*
		Source	*Percent*	*Percent*	*N*
Mountain	Water	Pipe	3.4	93.4	378
		Tanker	2.0	96.2	659
	Control Town	Tanker	0.4	89.7	262
Coastal	Water	Pipe	1.3	97.4	793
		Tanker	0.0	100.0	5*
	Control Town	Tanker	4.0	94.0	50
Total Sample			**1.81**	**95.25**	**2149**

Note: Households use multiple main sources

* Few households
Results for the towns of Amran (Mountains) and Zabid (Coastal)

Piped water in Amran is perceived to be smellier than other water in Amran.

Table 36: Water Quantity

Water quantity consumed: total amount by purpose, main source

			Quantity per capita per day	*Drinking*	*Cooking*	*Other*	*Sources*
		Source	*Liters*	*Percent*	*Percent*	*Percent*	*N*
Mountain	Water	Pipe	5.8	14.4	22.9	62.8	450
		Tanker	3.8	13.7	21.7	64.8	261
		Other	0.9	27.6	21.4	52.0	87*
		Subtotal	**10.5**	**15.6**	**22.4**	**62.2**	**798**
	None	Tanker	13.2	13.0	23.9	63.2	388
		Other	2.0	18.4	22.3	59.3	75*
		Subtotal	**15.2**	**13.8**	**23.7**	**62.6**	**463**
	Control Town	Tanker	14.7	11.2	23.3	65.5	264
		Other	1.2	15.3	24.0	60.7	28*
		Subtotal	**15.9**	**11.5**	**23.3**	**65.1**	**292**
Coastal	Water	Pipe	23.6	13.0	13.6	73.5	849
		Tanker	0.1	44.4	11.3	44.2	7*
		Other	0.3	35.4	7.7	59.8	15*
		Subtotal	**23.9**	**13.5**	**13.5**	**73.2**	**871**
	Control Town	Tanker	6.6	13.8	14.6	71.7	150
		Other	15.3	18.8	13.0	68.3	355
		Subtotal	**21.9**	**17.2**	**13.5**	**69.3**	**505**
Total Sample			**17.7**	**14.4**	**18.0**	**67.7**	**2968**

Note: Households use multiple main sources. Results refer to main sources only, therefore quantities in the first column are lower than in table 5.

* Few households

Results for the towns of Amran (Mountains) and Zabid (Coastal)

Connected residents in Amran (mountains) consume much less water than in control town, while the difference is less pronounced in the coastal plain.

Table 37: Water Cost Change

Only connected households / by source

			Higher Expenses	*No Change*	*Lower Expenses*	*HHs*
		Source	*Percent*	*Percent*	*Percent*	*N*
Mountain	Water	Pipe	54.3	18.1	27.5	265
		Tanker	49.2	25.0	25.8	124
Coastal	Water	Pipe	81.3	8.6	10.0	798
		Tanker	100.0	0.0	0.0	3*
Total			**72.0**	**12.4**	**15.5**	**1190**

Note: Only 1 answer per household

* Few households

Results for the towns of Amran (Mountains) and Zabid (Coastal)

Water expenses have risen significantly since the connection.

Table 38: Sanitation

Type of sewerage system

	in Percent	***Public sewerage system***	***Septic tank***	***Covered cesspit***	***Open cesspit***	***Canals to open area***	***Other***	***Toilet is not connected***	***Total***
Mountain	Water	1.0	0.0	80.6	1.0	6.0	1.0	10.4	**100.0**
	Water & Sanit.	94.1	1.0	1.7	0.0	0.0	0.0	3.1	**100.0**
	None	0.5	0.0	80.0	1.6	5.6	2.1	10.1	**100.0**
	Control Town	0.7	0.3	91.5	1.7	3.4	1.0	1.4	**100.0**
Coastal	Water	0.0	5.5	78.0	2.4	6.3	2.4	5.5	**100.0**
	Water & Sanit.	98.6	0.4	0.0	0.0	0.0	0.0	1.0	**100.0**
	Control Town	0.5	0.0	3.0	79.4	2.1	13.9	0.5	**100.0**
		* Treatment Scheme	* Technical tank	* Traditional tank	* Open pit	* Open canal			

Results for the towns of Amran (Mountains) and Zabid (Coastal)

Households without connection to sanitation use traditional underground cesspit tanks. Open canals are used by some households, possibly when living on the edge of town.

Table 39: Health - Change of subjective Disease Incidence

Change of subjective disease incidence as result of connection

		Abdominal pain					*Vomiting*					*Diarrhea*					
		More	*No Change*	*Less*	*No Inci-dence*	*Total*	*More*	*No Change*	*Less*	*No Inci-dence*	*Total*	*More*	*No Chang e*	*Less*	*No Inci-dence*	*Total*	*N (HHs)*
		%	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	
Mountain	Water	2.0	17.4	4.0	76.6	100.0	1.5	14.4	5.0	79.1	100.0	2.0	15.4	5.0	78.6	100.0	201
	Water & Sanit.	1.9	16.1	3.7	78.0	100.0	1.5	14.6	2.6	81.0	100.0	2.6	14.2	4.5	78.7	100.0	268*
Coastal	Water	0.0	12.6	11.8	75.6	100.0	0.8	12.6	9.4	77.2	100.0	0.8	14.2	11.8	73.2	100.0	127
	Water & Sanit.	1.3	12.3	14.3	72.1	100.0	1.1	9.7	12.7	76.5	100.0	1.3	11.1	14.6	73.4	100.0	714
Total		**1.4**	**13.9**	**10.3**	**74.4**	**100.0**	**1.2**	**11.7**	**9.2**	**77.9**	**100.0**	**1.6**	**12.7**	**10.8**	**75.3**	**100.0**	**1310**

* Two households had to be dropped due to incomplete data. Note: Households use multiple main sources; only households connected to water and/or sanitation are considered.

Results for the towns of Amran (Mountains) and Zabid (Coastal)

Table 40: Symptoms

Symptoms during past 30 days (by water source used for drinking)

			Diarrhea	***Abdominal Pain / Vomiting***	***Fever***	***People in subsample***
		Source	*Percent*	*Percent*	*Percent*	*N*
Mountain	Water	Pipe	3.8	3.8	3.7	678
		Tank	2.8	2.3	3.7	564
	Water & Sanit.	Pipe	4.9	4.0	5.4	1584
		Tank	4.8	6.6	4.4	273
	None	Tank	3.3	3.5	4.0	2506
	Control Town	Tank	3.3	3.6	2.5	2024
Coastal	Water	Pipe	4.8	4.5	6.6	851
	Water & Sanit.	Pipe	3.3	2.7	3.4	4638
		Tank	16.7	16.7	16.7	6*
	Control Town	Tank	2.9	3.1	3.9	1037
Total			**3.6**	**3.4**	**3.9**	**14161**

Note: Households use multiple drinking water sources

Each Household Member reported up to 4 Symptoms

* Few households

Results for the towns of Amran (Mountains) and Zabid (Coastal)

Interpretation (first cell):

3.8% of all persons in Amran households who drink pipe water suffered from diarrhea last month

Diarrhea appears to be more prominent among households using piped water compared to control areas.

Table 41: Health – Days missed due to Illness

Days missed due to fever, abdominal pain, vomiting and diarrhea

		Diarrhea	*Abdominal pain/Vomiting*	*Fever*	*People*
Mountain	Water	2.24	3.26	5.68	1744
	Water & Sanit.	1.17	4.45	9.16	2226
	None	0.34	4.66	3.79	2981
	Control town	0.20	2.50	4.15	2479
Coastal	Water	7.68	13.62	16.07	859
	Water & Sanit.	3.52	5.46	7.04	4746
	Control town	5.00	5.97	9.13	3100
Total		**2.58**	**5.06**	**7.03**	**18135**

Results for the towns of Amran (Mountains) and Zabid (Coastal)

Interpretation of first value (example): 100 people in subsample Amran water-only miss on average 2.24 days per month due to diarrhea

Mixed picture, more sick-leave due to diarrhea and fever reported both in treatment than in control groups, less sick-leave due to abdominal pain and vomiting in Amran than in mountain control group, more in Zabid than in coastal plain control group except for water and sanitation.

Table 42: Participation in Hygiene Training

Participation		*Training*	*No Training*	*Don't know*	*HHs*
		%	*%*	*%*	*N*
Mountain	Water	7.1	92.2	0.6	490
	None	1.1	96.3	2.7	374
	Control Town	1.0	97.3	1.7	299
Coastal	Water	8.0	90.8	1.2	841
	None	0.0	100.0	0.0	36
	Control Town	0.0	99.8	0.2	434
Total		**4.4**	**94.3**	**1.2**	**2476**

Results for the towns of Amran (Mountains) and Zabid (Coastal)

Very few households participated in hygiene training.

Table 43: Hand Washing

What is used for hand washing?

		Only water	*Soap*	*Other, Missing*	*HH members*
		%	*%*	*%*	*N*
Mountain	Water	30.9	62.4	6.7	4177
	None	48.1	45.0	6.9	2986
	Control Town	50.8	44.5	4.7	2517
Coastal	Water	17.0	79.0	4.0	5605
	Control Town	23.4	71.9	4.7	3100
Total		**31.0**	**63.7**	**5.3**	**18620**

Results for the towns of Amran (Mountains) and Zabid (Coastal)

More households use soap in the coastal plain than in the mountains.

Table 44: Time Saving due to Water Connection

		More time	*Not more time*	*HH*
		Percent	*Percent*	*N*
Mountain	Boys	67.9	32.1	28
	Girls	60.0	40.0	45
	Men	79.2	20.8	24
	Women	69.6	30.4	69
Coastal	Boys	97.8	2.2	92
	Girls	97.9	2.1	48
	Men	98.3	1.7	118
	Women	96.3	3.7	54
Total		**87.4**	**12.6**	**478**

Results for the towns of Amran (Mountains) and Zabid (Coastal)

Especially in the coastal plain the majority reports a time-saving effect of connection.

Table 45: Gender – Changes in Work Burden due to Water Connection

	Improvement	*No change*	*Deterioration*	*Don't know*	*HH*
	%	*%*	*%*	*%*	*N*
Mountain	43.6	45.8	4.4	6.1	472
Coastal	56.7	39.2	1.4	2.6	841
Total	**52.0**	**41.6**	**2.5**	**3.9**	**1313**

NOTE: 6 "not appl." und 1 "missing", taken out of basic population
Results for the towns of Amran (Mountains) and Zabid (Coastal)

Tendency of reduction of work burden through connection.

Table 46: Gender – Change of Socializing Pattern

	More Opportunities	*No Change*	*Less Opportunities*	*Don't know*	*HH*
	%	*%*	*%*	*%*	*N*
Mountain	11.4	73.1	9.1	6.4	472
Coastal	21.0	70.4	5.8	2.7	841
Total	**17.6**	**71.4**	**7.0**	**4.0**	**1313**

Results for the towns of Amran (Mountains) and Zabid (Coastal)

More positive effects in Zabid (generally quite ambivalent).

Annex 4: Asset Index

The asset index is a proxy for household wealth. It is calculated separately for each region (mountain and coastal plain), to account for local differences. The factors entering into the asset index are:

floor	A categorical variable describing the material of the floor of the dwelling[49]
roof	A categorical variable describing the material of the roof of the dwelling[50]
metal windows	A binary variable indicating whether the dwelling has windows with a metal frame
computer	A binary variable indicating whether the household owns a computer
mobile	A binary variable indicating whether the household owns a mobile phone
motor vehicle	A binary variable indicating whether the household owns a motor vehicle
own dwelling	A binary variable indicating whether the household owns the dwelling it lives in

The factors are weighted using polychoric principal component analysis, yielding the following compositions:

- Asset index (mountains) = 0.282 x floor + 0.359 x roof + 0.281 x metal windows + 0.457 x computer + 0.401 x mobile + 0.415 x motor vehicle + 0.414 x own dwelling
- Asset index (coastal plain) = 0.442 x floor + 0.369 x roof + 0.304 x metal windows + 0.44 x computer + 0.32 x mobile + 0.381 x motor vehicle + 0.373 x own dwelling

[49] The categories are: earthen/clay, cement/stone, tiles and carpet.
[50] The categories are: Clay/wood, straw/sticks, metal sheets and cement.

Table 47: Quality of Asset Index

Region AI vs. pooled AI

Assets pooled	Asset region 1	2	3	4	5	Total
1	356	195	0	0	0	551
2	396	18	289	1	0	704
3	16	9	167	83	0	275
4	19	1	141	252	74	487
5	0	0	2	90	411	503
Total	787	223	599	426	485	2520

Income vs. pooled AI

Income	Assets pooled 1	2	3	4	5	Total
1	174	178	53	77	54	536
2	97	175	47	112	73	504
3	103	134	64	93	100	494
4	82	124	60	104	127	497
5	94	91	51	100	148	484
Total	550	702	275	486	502	2515

Income vs. regional AI

Income	Assets by region 1	2	3	4	5	Total
1	256	49	118	63	50	536
2	178	36	138	81	71	504
3	144	41	122	95	92	494
4	115	40	119	105	118	497
5	91	57	102	80	154	484
Total	784	223	599	424	485	2515

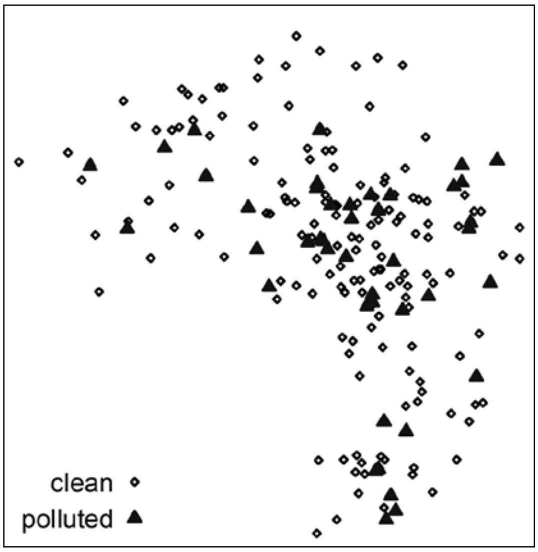
Interpretation: in case of identity, all observations must lie on the diagonal, which would mean the quintiles would be identical in both approaches.

Anyway, it makes quite some difference regarding the relative evaluation of poverty. About 350 households change from quintile 2 to 3 when pooled instead of regional asset index is used.

The comparison to income seems to render a similar picture, with a modest concentration on the diagonal, which is acceptable in light of a clear trend. Correlation lies around 20%.

Annex 5: Sources of Water Pollution

Figure 12: Spatial distribution of E.coli polluted storage tanks (Mountain)



Note: The figure shows spatial distribution of households with E.coli polluted storage tank using GPS coordinates. Pollution appears spatially random with no clear pattern. The lower west side of the mountain town is occupied by industry and not populated. The higher concentration of households is in line with the higher population density in the city center.

Annex 6: Impact Results

Table 48: PSM "Water only"

Var	Mountain			Amran		
	ATT	tv	N	ATT	tv	N
Disease	0.0424	1.41	338	0.0187	0.63	417
Diarrhea	0.0043	0.25	338	0.0036	0.22	417
Severity	0.0384	1.2	338	0.0254	0.8	417
Workdays missed	0.0025	0.12	341	0.0009	0.04	418
Schooldays missed	0.0022	0.42	341	0.0034	0.61	418
Disease (child)	-0.0223	-0.24	253	-0.0874	-1.00	301
Diarrhea (child)	-0.0078	-0.28	253	-0.0592	-1.95	301
Severity (child)	0.1186	0.88	253	0.0328	0.25	301
Disease	0.0424	1.41	338	0.0187	0.63	417
Total			**343**			**419**

Note: Treated: piped water, but no other sources used for drinking (44 households), control: no piped water

Table 49: IV.1 Disease Incidence per Capita

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
Treatment	water	sanitation	water	sanitation
control group	none	water	none	water
Water	0.0880**		0.0609	
	(0.0445)		(0.0489)	
Sanitation	-0.0191	0.00829	-0.0523	-0.152
	(0.0295)	(0.0280)	(0.0396)	(0.122)
primary	-0.00290	0.0365*	-0.00343	-0.00215
	(0.0123)	(0.0212)	(0.0109)	(0.0160)
Middle	-0.00162	-0.0338	0.0175	0.0136
	(0.0195)	(0.0285)	(0.0247)	(0.0346)
Secondary	0.0141	0.0383	0.00293	-0.00564
	(0.0179)	(0.0268)	(0.0131)	(0.0194)
Tertiary	-0.00174	0.0232	0.0228	0.0184
	(0.0209)	(0.0385)	(0.0157)	(0.0232)
knowledge (disease)	0.00481	-0.00495	0.00808	0.0168
	(0.0107)	(0.0183)	(0.00915)	(0.0119)
soap	0.0129	-0.00418	0.0104	0.0363**
	(0.0117)	(0.0202)	(0.00964)	(0.0167)
purify (water)	-0.00680	0.00313	0.0695	0.0969
	(0.0148)	(0.0223)	(0.0443)	(0.0600)
poor quality	0.0418	0.0339	0.0183	0.0228
	(0.0257)	(0.0347)	(0.0269)	(0.0414)
sewerage breakdown	0.00225	0.00771	0.0100	0.00894
	(0.00219)	(0.00846)	(0.00643)	(0.00655)
dependency ratio	0.122***	0.113*	0.0373*	0.0464
	(0.0375)	(0.0630)	(0.0217)	(0.0336)
own house	-0.0452***	-0.0567*	-0.0199	-0.00604
	(0.0142)	(0.0292)	(0.0174)	(0.0272)
assets	-0.00823	-0.00973	0.0104	0.0195*
	(0.00884)	(0.0180)	(0.00635)	(0.0107)
truck	0.0286	0.0245		
	(0.0176)	(0.0198)		
Amran	-0.00938			
	(0.0179)			
Constant	0.0226	0.0775	0.0273	0.114
	(0.0304)	(0.0569)	(0.0323)	(0.0729)
Observations	1.072	436	1.253	826
F test	44.29	46.91	54.35	3.160
Hansen P-val	0.436	0.887	0.646	0.330

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 50: IV.1 Disease Incidence per Capita including E.coli

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.109*		0.0891*	
	(0.0592)		(0.0501)	
sanitation	-0.0531	-0.00975	-0.0890**	-0.0349
	(0.0382)	(0.0412)	(0.0386)	(0.0676)
primary	0.00756	0.00312	0.0356	0.0433
	(0.0258)	(0.0275)	(0.0257)	(0.0384)
middle	0.0199	0.00484	0.0893	0.0960
	(0.0356)	(0.0501)	(0.0751)	(0.143)
secondary	0.00506	0.0417	0.0631	0.0183
	(0.0302)	(0.0439)	(0.0397)	(0.0374)
tertiary	-0.00950	-0.0152	0.00158	-0.0204
	(0.0339)	(0.0408)	(0.0369)	(0.0402)
knowledge (disease)	0.0122	-0.00164	0.0257	0.0243
	(0.0199)	(0.0249)	(0.0214)	(0.0281)
dependency ratio	-0.00844	-0.0600	0.00509	-0.0192
	(0.0821)	(0.0680)	(0.0449)	(0.0589)
own house	-0.0462	-0.0505	-0.0118	-0.0163
	(0.0310)	(0.0399)	(0.0333)	(0.0366)
assets	-0.0114	-0.0314	0.00278	0.00497
	(0.0144)	(0.0243)	(0.0155)	(0.0259)
e.coli	0.0411*	0.0464	0.0349	0.0229
	(0.0220)	(0.0300)	(0.0254)	(0.0347)
truck	0.0244	0.0368		
	(0.0338)	(0.0273)		
Amran	-0.0280			
	(0.0430)			
Constant	0.0882	0.187***	0.0124	0.0894
	(0.0560)	(0.0680)	(0.0582)	(0.0675)
Observations	251	134	222	135
F test	16.36	25.93	41.66	19.03
Hansen P-val	0.948	0.603	0.174	1.000

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 51: IV.1 Disease Incidence per Capita including Total Dissolved Solids

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.111		0.0804*	
	(0.0720)		(0.0439)	
sanitation	-0.0396	-0.0253	-0.0853**	-0.0342
	(0.0396)	(0.0434)	(0.0359)	(0.0687)
primary	0.00485	-0.00151	0.0306	0.0403
	(0.0250)	(0.0271)	(0.0263)	(0.0394)
middle	0.0185	0.0121	0.0829	0.0928
	(0.0348)	(0.0546)	(0.0762)	(0.141)
secondary	0.00227	0.0459	0.0589	0.0153
	(0.0305)	(0.0431)	(0.0393)	(0.0382)
tertiary	-0.0159	-0.0154	-0.000929	-0.0232
	(0.0346)	(0.0399)	(0.0369)	(0.0394)
knowledge (disease)	0.0125	-0.00146	0.0258	0.0261
	(0.0196)	(0.0248)	(0.0212)	(0.0272)
dependency ratio	0.000336	-0.0605	0.00971	-0.0193
	(0.0852)	(0.0706)	(0.0449)	(0.0589)
own house	-0.0480	-0.0417	-0.00772	-0.0130
	(0.0314)	(0.0387)	(0.0329)	(0.0365)
assets	-0.0116	-0.0279	0.000590	0.00477
	(0.0152)	(0.0238)	(0.0160)	(0.0258)
total dissolved solids	-0.000174	8.97e-05	-2.91e-05	1.32e-05
	(0.000170)	(0.000174)	(6.54e-05)	(8.49e-05)
truck	0.0265	0.0359		
	(0.0351)	(0.0273)		
Amran	-0.0243			
	(0.0430)			
Constant	0.149***	0.162**	0.0503	0.0894
	(0.0546)	(0.0792)	(0.0545)	(0.0743)
Observations	252	134	223	136
F test	13.65	16.96	63.15	17.18
Hansen P-val	0.915	0.722	0.191	0.976

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 52: IV.2 Disease Incidence per Child

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.288*		0.102	
	(0.149)		(0.254)	
sanitation	0.0321	0.103	-0.0719	-0.552
	(0.105)	(0.122)	(0.211)	(0.420)
primary	0.0653	0.223**	0.0270	0.0733
	(0.0551)	(0.0984)	(0.0582)	(0.0936)
middle	0.0369	0.0784	-0.0910	-0.1000
	(0.0838)	(0.184)	(0.0657)	(0.120)
secondary	0.101	0.213*	-0.0486	0.00635
	(0.0800)	(0.118)	(0.0513)	(0.120)
tertiary	-0.00886	0.117	0.0904	0.113
	(0.0696)	(0.119)	(0.0706)	(0.125)
knowledge (disease)	-0.0326	-0.0581	0.0376	0.0697
	(0.0481)	(0.0823)	(0.0453)	(0.0657)
soap	0.0784	0.0432	-0.0224	0.0724
	(0.0497)	(0.0874)	(0.0493)	(0.0846)
purify (water)	-0.0950	-0.0460	0.0327	-0.0233
	(0.0631)	(0.0907)	(0.106)	(0.0970)
poor quality	0.196	0.272	0.103	0.0515
	(0.122)	(0.179)	(0.152)	(0.310)
sewerage breakdown	0.00184	0.0303	0.0372	0.0322
	(0.00580)	(0.0361)	(0.0512)	(0.0901)
dependency ratio	-0.0333	-0.0172	-0.101	-0.0874
	(0.134)	(0.252)	(0.120)	(0.171)
own house	-0.0793	-0.153	-0.0166	0.129
	(0.0548)	(0.118)	(0.0826)	(0.134)
assets	-0.0213	-0.0676	0.0677**	0.0915**
	(0.0369)	(0.0715)	(0.0314)	(0.0427)
truck	0.139*	0.147*		
	(0.0744)	(0.0881)		
Amran	-0.0455			
	(0.0742)			
Constant	0.149	0.330	0.154	0.356
	(0.133)	(0.240)	(0.173)	(0.227)
Observations	784	311	671	411
F test	32.50	34.38	30.92	4.938
Hansen P-val	0.781	0.907	0.374	0.703

Robust standard errors in parentheses / *** p<0.01, ** p<0.05, * p<0.1

Table 53: IV.2 Disease Incidence per Child including E.coli

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.0568		-0.0919	
	(0.248)		(0.189)	
sanitation	0.0955	-0.215	-0.0544	-0.107
	(0.164)	(0.190)	(0.129)	(0.377)
primary	-0.00171	-0.00468	0.223*	0.208
	(0.118)	(0.136)	(0.121)	(0.186)
middle	0.116	0.138	0.107	-0.271
	(0.162)	(0.289)	(0.173)	(0.231)
secondary	-0.00369	0.00684	0.163	-0.0157
	(0.0985)	(0.155)	(0.119)	(0.221)
tertiary	-0.0479	-0.214	0.0540	-0.136
	(0.128)	(0.150)	(0.124)	(0.219)
knowledge (disease)	-0.0646	-0.151	0.0791	0.0898
	(0.0744)	(0.0993)	(0.0835)	(0.130)
dependency ratio	-0.436*	-0.358	-0.248	-0.217
	(0.245)	(0.291)	(0.240)	(0.280)
own house	-0.146	-0.0527	-0.0562	0.0213
	(0.118)	(0.173)	(0.111)	(0.127)
assets	0.00886	-0.0464	0.0612	0.127
	(0.0648)	(0.0988)	(0.0844)	(0.145)
e.coli	0.0989	0.245*	-0.0582	-0.0996
	(0.0879)	(0.128)	(0.106)	(0.158)
truck	0.131	0.0609		
	(0.109)	(0.118)		
Amran	0.0731			
	(0.141)			
Constant	0.386	0.749**	0.300	0.193
	(0.270)	(0.308)	(0.249)	(0.273)
Observations	181	96	127	73
F test	10.39	20.12	19.54	5.953
Hansen P-val	0.510	0.982	0.187	0.286

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 54: IV.2 Disease Incidence per Child including Total Dissolved Solids

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	-0.0141		-0.0360	
	(0.352)		(0.139)	
sanitation	0.136	-0.291	-0.0569	-0.102
	(0.182)	(0.225)	(0.126)	(0.362)
primary	-0.00871	-0.0176	0.230*	0.235
	(0.113)	(0.129)	(0.119)	(0.194)
middle	0.123	0.214	0.125	-0.199
	(0.159)	(0.277)	(0.163)	(0.191)
secondary	0.00147	0.0529	0.175	0.0222
	(0.102)	(0.165)	(0.116)	(0.204)
tertiary	-0.0348	-0.191	0.0616	-0.0949
	(0.144)	(0.164)	(0.123)	(0.197)
knowledge (disease)	-0.0653	-0.146	0.0820	0.0872
	(0.0757)	(0.106)	(0.0826)	(0.127)
dependency ratio	-0.398	-0.326	-0.218	-0.221
	(0.248)	(0.331)	(0.252)	(0.327)
own house	-0.142	0.0235	-0.0549	0.0194
	(0.114)	(0.181)	(0.108)	(0.130)
assets	-0.00230	-0.0441	0.0587	0.117
	(0.0684)	(0.102)	(0.0859)	(0.132)
total dissolved solids	0.000164	0.000792	-0.000140	-9.50e-05
	(0.000731)	(0.000941)	(0.000287)	(0.000417)
truck	0.130	0.0571		
	(0.118)	(0.123)		
Amran	0.0949			
	(0.155)			
Constant	0.370	0.473	0.293	0.207
	(0.254)	(0.441)	(0.245)	(0.317)
Observations	182	96	127	73
F test	7.468	16.15	33.28	5.831
Hansen P-val	0.549	0.922	0.236	0.304

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 55: IV.3 Diarrhea Incidence per Capita

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.0601**		0.0464	
	(0.0274)		(0.0318)	
sanitation	-0.00863	0.0114	-0.0393	-0.0708
	(0.0186)	(0.0205)	(0.0276)	(0.0959)
primary	0.0104	0.0259*	-0.00920	-0.00645
	(0.00785)	(0.0140)	(0.00691)	(0.00997)
middle	0.0120	-9.58e-05	0.00822	0.0265
	(0.0134)	(0.0186)	(0.0179)	(0.0277)
secondary	0.0232*	0.0304	0.0100	0.00903
	(0.0130)	(0.0188)	(0.0105)	(0.0143)
tertiary	0.0251	0.0473	0.0104	0.00801
	(0.0159)	(0.0306)	(0.0110)	(0.0168)
knowledge (disease)	0.00222	0.0141	0.00829	0.0102
	(0.00760)	(0.0132)	(0.00629)	(0.00815)
soap	0.00923	0.000607	-0.00267	0.00747
	(0.00853)	(0.0134)	(0.00699)	(0.0121)
purify (water)	-0.0110	-0.0107	0.0503	0.0624
	(0.0109)	(0.0165)	(0.0331)	(0.0447)
poor quality	0.0295	0.0275	0.0109	0.00653
	(0.0205)	(0.0276)	(0.0210)	(0.0367)
sewerage breakdown	0.000748	0.0103	0.00420	0.00682
	(0.000985)	(0.00739)	(0.00633)	(0.00710)
dependency ratio	0.0522**	0.0537	0.0258*	0.0229
	(0.0251)	(0.0460)	(0.0147)	(0.0226)
own house	-0.0167*	-0.0310	-0.0121	-0.00152
	(0.00947)	(0.0190)	(0.0137)	(0.0213)
assets	-0.00308	-0.000234	0.00816*	0.0157**
	(0.00667)	(0.0145)	(0.00418)	(0.00722)
truck	0.0432***	0.0441***		
	(0.0108)	(0.0128)		
Amran	-0.0150			
	(0.0117)			
Constant	-0.0254	-0.0102	0.00741	0.0435
	(0.0231)	(0.0458)	(0.0209)	(0.0558)
Observations	1,072	436	1,253	826
F test	44.29	46.91	54.35	3.160
Hansen P-val	0.422	0.335	0.910	0.420

Table 56: IV.3 Diarrhea Incidence per Capita including E.coli

IV Regression	(1)	(2)	(3)	(4)
	mountain		Coastal	
treatment	water	sanitation	water	Sanitation
control group	none	water	none	Water
water	0.0713*		0.0426	
	(0.0405)		(0.0361)	
sanitation	-0.0326	-0.0298	-0.0366	0.0506
	(0.0237)	(0.0367)	(0.0286)	(0.0520)
primary	0.00744	-0.0135	0.00410	-0.000907
	(0.0187)	(0.0196)	(0.0189)	(0.0289)
middle	0.0387*	0.0170	0.0341	0.0699
	(0.0222)	(0.0303)	(0.0504)	(0.100)
secondary	-0.000143	0.0135	0.0551	0.0148
	(0.0159)	(0.0261)	(0.0342)	(0.0304)
tertiary	0.0154	0.0165	0.00326	-0.00668
	(0.0230)	(0.0363)	(0.0238)	(0.0256)
knowledge (disease)	-0.00169	0.00891	0.0212	0.0158
	(0.0122)	(0.0159)	(0.0160)	(0.0201)
dependency ratio	-0.0415	-0.0891	-0.0292	-0.0561
	(0.0384)	(0.0544)	(0.0384)	(0.0549)
own house	-0.0110	-0.0311	0.0144	0.0168
	(0.0168)	(0.0269)	(0.0234)	(0.0201)
assets	-0.00575	-0.0238*	-0.00297	-0.00691
	(0.00766)	(0.0125)	(0.0113)	(0.0202)
e.coli	0.00432	0.0166	0.0216	0.0178
	(0.0120)	(0.0169)	(0.0195)	(0.0265)
truck	0.0442***	0.0422**		
	(0.0168)	(0.0180)		
Amran	-0.0148			
	(0.0219)			
Constant	0.0201	0.138**	0.00333	0.0218
	(0.0370)	(0.0552)	(0.0404)	(0.0557)
Observations	251	134	222	135
F test	16.36	25.93	41.66	19.03
Hansen P-val	0.536	0.343	0.0609	0.485

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 57: IV.3 Diarrhea Incidence per Capita including Total Dissolved Solids

IV Regression	(1)	(2)	(3)	(4)
	mountain		Coastal	
treatment	water	sanitation	water	Sanitation
control group	none	water	none	Water
water	0.0888		0.0396	
	(0.0538)		(0.0309)	
sanitation	-0.0345	-0.0365	-0.0340	0.0511
	(0.0274)	(0.0376)	(0.0275)	(0.0526)
primary	0.00588	-0.0151	0.00140	-0.00224
	(0.0179)	(0.0194)	(0.0195)	(0.0303)
middle	0.0387*	0.0198	0.0297	0.0683
	(0.0216)	(0.0320)	(0.0506)	(0.0988)
secondary	-0.00189	0.0150	0.0525	0.0134
	(0.0164)	(0.0261)	(0.0336)	(0.0319)
tertiary	0.0108	0.0163	0.00182	-0.00799
	(0.0230)	(0.0358)	(0.0240)	(0.0259)
knowledge (disease)	-0.000810	0.00908	0.0212	0.0176
	(0.0120)	(0.0158)	(0.0156)	(0.0189)
dependency ratio	-0.0426	-0.0899	-0.0246	-0.0539
	(0.0373)	(0.0544)	(0.0382)	(0.0550)
own house	-0.0127	-0.0280	0.0170	0.0196
	(0.0164)	(0.0260)	(0.0236)	(0.0199)
assets	-0.00383	-0.0224*	-0.00443	-0.00711
	(0.00868)	(0.0129)	(0.0118)	(0.0204)
total dissolved solids	-0.000138	3.29e-05	-3.14e-05	5.76e-06
	(0.000131)	(0.000110)	(4.77e-05)	(5.40e-05)
truck	0.0467***	0.0417**		
	(0.0176)	(0.0177)		
Amran	-0.0140			
	(0.0221)			
Constant	0.0555*	0.130**	0.0315	0.0224
	(0.0333)	(0.0592)	(0.0407)	(0.0583)
Observations	252	134	223	136
F test	13.65	16.96	63.15	17.18
Hansen P-val	0.494	0.400	0.0751	0.467

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 58: IV.4 Diarrhea Incidence per Child

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.112		0.0677	
	(0.0759)		(0.0920)	
sanitation	-0.00516	0.00115	-0.0386	-0.187
	(0.0490)	(0.0651)	(0.0745)	(0.148)
primary	0.0136	0.0632	0.0211	0.0580
	(0.0232)	(0.0446)	(0.0303)	(0.0481)
middle	0.0311	0.0455	-0.00441	0.00475
	(0.0371)	(0.0727)	(0.0434)	(0.0710)
secondary	0.0357	0.0700	0.00795	0.0380
	(0.0307)	(0.0516)	(0.0287)	(0.0502)
tertiary	0.0471	0.117*	0.00554	0.0186
	(0.0360)	(0.0632)	(0.0353)	(0.0518)
knowledge (disease)	-0.0311	0.00347	0.0292	0.0447
	(0.0197)	(0.0356)	(0.0219)	(0.0320)
soap	0.0129	-0.0294	-0.0129	0.00371
	(0.0214)	(0.0390)	(0.0273)	(0.0429)
purify (water)	-0.0190	-0.0363	0.0715	0.0647
	(0.0322)	(0.0427)	(0.0682)	(0.0770)
poor quality	0.0709	0.147**	0.0731	0.0437
	(0.0482)	(0.0735)	(0.0819)	(0.123)
sewerage breakdown	-0.000569	0.0177	-0.000556	0.00584
	(0.00220)	(0.0151)	(0.0221)	(0.0384)
dependency ratio	-0.0402	-0.0563	-0.0542	-0.0640
	(0.0640)	(0.131)	(0.0619)	(0.0822)
own house	-0.0394	-0.0726	-0.0151	0.0328
	(0.0257)	(0.0488)	(0.0429)	(0.0567)
assets	-0.0163	-0.0287	0.0164	0.0251
	(0.0144)	(0.0293)	(0.0153)	(0.0208)
truck	0.113***	0.132***		
	(0.0313)	(0.0367)		
Amran	0.0259			
	(0.0304)			
Constant	0.0203	0.151	0.0718	0.163*
	(0.0566)	(0.122)	(0.0778)	(0.0953)
Observations	784	311	671	411
F test	32.50	34.38	30.92	4.938
Hansen P-val	0.607	0.632	0.422	0.496

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 59: IV.4 Diarrhea Incidence per Child including E.coli

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.0502		-0.0864	
	(0.142)		(0.126)	
sanitation	0.00447	-0.182	0.111	0.314
	(0.0797)	(0.171)	(0.0911)	(0.247)
primary	-0.0363	-0.00196	0.0540	-0.0139
	(0.0540)	(0.0757)	(0.0840)	(0.116)
middle	0.0637	0.0807	-0.0251	-0.204
	(0.0847)	(0.128)	(0.122)	(0.152)
secondary	-0.0117	-0.0231	0.0429	-0.157
	(0.0548)	(0.102)	(0.0757)	(0.127)
tertiary	-0.00421	-0.0103	-0.0883	-0.211
	(0.0772)	(0.115)	(0.0814)	(0.136)
knowledge (disease)	-0.00881	0.0105	0.116**	0.160*
	(0.0381)	(0.0631)	(0.0571)	(0.0866)
dependency ratio	-0.0725	-0.100	-0.179	-0.117
	(0.127)	(0.226)	(0.168)	(0.251)
own house	0.00230	-0.0294	-0.0420	-0.00238
	(0.0524)	(0.102)	(0.0811)	(0.0902)
assets	-0.0211	-0.0198	0.0371	0.0253
	(0.0316)	(0.0536)	(0.0463)	(0.0862)
e.coli	0.0745	0.179**	-0.0159	-0.0129
	(0.0469)	(0.0833)	(0.0672)	(0.0947)
truck	0.0951	0.0848		
	(0.0610)	(0.0720)		
Amran	0.0532			
	(0.0837)			
Constant	0.0325	0.247	0.170	0.0471
	(0.150)	(0.245)	(0.181)	(0.207)
Observations	181	96	127	73
F test	10.39	20.12	19.54	5.953
Hansen P-val	0.467	0.563	0.728	0.946

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 60: IV.4 Diarrhea Incidence per Child including Total Dissolved Solids

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.00823		-0.0675	
	(0.172)		(0.0921)	
sanitation	0.0352	-0.218	0.102	0.313
	(0.0872)	(0.174)	(0.0816)	(0.235)
primary	-0.0412	-0.0185	0.0549	-0.0117
	(0.0523)	(0.0780)	(0.0833)	(0.113)
middle	0.0649	0.122	-0.0215	-0.187
	(0.0898)	(0.140)	(0.119)	(0.143)
secondary	-0.0107	-0.00369	0.0440	-0.146
	(0.0574)	(0.112)	(0.0778)	(0.129)
tertiary	0.000380	-0.00418	-0.0888	-0.203
	(0.0833)	(0.121)	(0.0810)	(0.131)
knowledge (disease)	-0.0108	0.0138	0.117**	0.164*
	(0.0383)	(0.0664)	(0.0564)	(0.0946)
dependency ratio	-0.0469	-0.0803	-0.178	-0.0925
	(0.130)	(0.236)	(0.170)	(0.290)
own house	0.00460	0.0150	-0.0408	-0.000811
	(0.0520)	(0.107)	(0.0804)	(0.0925)
assets	-0.0268	-0.0186	0.0373	0.0263
	(0.0328)	(0.0577)	(0.0465)	(0.0760)
total dissolved solids	1.80e-05	0.000235	9.69e-06	-9.95e-05
	(0.000338)	(0.000450)	(0.000147)	(0.000330)
truck	0.0971	0.0930		
	(0.0626)	(0.0727)		
Amran	0.0653			
	(0.0880)			
Constant	0.0493	0.175	0.145	0.0774
	(0.157)	(0.317)	(0.159)	(0.209)
Observations	182	96	127	73
F test	7.468	16.15	33.28	5.831
Hansen P-val	0.406	0.701	0.702	0.936

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 61: IV.5 Disease Severity per Capita

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.101**		0.0111	
	(0.0398)		(0.0403)	
sanitation	-0.0371	0.0237	-0.00886	-0.0788
	(0.0265)	(0.0259)	(0.0319)	(0.0832)
primary	-0.00389	0.0294	-0.00798	-0.00983
	(0.0112)	(0.0192)	(0.00872)	(0.0131)
middle	-0.0197	-0.0287	0.00986	0.00230
	(0.0156)	(0.0240)	(0.0183)	(0.0248)
secondary	-0.00333	0.0280	-0.0104	-0.0191
	(0.0149)	(0.0217)	(0.0101)	(0.0156)
tertiary	-0.0114	0.00980	0.00669	-0.00315
	(0.0178)	(0.0322)	(0.0132)	(0.0191)
knowledge (disease)	0.0254***	0.0156	0.0115	0.0161*
	(0.00908)	(0.0153)	(0.00729)	(0.00960)
soap	0.00172	-0.000284	0.00171	0.0168
	(0.0101)	(0.0177)	(0.00791)	(0.0127)
purify (water)	-0.0122	-0.0133	0.0381	0.0584
	(0.0121)	(0.0177)	(0.0340)	(0.0457)
poor quality	0.0393*	0.0273	0.0417	0.0483
	(0.0215)	(0.0283)	(0.0254)	(0.0387)
sewerage breakdown	0.00110	0.000676	-0.000493	-0.00258
	(0.00149)	(0.00524)	(0.00398)	(0.00494)
dependency ratio	0.101***	0.103*	0.0232	0.0444
	(0.0340)	(0.0559)	(0.0193)	(0.0287)
own house	-0.0317***	-0.0285	-0.00327	0.0139
	(0.0117)	(0.0236)	(0.0113)	(0.0174)
assets	-0.0125*	-0.0178	0.0118**	0.0177**
	(0.00688)	(0.0139)	(0.00517)	(0.00817)
truck	0.0259*	0.0207		
	(0.0153)	(0.0168)		
Amran	-0.0206			
	(0.0153)			
Constant	0.0226	0.0444	0.0106	0.0382
	(0.0257)	(0.0483)	(0.0266)	(0.0501)
Observations	1.072	436	1.253	826
F test	44.29	46.91	54.35	3.160
Hansen P-val	0.432	0.518	0.764	0.792

Robust standard errors in parentheses / *** p<0.01, ** p<0.05, * p<0.1

Table 62: IV.5 Disease Severity per Capita including E.coli

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.135***		0.0891***	
	(0.0521)		(0.0332)	
sanitation	-0.0693**	0.0119	-0.0593**	0.0193
	(0.0330)	(0.0445)	(0.0265)	(0.0588)
primary	0.0174	0.0163	0.0162	0.0120
	(0.0245)	(0.0247)	(0.0185)	(0.0331)
middle	0.00990	-0.00726	0.0670	0.0813
	(0.0317)	(0.0401)	(0.0503)	(0.0959)
secondary	-0.00328	0.0405	0.0127	-0.0199
	(0.0255)	(0.0354)	(0.0235)	(0.0307)
tertiary	-0.0203	-0.0309	0.00311	-0.00441
	(0.0306)	(0.0253)	(0.0292)	(0.0384)
knowledge (disease)	0.0290	0.0236	0.0500***	0.0395
	(0.0191)	(0.0228)	(0.0155)	(0.0246)
dependency ratio	0.0183	0.0367	0.000407	-0.0177
	(0.0779)	(0.0490)	(0.0348)	(0.0522)
own house	-0.0257	-0.0257	-0.00253	-0.00203
	(0.0267)	(0.0264)	(0.0246)	(0.0285)
assets	-0.00320	-0.0214	0.00228	-0.00435
	(0.0133)	(0.0248)	(0.0106)	(0.0244)
e.coli	0.0507**	0.0435	0.0301	0.0416
	(0.0217)	(0.0266)	(0.0186)	(0.0290)
truck	0.0331	0.0428*		
	(0.0316)	(0.0244)		
Amran	-0.0513			
	(0.0399)			
Constant	0.0153	0.0520	-0.0314	0.0360
	(0.0508)	(0.0480)	(0.0433)	(0.0641)
Observations	251	134	222	135
F test	16.36	25.93	41.66	19.03
Hansen P-val	0.556	0.655	0.597	0.543

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 63: IV.5 Disease Severity per Capita including Total Dissolved Solids

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.135**		0.0798***	
	(0.0674)		(0.0294)	
sanitation	-0.0521	0.00192	-0.0583**	0.0197
	(0.0346)	(0.0448)	(0.0278)	(0.0592)
primary	0.0142	0.0123	0.0114	0.00571
	(0.0236)	(0.0239)	(0.0197)	(0.0347)
middle	0.00803	-0.000509	0.0624	0.0753
	(0.0319)	(0.0448)	(0.0513)	(0.0968)
secondary	-0.00660	0.0427	0.00896	-0.0262
	(0.0264)	(0.0358)	(0.0239)	(0.0318)
tertiary	-0.0279	-0.0328	0.000547	-0.0102
	(0.0314)	(0.0245)	(0.0294)	(0.0376)
knowledge (disease)	0.0293	0.0229	0.0505***	0.0425*
	(0.0189)	(0.0225)	(0.0155)	(0.0241)
dependency ratio	0.0293	0.0389	0.00226	-0.0222
	(0.0815)	(0.0526)	(0.0348)	(0.0526)
own house	-0.0278	-0.0184	0.00113	0.00355
	(0.0277)	(0.0268)	(0.0240)	(0.0268)
assets	-0.00357	-0.0185	0.000793	-0.00479
	(0.0143)	(0.0240)	(0.0108)	(0.0243)
total dissolved solids	-0.000203	1.20e-05	-1.44e-06	4.63e-05
	(0.000163)	(0.000120)	(4.91e-05)	(6.33e-05)
truck	0.0353	0.0432*		
	(0.0330)	(0.0242)		
Amran	-0.0467			
	(0.0407)			
Constant	0.0884*	0.0528	-0.00928	0.0268
	(0.0524)	(0.0652)	(0.0443)	(0.0668)
Observations	252	134	223	136
F test	13.65	16.96	63.15	17.18
Hansen P-val	0.567	0.688	0.606	0.579

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 64: IV.6 Disease Severity per Child

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.377**		0.179	
	(0.175)		(0.244)	
sanitation	-0.0710	0.158	-0.0775	-0.626
	(0.114)	(0.120)	(0.208)	(0.446)
primary	0.108*	0.314***	0.0179	0.0504
	(0.0598)	(0.106)	(0.0712)	(0.115)
middle	0.00515	0.0613	0.0341	0.0519
	(0.0910)	(0.173)	(0.108)	(0.203)
secondary	0.0233	0.233**	-0.105*	-0.0609
	(0.0648)	(0.0989)	(0.0565)	(0.136)
tertiary	0.00463	0.175	0.0536	0.0984
	(0.0731)	(0.125)	(0.0746)	(0.139)
knowledge (disease)	0.0837*	0.0340	0.101**	0.151**
	(0.0465)	(0.0796)	(0.0486)	(0.0754)
soap	0.0172	0.0245	0.00804	0.112
	(0.0482)	(0.0834)	(0.0502)	(0.0911)
purify (water)	-0.106	-0.105	0.116	0.0655
	(0.0660)	(0.0907)	(0.146)	(0.191)
poor quality	0.230*	0.275	0.275	0.311
	(0.125)	(0.183)	(0.188)	(0.380)
sewerage breakdown	0.00459	0.0169	0.0575	0.0223
	(0.00775)	(0.0333)	(0.0543)	(0.0879)
dependency ratio	-0.144	-0.182	-0.256*	-0.274
	(0.141)	(0.253)	(0.134)	(0.197)
own house	-0.0878	-0.0811	-0.0285	0.102
	(0.0547)	(0.104)	(0.0840)	(0.134)
assets	-0.0419	-0.135**	0.122***	0.191***
	(0.0360)	(0.0639)	(0.0444)	(0.0710)
truck	0.165**	0.104		
	(0.0690)	(0.0797)		
Amran	-0.0422			
	(0.0815)			
Constant	0.203	0.446*	0.0499	0.312
	(0.130)	(0.244)	(0.171)	(0.259)
Observations	784	311	671	411
F test	32.50	34.38	30.92	4.938
Hansen P-val	0.416	0.667	0.289	0.793

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 65: IV.6 Disease Severity per Child including E.coli

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.462*		0.215	
	(0.245)		(0.233)	
sanitation	-0.194	-0.0660	-0.164	-0.0136
	(0.166)	(0.221)	(0.134)	(0.553)
primary	0.141	0.101	0.194	0.211
	(0.133)	(0.150)	(0.150)	(0.240)
middle	0.0861	-0.0517	0.223	-0.252
	(0.124)	(0.164)	(0.228)	(0.316)
secondary	-0.00805	0.0911	-0.00863	-0.186
	(0.107)	(0.169)	(0.120)	(0.255)
tertiary	-0.115	-0.225*	-0.0223	-0.212
	(0.134)	(0.126)	(0.160)	(0.304)
knowledge (disease)	0.0555	-0.0889	0.350***	0.428**
	(0.0935)	(0.113)	(0.102)	(0.203)
dependency ratio	-0.433	-0.00172	-0.204	-0.0187
	(0.263)	(0.282)	(0.269)	(0.307)
own house	-0.0605	0.0587	-0.0208	0.0553
	(0.125)	(0.135)	(0.123)	(0.111)
assets	0.0814	-0.0572	0.120	0.210
	(0.0752)	(0.102)	(0.149)	(0.289)
e.coli	0.100	0.198	0.0206	-0.0600
	(0.0964)	(0.122)	(0.164)	(0.269)
truck	0.184	0.0939		
	(0.116)	(0.127)		
Amran	-0.118			
	(0.152)			
Constant	0.0522	0.333	-0.132	-0.202
	(0.250)	(0.256)	(0.237)	(0.354)
Observations	181	96	127	73
F test	10.39	20.12	19.54	5.953
Hansen P-val	0.266	0.577	0.851	0.960

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 66: IV.6 Disease Severity per Child including Total Dissolved Solids

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.461		0.224	
	(0.351)		(0.140)	
sanitation	-0.160	-0.106	-0.185	0.00626
	(0.178)	(0.234)	(0.170)	(0.537)
primary	0.124	0.0844	0.188	0.232
	(0.127)	(0.148)	(0.153)	(0.287)
middle	0.0793	-0.00357	0.217	-0.242
	(0.124)	(0.174)	(0.221)	(0.228)
secondary	-0.0142	0.116	-0.0174	-0.192
	(0.110)	(0.172)	(0.121)	(0.239)
tertiary	-0.123	-0.215*	-0.0327	-0.203
	(0.147)	(0.125)	(0.162)	(0.252)
knowledge (disease)	0.0610	-0.0853	0.352***	0.409**
	(0.0949)	(0.117)	(0.106)	(0.182)
dependency ratio	-0.386	0.0228	-0.209	-0.121
	(0.262)	(0.318)	(0.298)	(0.369)
own house	-0.0636	0.110	-0.0173	0.0461
	(0.126)	(0.142)	(0.118)	(0.113)
assets	0.0768	-0.0562	0.123	0.192
	(0.0772)	(0.0986)	(0.152)	(0.255)
total dissolved solids	-0.000284	0.000332	0.000100	0.000304
	(0.000744)	(0.000644)	(0.000388)	(0.000463)
truck	0.197	0.101		
	(0.123)	(0.125)		
Amran	-0.102			
	(0.161)			
Constant	0.136	0.223	-0.176	-0.312
	(0.238)	(0.370)	(0.310)	(0.457)
Observations	182	96	127	73
F test	7.468	16.15	33.28	5.831
Hansen P-val	0.243	0.645	0.819	0.931

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 67: Probit E.coli Tank/Tap Level

Probit Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.192		-0.421**	
	(0.258)		(0.212)	
sanitation	0.124	0.180	-0.109	-0.167
	(0.235)	(0.247)	(0.229)	(0.236)
primary	-0.00335	-0.160	-0.115	0.0809
	(0.211)	(0.297)	(0.224)	(0.299)
middle	-0.748*	-0.718	-0.241	-0.373
	(0.451)	(0.611)	(0.376)	(0.533)
secondary	-0.182	-0.357	-0.200	-0.130
	(0.243)	(0.326)	(0.250)	(0.315)
tertiary	0.00718	-0.156	-0.635*	-0.251
	(0.286)	(0.413)	(0.352)	(0.413)
knowledge (disease)	0.126	0.362	-0.212	-0.128
	(0.175)	(0.236)	(0.178)	(0.232)
soap	-0.230	-0.154	-0.304	-0.468
	(0.183)	(0.265)	(0.215)	(0.300)
purify (water)	0.413*	0.335	-0.224	-0.394
	(0.224)	(0.277)	(0.455)	(0.709)
dependency ratio	0.0470	1.292**	-0.429	-0.540
	(0.452)	(0.641)	(0.345)	(0.461)
own house	0.161	0.194	0.187	0.394
	(0.218)	(0.334)	(0.288)	(0.352)
assets	0.281**	0.512**	0.0450	0.143
	(0.131)	(0.207)	(0.127)	(0.162)
truck	-0.204	-0.147		
	(0.221)	(0.250)		
Amran	-0.765***			
	(0.253)			
Constant	-0.497	-2.243***	0.536	-0.184
	(0.473)	(0.684)	(0.462)	(0.527)
Observations	260	140	228	140

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 68: Probit E.coli Drinking Level.

Probit Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	0.0348		-0.386*	
	(0.252)		(0.212)	
sanitation	0.630***	0.714***	-0.139	-0.207
	(0.234)	(0.242)	(0.225)	(0.239)
primary	0.0726	-0.380	-0.431*	-0.434
	(0.212)	(0.309)	(0.227)	(0.302)
middle	0.0512	0.271	-0.312	-0.646
	(0.348)	(0.493)	(0.393)	(0.564)
secondary	0.0376	0.314	-0.373	-0.382
	(0.247)	(0.333)	(0.250)	(0.316)
tertiary	-0.0532	0.136	-0.224	-0.180
	(0.313)	(0.455)	(0.316)	(0.396)
knowledge (disease)	-0.00531	-0.184	0.0478	0.0463
	(0.177)	(0.245)	(0.178)	(0.233)
soap	-0.103	0.162	-0.209	-0.587*
	(0.186)	(0.272)	(0.217)	(0.309)
purify (water)	-0.0760	0.112	-0.826	omitted
	(0.240)	(0.290)	(0.522)	
dependency ratio	0.403	0.686	0.110	-0.346
	(0.468)	(0.644)	(0.356)	(0.478)
own house	0.105	0.703**	0.455	0.607
	(0.217)	(0.320)	(0.294)	(0.387)
assets	-0.148	-0.0255	-0.0722	0.135
	(0.138)	(0.203)	(0.121)	(0.158)
truck	0.138	0.207		
	(0.231)	(0.266)		
amran	-0.661***			
	(0.252)			
Constant	-0.261	-1.963***	0.344	-0.0169
	(0.464)	(0.589)	(0.467)	(0.546)
Observations	262	142	227	135

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 69: IV.7 TDS Drinking Level

IV Regression	(1)	(2)	(3)	(4)
	mountain		coastal	
treatment	water	sanitation	water	sanitation
control group	none	water	none	water
water	124.9**		-86.98	
	(51.52)		(65.44)	
sanitation	-18.51	52.55	188.3***	58.16
	(26.51)	(50.42)	(45.78)	(62.92)
primary	-7.244	6.362	25.39	-5.408
	(17.44)	(24.15)	(30.38)	(35.58)
middle	1.516	6.040	-38.90	-49.59
	(24.99)	(38.00)	(54.95)	(77.81)
secondary	-10.18	-24.48	22.57	-3.656
	(20.42)	(26.38)	(35.84)	(33.39)
tertiary	-31.34	-16.48	51.16	3.718
	(22.51)	(33.06)	(48.18)	(41.98)
knowledge (disease)	4.136	-9.785	-25.29	2.118
	(13.38)	(19.15)	(23.85)	(24.16)
dependency ratio	-16.83	33.70	53.24	107.5**
	(32.09)	(45.74)	(53.61)	(45.59)
own house	-14.33	-20.83	-13.51	10.95
	(14.34)	(18.07)	(43.32)	(42.37)
assets	17.03	0.139	-32.79**	9.822
	(10.54)	(12.66)	(16.05)	(16.36)
soap	3.803	21.42	-6.558	0.402
	(13.73)	(19.33)	(32.69)	(32.46)
purify (water)	2.318	0.431	-31.52	-59.47
	(14.81)	(12.79)	(38.17)	(61.08)
sewerage breakdown	-1.251	7.238	-30.35	-56.02
	(1.245)	(8.826)	(24.96)	(51.61)
truck	14.99	14.62		
	(17.02)	(16.64)		
Amran	5.496			
	(28.61)			
Constant	247.9***	330.9***	571.0***	490.7***
	(36.35)	(45.42)	(73.74)	(55.67)
Observations	256	137	223	136
F test	14.64	15.81	43.46	16.91
Hansen P-val	0.830	0.809	0.128	0.932

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Annex 7: Household Questionnaire Main Survey

KfW Development Bank Germany

Development Economics Research Group, University of Goettingen

SOUL for Development, Sana'a Yemen

Ministry of Water and Environment Yemen

REPUBLIC OF YEMEN

Water & Sanitation Survey - 2009

Household Questionnaire

HOUSEHOLD ID			(1.01)
CITY	CLUSTER	EA	HH

TO BE FILLED IN BY SUPERVISOR AND DATA ENTRY MANAGER

IS THIS HOUSEHOLD A REPLACEMENT?	(1.02)
FILL IN HOUSEHOLD ID OF REPLACED HH IN (1.03)	1 YES
(1.05) ◀	2 NO

CITY	CLUSTER	EA	HH	(1.03)

ID	INTERVIEWER	(1.05)
	NAME + SIGNATURE	

DAY	MONTH	YEAR	VISIT 1
			(1.06)

DAY	MONTH	YEAR	VISIT 2
			(1.07)

DAY	MONTH	YEAR	VISIT 3
			(1.08)

		WHY WAS HOUSEHOLD REPLACED (1.04)
1	HOUSE NOT FOUND	
2	HOUSE IS BUSINESS BUILDING	
3	HOUSE NOT INHABITATED	
4	NO SUITABLE INTERVIEW PARTNER PRESENT	
5	INTERVIEW WAS REFUSED	
6	SECURITY PROBLEM	
96	OTHER (SPECIFY)	

		COMPLETION (1.09)
1	INTERVIEW COMPLETE	
2	PARTIALLY COMPLETED (GIVE REASON)	

DAY	MONTH	YEAR	CHECKED
			(1.11)a

◀

ID	SUPPORTER	(1.10)a
	NAME + SIGNATURE	

DAY	MONTH	YEAR	CHECKED
			(1.11)

◀

ID	SUPERVISOR	(1.10)
	NAME + SIGNATURE	

DAY	MONTH	YEAR	ENTERED
			(1.13)

◀

ID	DATA ENTRANT	(1.12)
	NAME + SIGNATURE	

NO. OF INCONSISTENCIES DETECTED BY DATA ENTRANT	(1.14)
	NOTES

MAP ID	(1.16)
LETTER	CODE

1	AMRAN	(1.15)
2	RAYDAH	
3	ZABID	CITY
4	AL JARRAHI	

SAMPLING		HOUSEHOLDS LIVING IN HOUSE	(1.17)
(1.18) ◄	IF MORE THAN 1	◄	NUMBER
(1.20) ◄	IF ONLY 1		

LIST OF HOUSEHOLDS (BY NAME OF HEAD)		(1.18)
5	1	
6	2	
7	3	NAMES
8	4	

SAMPLING RESULT	(1.19)
	NUMBER

NAME OF SELECTED HOUSEHOLD HEAD	(1.20)
	NAME

GPS COORDINATES OF DWELLING	
N * '	(1.21)
E * '	(1.22)

CENSUS ID FROM HOUSEWALL	(1.23)

ADDRESS
SPECIFY LANDMARKS TO FIND HOUSEHOLD AGAIN

FILL IN DURING INTERVIEW:

1	YES	CONNECTED TO WATER PIPE SYSTEM ?	(2.01)
2	NO		

1	YES	CONNECTED TO PUBLIC SEWERAGE SYSTEM ?	(4.01)
2	NO		

ASK FOR EACH HOUSEHOLD MEMBER

RESPONDENT ID:

(1.26) What is [NAME]'s gender? 1 MALE 2 FEMALE	(1.25) How old is [NAME]? IF BABY LESS THAN 1 YEAR ENTER ZERO. ESTIMATE FOR ELDERLY USING THEIR CHILDREN'S AGE. YEARS	(1.24) NAME. LIST THE NICKNAME/ CALLING NAME OF ALL PEOPLE CURRENTLY LIVING IN THIS HOUSEHOLD. ORDER OF RECORDING: HOUSEHOLD HEAD • EACH SPOUSE AND CHILDREN • CHILDREN: YOUNGEST TO OLDEST • ELDERLY AND GRANDCHILDREN • COUSINS AND EXTENDED FAMILY • NON-FAMILY MEMBERS •. IF MORE THAN 15 HOUSEHOLD MEMBERS USE SECOND QUESTIONNAIRE	ID CODE
			01
			02
			03
			04
			05
			06
			07
			08
			09
			10
			11
			12
			13
			14
			15

Section 1: Household Composition

ASK FOR EACH HOUSEHOLD MEMBER

RESPONDENT ID:

(1.32)	(1.31)	(1.30)	(1.29)	(1.28)	(1.27)	
During the past 12 months,how many days was [NAME] not present in the household? ASK FOR APPROXIMATION INCLUDES TRAVELS, WORK AWAY, STUDIES, ETC.	MOTHER'S ID CODE IF MOTHER IS NOT A HOUSE-HOLD MEMBER, CODE 98 IF MOTHER IS DEAD, CODE 100	FATHER'S ID CODE IF FATHER IS NOT A HOUSE-HOLD MEMBER, CODE 98 IF FATHER IS DEAD, CODE 100	SPOUSE'S ID CODE IF MULTIPLE WIVES ENTER ALL THAT APPLY IF SPOUSE IS NOT A HOUSE-HOLD MEMBER, CODE 98 IF SPOUSE IS DEAD, CODE 100	What is [NAME]'s present marital status? (1.30) ◄ 1 TOO YOUNG (1.30) ◄ 2 NEVER MARRIED 3 MARRIED (1.30) ◄ 4 DIVORCED / SEPARATED (1.30) ◄ 5 WIDOWED 99 OTHER (SPECIFY)	How is [NAME] related to the household head? 1 HEAD 2 SPOUSE 3 CO-WIFE 4 SON / DAUGHTER 5 SPOUSE OF SON / DAUGHTER 6 GRANDCHILD 7 BROTHER / SISTER 8 FATHER / MOTHER 9 FATHER / MOTHER OF SPOUSE 10 CHILD OF RELATIVE 11 CHILD OF NON-RELATIVE 12 OTHER RELATIVE 13 OTHER NON-RELATIVE	ID CODE
DAYS ABSENT	ID	ID	ID			
						01
						02
						03
						04
						05
						06
						07
						08
						09
						10
						11
						12
						13
						14
						15

Section 2.1: Water Supply

RESPONDENT ID:

COPY ANSWER TO OUTER FLAP 1 ☐ YES (2.06) ◄ 2 ☐ NO	Is your household connected to a water pipe system?	(2.01)
USE GREGORIAN CALENDAR ☐ YEAR	Since which year is your household connected to water pipe system?	(2.02)
☐ NO OF MONTHS 12 ☐ ALWAYS 99 ☐ DON'T KNOW	During the past 12 months, in how many months was water available from the water pipe system? COUNT MONTH IF WATER AVAILABLE AT LEAST 1 DAY	(2.02)a
☐ NO OF DAYS 30 ☐ ALWAYS 99 ☐ DON'T KNOW	During the past 30 days, on how many days was water available from the water pipe system? COUNT DAY IF WATER AVAILABLE AT LEAST 1 HOUR	(2.03)
☐ HRS PER DAY 99 ☐ DON'T KNOW	On a day with water, on average how many hours per day are you able to get water from the water pipe system?	(2.04)
1 ☐ COST PAID BY HOUSEHOLD 2 ☐ COST SHARED WITH OTHER HOUSEHOLDS 3 ☐ WATER IS FOR FREE 99 ☐ DON'T KNOW	How is the water from the water pipe system paid for?	(2.05)
1 ☐ WATER TAP IN KITCHEN 2 ☐ WATER TAP IN TOILET 3 ☐ HAND WASH BASIN 4 ☐ SHOWER 5 ☐ LAUNDRY MACHINE/ ROOM	Which of the following water connections exist in your house? TICK ALL THAT APPLY IF CONNECTION CAN BE OBSERVED TICK WITHOUT PROMPTING	(2.06)
1 ☐ YES (2.10) ◄ 2 ☐ NO	Does your household use any water tanks to store water? ON ROOF, NEXT TO HOUSE, UNDERGROUND, ETC	(2.07)
☐ AMOUNT	How many tanks does your household use?	(2.08)
☐ DAYS	For how many days does a full tank usually last?	(2.09)
1 ☐ AT HOME 2 ☐ OUTSIDE AT WATER PIPE 3 ☐ OUTSIDE AT A STREAM/ POND 4 ☐ AT A SHOP 5 ☐ AT RELATIVE'S/ FRIEND'S HOME 96 ☐ OTHER	Where does your household wash most of its clothes? TICK ONLY THE PLACE USED MOST	(2.10)
1 ☐ YES 2 ☐ NO	Do you know any neighbours or household members who complained about kidney stones?	(2.10)a

READ OUT
I will now ask you some questions regarding the importance of water. Please rate the following aspects between UNIMPORTANT and VERY IMPORTANT according to your judgement.

1 ☐ Unimportant 2 ☐ Little important 3 ☐ Important 4 ☐ Very important	How important is the quality of the daily drinking water? READ OUT	**(2.11)**
1 ☐ Unimportant 2 ☐ Little important 3 ☐ Important 4 ☐ Very important	How important is the amount of daily drinking water you are able to fetch? READ OUT	**(2.12)**
1 ☐ Unimportant 2 ☐ Little important 3 ☐ Important 4 ☐ Very important	How important is the uninterrupted availability of your daily drinking water? READ OUT EXCLUDES BOTTLED WATER	**(2.13)**
1 ☐ Unimportant 2 ☐ Little important 3 ☐ Important 4 ☐ Very important	How important is the price you pay for daily water? READ OUT	**(2.14)**
1 ☐ Unimportant 2 ☐ Little important 3 ☐ Important 4 ☐ Very important	How important is the time needed to fetch the daily drinking water? READ OUT	**(2.15)**
1 ☐ Unimportant 2 ☐ Little important 3 ☐ Important 4 ☐ Very important	How important is the work burden of cleaning and other house work? READ OUT	**(2.16)**
1 ☐ Unimportant 2 ☐ Little important 3 ☐ Important 4 ☐ Very important	How important is it to meet and discuss with other women outside the home? READ OUT	**(2.17)**

Answer	Question	No.
1 ☐ YES (2.31) ◄ 2 ☐ NO	**REPEAT ANSWER OF (2.01)** IS HOUSEHOLD CONNECTED TO WATER PIPE SYSTEM?	**(2.18)**
1 ☐ Improvement 2 ☐ No Change 3 ☐ Deterioration 99 ☐ DON'T KNOW	How has the quality of supplied water changed due to the connection to the water pipe system? READ OUT	**(2.19)**
1 ☐ Increase 2 ☐ No Change 3 ☐ Decrease 99 ☐ DON'T KNOW	How has the amount of water used changed due to the connection to the water pipe system? READ OUT	**(2.20)**
1 ☐ Improvement 2 ☐ No Change 3 ☐ Deterioration 99 ☐ DON'T KNOW	How has the reliability of water supply changed due to the connection to the water pipe system? READ OUT	**(2.21)**
1 ☐ Higher expenses 2 ☐ No change 3 ☐ Lower expenses 99 ☐ DON'T KNOW	How has the amount of money spent on water changed due to the connection to the water pipe system? READ OUT	**(2.22)**
1 ☐ More time available 2 ☐ No Change 3 ☐ Less time available 99 ☐ DON'T KNOW	How has the time use of household members changed due to the connection to the water pipe system? READ OUT	**(2.23)**
1 ☐ Improvement 2 ☐ No Change 3 ☐ Deterioration 99 ☐ DON'T KNOW	How has the work burden of cleaning and other house work changed due to the connection to the water pipe system? READ OUT	**(2.24)**
1 ☐ More Opportunities 2 ☐ No Change 3 ☐ Less Opportunities 98 ☐ NOT APPLICABLE/ MALE RESPONDENT 99 ☐ DON'T KNOW	How have your opportunities to meet and discuss with other women outside the home changed due to the connection to the water pipe system? ONLY ASK TO FEMALE RESPONDENT READ OUT	**(2.25)**

Answer	Question	No.
1 YES (2.28) ◄ 2 NO	Besides the points discussed, has your situation deteriorated since the connection to the water pipe system in any regard?	(2.26)
Specify here	Please specify any reasons not mentioned yet why your situation has deteriorated since the connection to the water pipe system.	(2.27)
1 YES (2.30) ◄ 2 NO	Besides the points discussed, has your situation improved since the connection to the water pipe system in any regard?	(2.28)
Specify here	Please specify all other reasons not mentioned yet why your situation has improved since the connection to the water pipe system.	(2.29)
1 Improved 2 No Change 3 Deterioration 99 DON'T KNOW	Overall, how has your situation changed due to the connection of your household to the water pipe system? READ OUT	(2.30)
1 YES (2.35) ◄ 2 NO 99 DON'T KNOW	Did your household have a choice to be connected to the water pipe system?	(2.31)
1 YES (2.34) ◄ 2 NO	**REPEAT ANSWER OF (2.01)** IS HOUSEHOLD CONNECTED TO WATER PIPE SYSTEM?	(2.32)
HOPE FOR ... (2.35) ◄ 1 CHEAPER WATER (2.35) ◄ 2 BETTER HEALTH (2.35) ◄ 3 BETTER QUALITY OF LIFE (2.35) ◄ 4 TIME GAINS (2.35) ◄ 96 OTHER (2.35) ◄ 99 DON'T KNOW	Why did you decide to have your household connected to the water supply system? TICK ALL THAT APPLY	(2.33)
1 NO NEED 2 INITIAL COSTS WERE TOO HIGH **AFRAID OF ...** 3 MORE EXPENSIVE WATER 4 WORSE HEALTH 5 WORSE QUALITY OF LIFE 6 TIME LOSS *specify here* 96 OTHER (SPECIFY) 99 DON'T KNOW	Why did you decide against the connection of your household to the water system? TICK ALL THAT APPLY	(2.34)

Section 2.1: Water Supply

RESPONDENT ID:

(2.35)	REPEAT ANSWER OF (2.01) IS HOUSEHOLD CONNECTED TO WATER PIPE SYSTEM?
1	YES
2	NO (2.44) ◄

ASK EACH QUESTION FOR BOTH

GIRLS	BOYS	Answer	Question	No.
1	1	YES	Before the water pipe system was constructed, would boys/ girls go to fetch water sometimes? AGE 15 AND YOUNGER	(2.36)
(2.40) ◄ 2	(2.40) ◄ 2	NO		
(2.40) ◄ 98	(2.40) ◄ 98	NOT APPLICABLE		
1	1	REGULARILY	Would the boys/ girls fetch the water regularly, or only in exceptional cases?	(2.37)
2	2	EXCEPTIONALLY (EXCEPTION: VACATION, FESTIVITY, OTHER HH MEMBER ILL, DISTANT SOURCE)		
1	1	MORE TIME	Do boys/ girls in your household have more time available since the household is connected to the water pipe system?	(2.38)
(2.40) ◄ 2	(2.40) ◄ 2	NOT MORE TIME		
1	1	Other housework	What are the main activities boys/ girls are doing with the extra time? READ OUT TICK ALL THAT APPLY	(2.39)
2	2	Work/ Earn income		
3	3	Collect firewood		
4	4	Play		
5	5	Go to school		
specify here 96	specify here 96	OTHER (SPECIFY)		
99	99	DON'T KNOW		

ASK EACH QUESTION FOR BOTH

WOMEN	MEN	Answer	Question	No.
1	1	YES	Before the water pipe system was constructed, would men/ women go to fetch water sometimes? AGE 16 AND OLDER	(2.40)
(2.44) ◄ 2	(2.44) ◄ 2	NO		
(2.44) ◄ 98	(2.44) ◄ 98	NOT APPLICABLE		
1	1	REGULARILY	Would the men/ women fetch the water regularly, or only in exceptional cases?	(2.41)
2	2	EXCEPTIONALLY (EXCEPTION: FESTIVITY, OTHER HH MEMBER ILL, DISTANT SOURCE)		
1	1	MORE TIME	Do men/ women in your household have more time available since the household is connected to the water pipe system?	(2.42)
(2.44) ◄ 2	(2.44) ◄ 2	NOT MORE TIME		
1	1	Other housework	What are the main activities men/ women are doing with the extra time? READ OUT TICK ALL THAT APPLY	(2.43)
2	2	Work/ Earn income		
3	3	Collect firewood		
4	4	Leisure/ see friends		
specify here 96	specify here 96	OTHER (SPECIFY)		
99	99	DON'T KNOW		

ASK FOR EACH WATER SOURCE
RESPONDENT ID:

SIZE (2.49)	(2.48)	(2.47)	(2.46)	READ OUT / (2.45)	WATER SOURCES	(2.44) SOURCE ID
How many liters fit into this container? USE 20 LITER YELLOW BUCKET AS STANDARD REFERENCE IF NO CONTAINER SIZE SPECIFIED IF SIZE NOT KNOWN APPROXIMATE LITERS	Usually, which container do you use to take water from [SOURCE]? 1 NONE 2 BOTTLE 3 YELLOW PLASTIC BUCKET 4 METAL BUCKET 5 CLAY JAR 96 OTHER	Of all the sources used, which are your main sources for non-drinking water? READ OUT WATER SOURCES MORE THAN 1 MAIN SOURCE POSSIBLE 1 MAIN SOURCE 2 NOT MAIN SOURCE	Of all the sources used, which are your main sources for drinking water? READ OUT WATER SOURCES MORE THAN 1 MAIN SOURCE POSSIBLE 1 MAIN SOURCE 2 NOT MAIN SOURCE	I will now ask you some questions about your typical sources of water (2.45) Which of the following water sources did you use in the past 12 months? INCLUDE RARELY USED SOURCES READ OUT WATER SOURCES 1 SOURCE USED 2 NEVER USED ◄ NEXT SOURCE	WATER SOURCES RECORDING: FILL EACH COLUMN FOR ALL SOURCES BEFORE GOING TO NEXT QUESTION IF SOURCE NOT APPLICABLE CROSS OUT ROW AND GO TO NEXT SOURCE DO NOT USE THE FLAP IDs FOR THIS WATER SOURCE TABLE	SOURCE ID
					PIPED WATER INTO DWELLING	01
					PIPED WATER TO YARD/ PLOT	02
					PUBLIC TAP/ STANDPIPE	03
					TUBEWELL/ BOREHOLE	04
					DUG WELL WITH COVER	05
					DUG WELL WITHOUT COVER	06
					SPRING WITH PIPE	07
					SPRING WITHOUT PIPE	08
					WADI/ RIVER	09
					RAINWATER FROM ROOF	10
					POND/ CYSTERN/ DAM	11
					BOTTLED WATER	12
					CART WITH SMALL TANK/ DRUM	13
					TANKER TRUCK	14
					OTHER SOURCE (SPECIFY)	15

PAST 7 DAYS								
(2.56) During the past 7 days, how much water did your use for other purposes from [SOURCE]? IF NONE ENTER ZERO IF NOT KNOWN APPROXIMATE USE 20 L YELLOW BUCKET	(2.55) During the past 7 days, how much water did your household use for Animals/ Home Gardening/ Farming from [SOURCE]? IF NONE ENTER ZERO IF NOT KNOWN APPROXIMATE USE 20 L YELLOW BUCKET	(2.54) During the past 7 days, how much water did your household use for cleaning the house from [SOURCE]? IF NONE ENTER ZERO IF NOT KNOWN APPROXIMATE USE 20 L YELLOW BUCKET	(2.53) During the past 7 days, how much water did your household use for washing clothes from [SOURCE]? IF NONE ENTER ZERO IF NOT KNOWN APPROXIMATE USE 20 L YELLOW BUCKET	(2.52) During the past 7 days, how much water did your household use for bathing from [SOURCE]? IF NONE ENTER ZERO IF NOT KNOWN APPROXIMATE USE 20 L YELLOW BUCKET	(2.51) During the past 7 days, how much water did your household use for cooking from [SOURCE]? IF NONE ENTER ZERO IF NOT KNOWN APPROXIMATE USE 20 L YELLOW BUCKET	(2.50) During the past 7 days, how much water did your household use for drinking from [SOURCE]? IF NONE ENTER ZERO IF NOT KNOWN APPROXIMATE USE 20 L YELLOW BUCKET	WATER SOURCES USE 20 LITER YELLOW BUCKET AS STANDARD REFERENCE FOR ALL SOURCES IF SOURCE NOT APPLICABLE CROSS OUT ROW AND GO TO NEXT SOURCE	SOURCE ID
BUCKETS	BUCKETS	BUCKETS	BUCKETS	BUCKETS	BUCKETS	BUCKETS		
							PIPED WATER INTO DWELLING	01
							PIPED WATER TO YARD/ PLOT	02
							PUBLIC TAP/ STANDPIPE	03
							TUBEWELL/ BOREHOLE	04
							DUG WELL WITH COVER	05
							DUG WELL WITHOUT COVER	06
							SPRING WITH PIPE	07
							SPRING WITHOUT PIPE	08
							WADI/ RIVER	09
							RAINWATER FROM ROOF	10
							POND/ CYSTERN/ DAM	11
				98			BOTTLED WATER	12
							CART WITH SMALL TANK/ DRUM	13
							TANKER TRUCK	14
							OTHER SOURCE (SPECIFY)	15

	MONTHLY COST							
(2.63)	(2.62)	(2.61)	(2.60)	(2.59)	(2.58)	(2.57)		
Which is the most substantial problem with [SOURCE]	How much do you pay per 20L yellow bucket of water when using water from [SOURCE]?	Do you pay per water use or a lump sum when using water from [SOURCE]?	Why do you not pay money for water used from [SOURCE]?	How much did you spend during the past month for all the water used from [SOURCE]?	Over all, how many 20L yellow buckets of water did you use during the past month from [SOURCE]?	During the past month, on how many days did you use water from [SOURCE]?	WATER SOURCES	SOURCE ID
1 NO PROBLEMS 2 GENERALLY UNRELIABLE 3 SEASONALLY UNRELIABLE 4 POOR QUALITY 5 TOO EXPENSIVE 96 OTHER	IF NONE ENTER ZERO IF NOT KNOWN APPROXIMATE	LUMP SUM IS A SINGLE PAYMENT / RELATED TO HOUSEHOLD SIZE OR TOTAL WATER USE 1 PER WATER USE (2.63)◄ 2 PER LUMP SUM (2.63)◄ 3 DEPENDS ON OWNER (2.63)◄ 96 OTHER (SPECIFY)	1 PAY IN-KIND 2 RELATIVE OF OWNER 3 NATURAL WATER 4 PUBLIC WATER 96 OTHER (SPECIFY) 98 NOT APPLICABLE (2.63)◄	IF NOT KNOWN APPROXIMATE IF NOTHING IS PAID ENTER ZERO AND (2.60) ◄ IF WATER IS PAID ENTER COST AND (2.61) ◄	CONVERT ALL WATER USE TO YELLOW BUCKETS IF NONE ENTER ZERO AND (2.61) ◄ IF NOT KNOWN APPROXIMATE	IF NONE ENTER ZERO IF EVERY DAY ENTER 30 IF NOT KNOWN APPROXIMATE	USE 20 LITER YELLOW BUCKET AS STANDARD REFERENCE FOR ALL SOURCES IF SOURCE NOT APPLICABLE CROSS OUT ROW AND GO TO NEXT SOURCE	
	YER			YER	BUCKETS	DAYS		
							PIPED WATER INTO DWELLING	**01**
							PIPED WATER TO YARD/ PLOT	**02**
							PUBLIC TAP/ STANDPIPE	**03**
							TUBEWELL/ BOREHOLE	**04**
							DUG WELL WITH COVER	**05**
							DUG WELL WITHOUT COVER	**06**
							SPRING WITH PIPE	**07**
							SPRING WITHOUT PIPE	**08**
							WADI/ RIVER	**09**
							RAINWATER FROM ROOF	**10**
							POND/ CYSTERN/ DAM	**11**
		1					**BOTTLED WATER**	**12**
							CART WITH SMALL TANK/ DRUM	**13**
							TANKER TRUCK	**14**
							OTHER SOURCE (SPECIFY)	**15**

WATER FETCHING						BREAKDOWNS				
(2.73) Do men usually go to [SOURCE] to fetch the water for your household? 1 YES 2 NO	(2.72) Do women usually go to [SOURCE] to fetch the water for your household? 1 YES 2 NO	(2.71) Do boys usually go to [SOURCE] to fetch the water for your household? BOYS AGE 15 YEARS AND YOUNGER 1 YES 2 NO	(2.70) Do girls usually go to [SOURCE] to fetch the water for your household? GIRLS AGE 15 YEARS AND YOUNGER 1 YES 2 NO	(2.69) Do children usually go to [SOURCE] to fetch the water for your household? CHILDREN AGE 15 YEARS AND YOUNGER 1 YES 2 NO (2.72) ◄	(2.68) How many minutes does it take to fill a 20 Liter Bucket from [SOURCE]? ESTIMATE TIME INCLUDES GOING TO SOURCE, WAITING TIME FETCHING WATER AND COMING BACK MINUTES	(2.67) During breakdown/ interruptions of a main water source, is [SOURCE] used as alternative source for non-drinking water? 1 USED 2 NOT USED 3 HOUSE TANK USED	(2.66) During breakdown/ interruptions of a main water source, is [SOURCE] used as alternative source for drinking water? 1 USED 2 NOT USED 3 HOUSE TANK USED	(2.64) During the past 3 months, how many days did [SOURCE] not provide any water for an entire day? INCLUDES CLOSING DOWN OF SOURCE IF NO BREAKDOWN/ INTERRUPTION ENTER ZERO AND (2.66) ◄ NUMBER OF DAYS UNAVAILABLE	WATER SOURCES USE 20 LITER YELLOW BUCKET AS STANDARD REFERENCE FOR ALL SOURCES IF SOURCE NOT APPLICABLE CROSS OUT ROW AND GO TO NEXT SOURCE	SOURCE ID
98	98	98	98	98	98				PIPED WATER INTO DWELLING	01
98	98	98	98	98	98				PIPED WATER TO YARD/ PLOT	02
									PUBLIC TAP/ STANDPIPE	03
									TUBEWELL/ BOREHOLE	04
									DUG WELL WITH COVER	05
									DUG WELL WITHOUT COVER	06
									SPRING WITH PIPE	07
									SPRING WITHOUT PIPE	08
									WADI/ RIVER	09
									RAINWATER FROM ROOF	10
									POND/ CYSTERN/ DAM	11
98	98	98	98	98	98			98	BOTTLED WATER	12
98	98	98	98	98	98			98	CART WITH SMALL TANK/ DRUM	13
98	98	98	98	98	98			98	TANKER TRUCK	14
								98	OTHER SOURCE (SPECIFY)	15

POLLUTION		QUALITY						
(2.81) What is the source of the pollution? RECORD ALL THAT APPLY 1 PIPES 2 WELL 3 TRUCK 4 MAIN TANK 5 HOUSEHOLD TANK 96 OTHER 99 DON'T KNOW	(2.80) Have you noticed any pollution coming from [SOURCE]? 1 YES 2 NO **NEXT SOURCE ◄**	(2.79) How is the odour of the water? RECORD ALL THAT APPLY 1 FREE OF SMELL 2 SMELLY 3 BAKHUR/ ROSE WAX 96 OTHER	(2.78) How is the colour of the water? RECORD ALL THAT APPLY 1 CLEAR 2 WHITE MILKY 3 GREEN 4 BROWN RUSTY 5 BROWN MUDDY 96 OTHER	(2.77) How is the taste of the water? RECORD ALL THAT APPLY 1 CLEAN / NO TASTE 2 SALTY 3 BITTER 4 CHLORINE 96 OTHER	(2.76) Overall, how do you rate the water quality of the [SOURCE]? READ OUT 1 VERY GOOD 2 GOOD 3 ACCEPTABLE 4 BAD 5 VERY BAD	(2.74) **REPEAT ANSWER OF (2.01)** IS HOUSEHOLD CONNECTED TO WATER PIPE SYSTEM? 1 YES 2 NO (2.76) ◄ (2.75) Since you got connected to the water pipe system, do you use [SOURCE] more, less, or still the same? 1 MORE 2 UNCHANGED 3 LESS	WATER SOURCES USE 20 LITER YELLOW BUCKET AS STANDARD REFERENCE FOR ALL SOURCES IF SOURCE NOT APPLICABLE CROSS OUT ROW AND GO TO NEXT SOURCE	**SOURCE ID**
							PIPED WATER INTO DWELLING	**01**
							PIPED WATER TO YARD/ PLOT	**02**
							PUBLIC TAP/ STANDPIPE	**03**
							TUBEWELL/ BOREHOLE	**04**
							DUG WELL WITH COVER	**05**
							DUG WELL WITHOUT COVER	**06**
							SPRING WITH PIPE	**07**
							SPRING WITHOUT PIPE	**08**
							WADI/ RIVER	**09**
							RAINWATER FROM ROOF	**10**
							POND/ CYSTERN/ DAM	**11**
98	98						**BOTTLED WATER**	**12**
							CART WITH SMALL TANK/ DRUM	**13**
							TANKER TRUCK	**14**
							OTHER SOURCE (SPECIFY)	**15**

RESPONDENT ID:

1 ☐ PLASTIC CONTAINER (INCL. BOTTLES) 2 ☐ METAL CONTAINER 3 ☐ CLAY CONTAINER specify here 96 ☐ OTHER (SPECIFY)	What is the material of the container you use for storing drinking water in the house?	(3.01)
1 ☐ YES 2 ☐ NO	Is the container usually covered? COVERED FROM INSECTS, ETC	(3.02)
1 ☐ YES (3.05) ◄ 2 ☐ NO (3.05) ◄ 99 ☐ DON'T KNOW	Do you treat your water in any way before drinking?	(3.03)
1 ☐ BOIL 2 ☐ LET IT STAND AND SETTLE 3 ☐ USE WATER FILTER 4 ☐ STRAIN THROUGH CLOTH 5 ☐ ADD CHLORINE / BLEACH 6 ☐ SOLAR DISINFECTION specify here 96 ☐ OTHER (SPECIFY) 99 ☐ DON'T KNOW	How do you treat the water before drinking?	(3.04)
1 ☐ YES (3.08) ◄ 2 ☐ NO (3.08) ◄ 99 ☐ DON'T KNOW	ASK TO ALL TYPES OF HOUSEHOLDS Have any members of your household previously participated in any type of hygiene training?	(3.05)
1 ☐ HAND WASHING 2 ☐ SOAP USE 3 ☐ WATER TREATMENT 4 ☐ DRINKING WATER QUALITY 5 ☐ LATRINE BUILDING 6 ☐ SEPTIC TANK BUILDING 7 ☐ WATER RELATED DISEASES (INCL DIARRHEA) specify here 96 ☐ OTHER (SPECIFY) 99 ☐ DON'T KNOW	What were the main topics of the training? TICK ALL THAT APPLY	(3.06)
USE GREGORIAN CALENDAR ☐ YEAR	In which year did the training take place?	(3.07)

Section 3.2: Water Handling

ASK FOR EACH HOUSEHOLD MEMBER

RESPONDENT ID:

(3.13) What does [NAME] usually use for washing his/her hands?	(3.12) Does [NAME] usually wash his/her hands after going to the toilet?	(3.11) Does [NAME] usually wash his/her hands after disposing of feaces of babies? IF NO BABIES IN HOUSEHOLD ENTER 98	(3.10) Does [NAME] usually wash his/ her hands before preparing/ serving food?	(3.09) Does [NAME] usually wash his/her hands after eating?	(3.08) Does [NAME] usually wash his/her hands before eating?	ID CODE
1 WATER ONLY 2 LAUNDRY DETERGENT 3 SOAP (LIQUID OR BAR) 4 DRY WIPE / PAPER TOWEL 5 WET WIPE 96 OTHER	1 YES 2 NO 98 NOT APPLICABLE	1 YES 2 NO 98 NOT APPLICABLE	1 YES 2 NO 98 NOT APPLICABLE	1 YES 2 NO 98 NOT APPLICABLE	1 YES 2 NO 98 NOT APPLICABLE	
						01
						02
						03
						04
						05
						06
						07
						08
						09
						10
						11
						12
						13
						14
						15

Section 4: Sanitation

RESPONDENT ID:

COPY ANSWER TO FLAP (4.01)			
1 YES (4.03) ◄ 2 NO	Is your household connected to a public sewerage system? EXCLUDES PRIVATE SEPTIC TANKS	(4.01)
YEAR	Since which year is your household connected to the sewerage system?	(4.02)
1 TRADITIONAL PIT LATRINE 2 MODERN CERAMIC LATRINE (4.08) ◄ 3 NO TOILET / LATRINE specify here 96 OTHER (SPECIFY)	What type of toilet/ latrine is used by your household?	(4.03)
1 YES 2 NO (INCL BUCKET) 97 REFUSED	Does your toilet/ latrine have a functioning flush water system? IF NOT KNOWN EXPLAIN FLUSH	(4.04)
1 YES 2 NO 97 REFUSED	Do any people not belonging to your household use this toilet/ latrine regularly? PLEASE ASK CAREFULLY	(4.05)
YEARS (APPROXIMATE) IF VERY OLD ENTER 100 99 DON'T KNOW	For how many years has your household been using this kind of toilet/ latrine? IF NOT KNOWN ESTIMATE	(4.06)
YER PER MONTH	What are the monthly cleaning cost of your toilet/ latrine? IF NO COST ENTER ZERO	(4.07)
1 OPEN AREA 2 NEIGHBOR'S TOILET 3 MOSQUE'S TOILET 4 OTHER PUBLIC TOILET specify here 96 OTHER (SPECIFY) 98 NOT APPLICABLE	In absence of a toilet/ latrine, where do household members defecate?	(4.08)
1 YES 2 NO 97 REFUSED	Is this a toilet/ latrine that can be used by any person?	(4.09)
NUMBER OF HOUSEHOLDS	Approximately how many households use this toilet/ latrine?	(4.10)
1 PUT/ RINSE INTO TOILET/ LATRINE 2 PUT/ RINSE INTO DRAIN/ DITCH 3 THROW TO GARBAGE 4 BURIED 5 LEFT IN OPEN 96 OTHER 98 NOT APPLICABLE 99 DON'T KNOW	How are the faeces of children too young to use the toilet/ latrine disposed of?	(4.11)

(4.16) ◄ 1 ☐ TOILET IS NOT CONNECTED (4.16) ◄ 2 ☐ PUBLIC SEWERAGE SYSTEM 3 ☐ SEPTIC TANK FOR HOUSE 4 ☐ COVERED CESSPIT 5 ☐ OPEN CESSPIT (4.16) ◄ 6 ☐ PIPE/ CANAL LEADING TO OPEN AREA specify here (4.16) ◄ 96 ☐ OTHER (SPECIFY)	What type of sewerage system is your toilet/ latrine connected to? IF NOT KNOWN READ OUT IF UNCONNECTED PIT LATRINE TICK 1	(4.12)
☐ YEAR 99 ☐ DON'T KNOW	Since what year is your curent cesspit in use? IF VERY OLD ENTER 88	(4.13)
☐ MONTHS AGO 99 ☐ DON'T KNOW	How many months ago was your cespit emptied the last time?	(4.14)
☐ EVERY X MONTH(S) 99 ☐ DON'T KNOW 101 ☐ NEVER	Typically every how many months is your cesspit emptied?	(4.15)
ASK THE FOLLOWING QUESTIONS TO EVERY HOUSEHOLD READ OUT I will now ask you some questions regarding the importance of sanitation. Please rate the following aspects between UNIMPORTANT and VERY IMPORTANT according to your judgement.		(4.16)
1 ☐ Unimportant 2 ☐ Little important 3 ☐ Important 4 ☐ Very important	How important is privacy of a toilet/ latrine? READ OUT	
1 ☐ Unimportant 2 ☐ Little important 3 ☐ Important 4 ☐ Very important	How important is the odour of a toilet/ latrine? READ OUT	(4.17)
1 ☐ Unimportant 2 ☐ Little important 3 ☐ Important 4 ☐ Very important	How important are the hygenic conditions of a toilet/ latrine? READ OUT	(4.18)
1 ☐ Unimportant 2 ☐ Little important 3 ☐ Important 4 ☐ Very important	How important are problems of plugging and overflow of a toilet/ latrine? [READ OUT]	(4.19)

Answer	Question	No.
YES (4.25) ◄ NO	**REPEAT ANSWER OF (4.01)** IS HOUSEHOLD CONNECTED TO PUBLIC SEWERAGE SYSTEM?	(4.20)
1 Improved 2 No Change 3 Deterioration 99 DON'T KNOW	How has the privacy of your toilet/ latrine changed due to the connection to the public sewerage system? READ OUT	(4.21)
1 Improved 2 No Change 3 Deterioration 99 DON'T KNOW	How has the odour of your toilet/ latrine changed due to the connection to the public sewerage system? READ OUT	(4.22)
1 Improved 2 No Change 3 Deterioration 99 DON'T KNOW	How have the hygenic conditions of your toilet/ latrine changed due to the connection to the public sewerage system? READ OUT	(4.23)
1 Improved 2 No Change 3 Deterioration 99 DON'T KNOW	How have issues of plugging and overflow of your toilet/ latrine changed due to the connection to the public sewerage system? READ OUT	(4.24)
1 NO PROBLEM 2 UNHYGENIC CONDITIONS 3 OVERFLOW ON ROAD 4 BAD ODOUR 5 DAMAGE TO BUILDING specify here 96 OTHER (SPECIFY) 99 DON'T KNOW	What are the problems that currently affect your toilet/ latrine? TICK ALL THAT APPLY	(4.25)
TIMES IF NO BREAKDOWNS FILL IN ZERO AND (4.28) ◄ 99 DON'T KNOW	How many times during the last 3 months was your toilet/ latrine broken or could not be used?	(4.26)
DAYS 99 DON'T KNOW	What is the average duration of these breakdowns/ interruptions?	(4.27)
(4.31) ◄ 1 NOT CLEANED (4.29) ◄ 2 WATER (4.29) ◄ 3 BLEACH / DETERGENT + WATER (4.31) ◄ 99 DON'T KNOW	How is your toilet/ latrine usually cleaned?	(4.28)

(4.29)	How many times per week is your toilet/ latrine cleaned?		TIMES	
		98	NEVER	(4.31)
(4.30)	Who is usually in charge of cleaning the toilet/ latrine? ENTER UP TO 4 PERSON IDs FROM FLAP		ID 1	
			ID 2	
			ID 3	
			ID 4	
(4.31)	Where do you usually dispose used kitchen water?	1	KITCHEN SINK (CONNECTED TO SEWERAGE)	(4.34)
		2	TRHOW IN COURTYARD OF HOUSE	(4.33)
		3	THROW OUTSIDE PREMISES	(4.33)
		4	USE FOR OTHER PURPOSES (INCLUDES ALL OTHER USAGE)	
		96	OTHER DUMPING (SPECIFY) specify here	(4.33)
(4.32)	What do you do with kitchen/other waste water?	1	AGRICULTURE/ GARDENING	
		2	GIVE LIVESTOCK	
		96	OTHER (SPECIFY) specify here	
		99	DON'T KNOW	
(4.33)	**REPEAT ANSWER OF (4.01)** IS HOUSEHOLD CONNECTED TO PUBLIC <u>SEWERAGE</u> SYSTEM?		YES	
			NO	(4.38)
(4.34)	Generally, how has your situation changed due to the connection of your household to the <u>public sewerage</u> system? READ OUT	1	Improved	
		2	No Change	(4.37)
		3	Deterioration	(4.36)
		99	DON'T KNOW	(4.37)
(4.35)	Why has your situation improved? TICK ALL THAT APPLY	1	POSITIVE HEALTH EFFECTS	(4.37)
		2	IMPROVED RELIABILITY OF TOILET	(4.37)
		3	CLEANER BATHROOM / TOILET	(4.37)
		4	BETTER SMELL / LESS ODOUR	(4.37)
		5	LESS FLIES/ INSECTS	(4.37)
		6	MORE PRIVACY	(4.37)
		7	REDUCTION OF COST	(4.37)
		96	OTHER (SPECIFY) specify here	
(4.36)	Why has your situation deteriorated? TICK ALL THAT APPLY	1	NEGATIVE HEALTH EFFECTS	
		2	TOILET OFTEN CLOGGED / LESS RELIABLE	
		3	BATHROOM / TOILET DIRTIER	
		4	WORSE SMELL / MORE ODOUR	
		5	MORE FLIES / INSECTS	
		6	LESS PRIVACY	
		7	INCREASE OF COST	
		96	OTHER (SPECIFY) specify here	

1 Increased 2 No Change 3 Decreased 4 Don't pay anything for sewerage 99 DON'T KNOW	Generally, how has the money spent on sanitation and sewerage disposal changed due to the connection of your household to the public sewerage system? READ OUT	(4.37)
1 YES 2 NO 99 DON'T KNOW	Did you ever have the choice to connect your household to a public sewerage system?	(4.38)
YES (4.41) ◄ NO	**REPEAT ANSWER OF (4.01)** IS HOUSEHOLD CONNECTED TO PUBLIC SEWERAGE SYSTEM?	(4.39)
(5.01) ◄ 1 EVERYBODY DID SO (5.01) ◄ 2 POSITIVE HEALTH EFFECTS (5.01) ◄ 3 IMPROVED RELIABILITY OF TOILET (5.01) ◄ 4 CLEANER BATHROOM / TOILET (5.01) ◄ 5 BETTER SMELL / LESS ODOUR (5.01) ◄ 6 LESS FLIES/ INSECTS (5.01) ◄ 7 MORE PRIVACY (5.01) ◄ 8 REDUCTION OF COST specify here 96 OTHER (SPECIFY) (5.01) ◄ 99 DON'T KNOW	Why did you decide to have your household connected to the public sewerage system? READ OUT TICK ALL THAT APPLY	(4.40)
ONLY APPLICALE IF HOUSEHOLD HAD A CHOICE AND DID NOT CONNECT TO PUBLIC SEWERAGE SYTSEM		
1 NEGATIVE HEALTH EFFECTS 2 TOILET OFTEN CLOGGED / LESS RELIABLE 3 BATHROOM / TOILET DIRTIER 4 WORSE SMELL / MORE ODOUR 5 MORE FLIES / INSECTS 6 LESS PRIVACY 7 INCREASE OF COST specify here 96 OTHER (SPECIFY) 99 DON'T KNOW	Why did you decide against being connected to the public sewerage system? READ OUT TICK ALL THAT APPLY	(4.41)

NOW I WILL ASK YOU SOME QUESTIONS ON THE HEALTH OF YOUR FAMILY.YOUR ANSWERS WILL BE TREATED CONFIDENTIAL AND REMAIN ANONYMOUS. IT IS IMPORTANT THAT YOU ANSWER ACCURATELY.

:READ OUT

Section 5.1: Health

ASK FOR EACH HOUSEHOLD MEMBER

RESPONDENT ID:

(5.05)	(5.04)	(5.03)	(5.02)	SYMPTOMS	(5.01)	ID CODE
For how many days was [NAME] unable to work or attend school because of the illness related to these symptoms? AVOID DOUBLE COUNTING: RECORD TOTAL **ABSENCE** IF TOO YOUNG ENTER 98	How many days did/ does [SYMPTOM] persist? IF UNKNOWN PROMPT FOR ESTIMATE	Does [NAME] still suffer from [SYMPTOM]? 1 YES 2 NO	How strong was [SYMPTOM]? READ OUT 1 SEVERE 2 MODERATE 3 MILD	1 FEVER 2 ABDOMINAL PAIN 3 VOMITING 4 WATERY DIAHORREA 5 BLOODY DIAHORREA 6 BLOODY STOOL 7 WHITISH STOOL 8 BLOODY URINE 9 HEMORRHAGE/ INTERN.BLEEDING 10 YELLOW EYES 11 RED EYES/ SECRETION 12 EYE LESIONS 13 SORE /RASH/ ITCHY SKIN 14 ANEMIA/ RED BLOOD CELL DEFICIENCY 15 SEVERE WEIGHT LOSS 16 MUSCLE ACHE 17 COLORING OF TEETH 18 SEVERE FATIGUE IF NO SYMPTOMS **(5.24)◄**	During the past 4 weeks, has [NAME] experienced [SYMPTOM]? READ OUT ALL SYMPTOMS RECORD UP TO FOUR SYMPTOMS PER MEMBER IF MORE THAN FOUR SYMPTOMS APPLY RECORD THE FOUR MOST SEVERE SYMPTOMS	
DAYS	DAYS			CODE		

1st	1st	1st	1st	1st	01
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	02
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	03
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	04
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	05
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	06
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	07
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	08
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	09
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	10
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	11
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	12
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	13
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	14
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	15
2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	

(5.12)	(5.11)	(5.10)	(5.09)	(5.08)	(5.07)	(5.06)	ID CODE
What was the cost of medicine?	What were the costs of transportation?	What were the costs of treatment?	Which health facility did [NAME] go to for medical help?	Which type of health facility did [NAME] go for medical help?	Why was this illness not treated by a doctor or nurse?	Whom did [NAME] consult for medical help?	
IF NO MEDICINE ENTER ZERO	IF NO TREATMENT ENTER ZERO	IF NO TREATMENT ENTER ZERO EXCL. MEDICINE AND TRANS-PORTATION	GIVE NAME OF HEALTH FACILITY ENTER FACILITY CODE ACCORDING TO HEALTH FACILITY OVERVIEW. IF OTHER, SPECIFY NAME	READ OUT		READ OUT	
						0 NOT TREATED	
						(5.08) ◄ 1 PRIVATE DOCTOR	
				1 PUBLIC HOSPITAL	(5.10) ◄ 1 NOT NECESSARY	(5.08) ◄ 2 PUBLIC DOCTOR	
						(5.08) ◄ 3 MEDICAL ASSISTANT	
				2 PUBLIC CLINIC	(5.10) ◄ 2 TOO EXPENSIVE	(5.08) ◄ 4 NURSE	
						5 PARAMEDIC	
				3 PRIVATE CLINIC	(5.10) ◄ 3 NO DOCTOR/ NURSE	6 PHARMACIST	
						7 HEALER	
				4 PRIVATE DOCTOR	(5.10) ◄ 4 DON'T TRUST DOCTOR/	8 RELATIVE	
						9 PREACHER	
YER	YER	YER	CODE	96 OTHER	(5.10) ◄ 96 OTHER	96 OTHER	
1st	1st	1st	1st	1st	1st	1st	01
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	1st	1st	02
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	1st	1st	03
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	1st	1st	04
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	1st	1st	05
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	1st	1st	06
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	1st	1st	07
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	1st	1st	08
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	1st	1st	09
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	1st	1st	10
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	1st	1st	11
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	1st	1st	12
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	1st	1st	13
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	1st	1st	14
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	
1st	1st	1st	1st	1st	1st	1st	15
2nd	2nd	2nd	2nd	2nd	2nd	2nd	
3rd	3rd	3rd	3rd	3rd	3rd	3rd	
4th	4th	4th	4th	4th	4th	4th	

DEFINITION DIARRHEA
THREE OR MORE LIQUID/ WATERY STOOLS PER DAY
OR STOOL CONTAINING BLOOD

Section 5.2. Symptoms

ASK FOR EACH SYMPTOM
RESPONDENT ID:

(5.18)	(5.17)	(5.16)	(5.14) / (5.15)		(5.13)
Was [SYMPTOM] more or less severe before the connection to the water pipe system? IF CHILD TOO YOUNG ENTER 98	Did [SYMPTOM] appear more or less frequently since the connection to the water pipe system? IF CHILD TOO YOUNG ENTER 98	Did children in your household ever suffer from [SYMPTOM] before you were connected to the water pipe system? AGE 15 AND BELOW IF CHILD TOO YOUNG ENTER 98	(5.14) REPEAT ANSWER OF (2.01): IS HOUSEHOLD CONNECTED TO WATER PIPE SYSTEM? 1 YES (5.19)◄ 2 NO (5.15) Did adults in your household ever suffer from [SYMPTOM] before you were connected to the water pipe sytsem?	DISEASE SYMPTOMS	SYMPTOM ID
1 MORE SEVERE 2 NO CHANGE 3 LESS SEVERE	1 MORE FREQUENTLY 2 NO CHANGE 3 LESS FREQUENTLY	1 YES (5.19)◄ 2 NO	1 YES 2 NO		
				FEVER	01
				ABDOMINAL PAIN	02
				VOMITING	03
				WATERY DIAHORREA	04
				BLOODY DIAHORREA	05
				BLOODY STOOL	06
				WHITISH STOOL	07
				BLOODY URIN	08
				HEMORRHAGE	09
				YELLOW EYES	10
				RED EYES/ SECRETION	11
				EYE LESIONS	12
				SORE/ RASH/ ITCHY SKIN	13
				ANEMIA	14
				SEVERE WEIGHT LOSS	15
				MUSCLE ACHE	16
				COLORING OF TEETH	17
				SEVERE FATIGUE	18

(5.24) In your opinion, does [SYMPTOM] have anything to do with water & sanitation or hygienic conditions? ONLY ASK FOR OPINION OF RESPONDENT 1 YES 2 NO 99 DON'T KNOW	(5.23) Was [SYMPTOM] more or less severe before the connection to the sewerage pipe system? 1 MORE SEVERE 2 NO CHANGE 3 LESS SEVERE	(5.22) Did the frequency of [SYMPTOM] appear more or less frequently since the connection to the sewerage pipe system? 1 MORE FREQUENTLY 2 NO CHANGE 3 LESS FREQUENTLY	(5.21) Did children in your household ever suffer from [SYMPTOM] before you were connected to the sewerage pipe system? AGE 15 AND UNDER 1 YES (5.24)◄ 2 NO	(5.19) REPEAT ANSWER OF (4.01): IS HOUSEHOLD CONNECTED TO PUBLIC SEWERAGE SYSTEM? 1 YES (5.24)◄ 2 NO (5.20) Did adults in your household ever suffer from [SYMPTOM] before you were connected to the sewerage sytsem? 1 YES (5.24)◄ 2 NO	DISEASE SYMPTOMS	SYMPTOM ID
					FEVER	01
					ABDOMINAL PAIN	02
					VOMITING	03
					WATERY DIAHORREA	04
					BLOODY DIAHORREA	05
					BLOODY STOOL	06
					WHITISH STOOL	07
					BLOODY URIN	08
					HEMORRHAGE	09
					YELLOW EYES	10
					RED EYES/ SECRETION	11
					EYE LESIONS	12
					SORE/ RASH/ ITCHY SKIN	13
					ANEMIA	14
					SEVERE WEIGHT LOSS	15
					MUSCLE ACHE	16
					COLORING OF TEETH	17
					SEVERE FATIGUE	18

1 YES (5.27) ◄ 2 NO	REPEAT ANSWER OF (2.01) IS HOUSEHOLD CONNECTED TO WATER PIPE SYSTEM?	(5.25)
1 INCREASE 2 NO CHANGE 3 DECREASE 99 DON'T KNOW	How did your expenses for medical treatment and medication for water related illnesses change due to the connection to the water pipe system? READ OUT	(5.26)
1 YES (5.29) ◄ 2 NO	REPEAT ANSWER OF (4.01) IS HOUSEHOLD IS CONNECTED TO PUBLIC SEWERAGE SYSTEM?	(5.27)
1 INCREASE 2 NO CHANGE 3 DECREASE 99 DON'T KNOW	How did your expenses for medical treatment and medication for water related illnesses change due to the connection to the public sewerage system? READ OUT	(5.28)
READ OUT On a scale from very bad to very good, how would you rate the health of the following people?		
1 VERY GOOD 2 GOOD 3 ACCEPTABLE 4 BAD 5 VERY BAD	* A usually goes to the toilet (to pass stool) once a day. * She rarely suffers from intestinal or stomach pain and fever. * During the day she feels active and is usually able to perform all needed tasks. READ OUT	(5.29)
1 VERY GOOD 2 GOOD 3 ACCEPTABLE 4 BAD 5 VERY BAD	* B usually goes to the toilet to pass stool once a day. * There are short phases 2-3 times a month when she has to go more often. During these phases she experiences intestinal and stomach pain and occasionally also fever. * During these phases she feels more tired. * She is still able to fulfill all tasks, but it takes her more effort than usual. READ OUT	(5.30)
1 VERY GOOD 2 GOOD 3 ACCEPTABLE 4 BAD 5 VERY BAD	* C goes to the toilet to pass stool 2-3 times a day. * She often experiences mild intestinal and stomach pain, but it is usually not accompanied by fever. * She tires fast. Yet she is able to fulfill all needed tasks, but it usually takes her some effort. READ OUT	(5.31)
1 VERY GOOD 2 GOOD 3 ACCEPTABLE 4 BAD 5 VERY BAD	* D goes to the toilet to pass stool 2-3 times a day. * Mild intestinal and/or stomach pain is common to her. * Frequently there are phases she uses the toilet more often and the pain grows strong. This is usually accompanied by fever. * Fulfilling all needed tasks is usually not possible during these phases, and it is sometimes necessary to seek medical help. READ OUT	(5.32)
1 VERY GOOD 2 GOOD 3 ACCEPTABLE 4 BAD 5 VERY BAD	How do you rate your health with regard to such gastrointestinal functions? READ OUT	(5.33)

Section 6: Education

ASK FOR EACH HOUSEHOLD MEMBER

RESPONDENT ID:

ONLY ASK IF CURRENTLY ENROLLED		ASK FOR ALL HH MEMBERS					
(6.06)	(6.05)	(6.04)	(6.03)	(6.02)	READ OUT: I WILL NOW ASK YOU SOME QUESTIONS ON EDUCATION		
					(6.01)a	(6.01)	ID CODE
In which grade is [NAME] currently studying?	In which school is [NAME] currently enrolled? ENTER FACILITY CODE ACCORDING TO SCHOOL OVERVIEW. IF OTHER, SPECIFY NAME	Is [NAME] currently enrolled in school? IF TOO YOUNG ENTER 98 (7.01)◄ 1 YES 2 NO (7.01)◄	How many years of education has [NAME] completed in total? IF TOO YOUNG ENTER 98 IF NEVER BEEN TO SCHOOL ENTER ZERO	What is the highest level of education [NAME] completed? IF TOO YOUNG ENTER 98 IF NEVER BEEN TO SCHOOL ENTER 1 1 NONE 2 MADRASA 3 PRESCHOOL 4 PRIMARY 5 MIDDLE / PREPARATORY 6 SECONDARY 7 TERTIARY / UNIVERSITY 8 VOCATIONAL SCHOOL	Does [NAME] know how to write? IF TOO YOUNG ENTER 98 1 YES 2 NO	Does [NAME] know how to read? IF TOO YOUNG ENTER 98 1 YES 2 NO	
GRADE	CODE		YEARS				
							01
							02
							03
							04
							05
							06
							07
							08
							09
							10
							11
							12
							13
							14
							15

THE NEXT QUESTIONS REGARD THE POSSIBLE RELATIONSHIP BETWEEN ILLNESSES AND SCHOOL ATTENDANCE	1 YES 2 NO (7.01) ◄	(6.11) REPEAT ANSWER OF (2.01): IS HOUSEHOLD CONNECTED TO WATER PIPE SYSTEM?

(6.15)	(6.14)	(6.13)	(6.12)	(6.10)	(6.09)	(6.08)	(6.07)	ID CODE
				REFERS TO REGULAR SCHOOL PERIOD. EXCLUDE HOLIDAYS				
How were exam scores of [NAME] influenced by the connection to the <u>sewerage system</u>?	How were exam scores of [NAME] influenced by the connection to the <u>water pipe system</u>?	How did the number of missed days due to sickness change because of the connection to the <u>sewerage system</u>?	How did the number of missed days due to sickness change because of the connection to the <u>water pipe system</u>?	During the past 4 weeks, <u>in total</u> how many school days did [NAME] miss due to <u>water-related illness</u>?	During the past 4 weeks, <u>in total</u> how many days of school did [NAME] miss due to <u>illness</u>?	During the past 4 weeks, on average how many <u>hours per schoolday</u> did [NAME] spend at school?	During the Past 4 weeks, how many <u>days per week</u> did [NAME] attend school?	
				INCLUDES CARING FOR ILL FAMILY MEMBERS	INCLUDES CARING FOR ILL FAMILY MEMBERS			
				INCLUDES DIARRHEA, WORMS, STOMACH PAIN, VOMITTING	INCLUDES ALL TYPES OF DISEASES AND INJURIES	REFER TO REGULAR SCHOOL PERIOD	REFER TO REGULAR SCHOOL PERIOD	
READ OUT	READ OUT	READ OUT	READ OUT	IF UNKNOWN PROMPT FOR ESTIMATE	IF UNKNOWN PROMPT FOR ESTIMATE	IF UNKNOWN PROMPT FOR ESTIMATE	IF UNKNOWN PROMPT FOR ESTIMATE	
1 IMPROVEMENT 2 NO CHANGE 3 DETERIORATION	1 IMPROVEMENT 2 NO CHANGE 3 DETERIORATION	1 INCREASE 2 NO CHANGE 3 DECREASE	1 INCREASE 2 NO CHANGE 3 DECREASE	DAYS	DAYS	HRS	DAYS	
								01
								02
								03
								04
								05
								06
								07
								08
								09
								10
								11
								12
								13
								14
								15

Section 7: Livelihood

ASK FOR EACH HOUSEHOLD MEMBER

RESPONDENT ID:

ASK ONLY FOR AGE 10 AND OLDER (applies to 7.04 – 7.06)

(7.06)	(7.05)	(7.04)a	(7.04)	(7.03)	(7.02)	READ OUT	ID CODE
During the past 4 weeks, how many <u>hours per workday</u> did [NAME] work?	During the past 4 weeks, how many <u>days per week</u> did [NAME] work?	Do you use water from the pipe system for your main work?	In which sector does [NAME] mainly work?	Is the major part of [NAME]s work activity farm related?	Does [NAME] have a permanent work, or does he/she work occasionally?	Now I will ask you some questions on the work activity and income of household members. It is important that you answer accurately. **(7.01)** Did [NAME] work during the past 30 days?	
IF UNKNOWN PROMPT FOR ESTIMATE	IF UNKNOWN PROMPT FOR ESTIMATE		1 TRADING / RETAIL/ INCL SHOP-OWNER 2 DRIVER / SERVICES 3 PUBLIC EMPLOYEE INCL TEACHER, DOCTOR 4 FARMING 5 FISHING 6 CASUAL LABOUR 96 OTHER (SPECIFY)	INCLUDES FARMING AND ANIMALS 1 YES 2 NO	1 PERMANENTLY 2 OCCASIONALLY	1 YES **NEXT PERSON ◄** 2 NO	
HRS	DAYS	1 YES 2 NO					
							01
							02
							03
							04
							05
							06
							07
							08
							09
							10
							11
							12
							13
							14
							15

ASK ONLY FOR AGE 10 AND OLDER

(7.13) In total, how much did [NAME] earn during the past 30 days? PROMPT FOR ESTIMATE. INCLUDES ALL SOURCES OF INCOME	(7.11) REPEAT ANSWER OF (4.01): IS HOUSEHOLD CONNECTED TO PUBLIC SEWERAGE SYSTEM? YES 1; NO 2 ◄ (7.13). (7.12) How did the number of work days that [NAME] missed due to sickness change due to the connection to the public sewerage system? 1 INCREASED; 2 NO CHANGE; 3 DECREASE	(7.09) REPEAT ANSWER OF (2.01): IS HOUSEHOLD CONNECTED TO WATER PIPE SYSTEM? YES 1; NO 2 ◄ (7.11). (7.10) How did the number of work days that [NAME] missed due to sickness change due to the connection to the water pipe system? 1 INCREASED; 2 NO CHANGE; 3 DECREASE	(7.08) During the past 4 weeks, in total how many work days did [NAME] miss due to water-related illness? INCLUDES CARING FOR ILL FAMILY MEMBERS. INCLUDES DIARRHEA, WORMS, STOMACH PAIN, VOMITTING. IF UNKNOWN PROMPT FOR ESTIMATE	(7.07) During the past 4 weeks, in total how many days of work did [NAME] miss due to illness? INCLUDES CARING FOR ILL FAMILY MEMBERS. IF RETIRED WRITE 98. INCLUDES ALL TYPES OF DISEASES AND INJURIES. PREGNANCY IS NOT AN ILLNESS. IF UNKNOWN PROMPT FOR ESTIMATE	ID CODE
YER			DAYS	DAYS	
					01
					02
					03
					04
					05
					06
					07
					08
					09
					10
					11
					12
					13
					14
					15

(7.14) How much is earned in the household per month through [SOURCE] …

READ OUT

Public sector employment	1	YER
Private sector employment	2	YER
Shop/ Self employment	3	YER
Agriculture	4	YER
Pensions	5	YER
Remittances	6	YER
Gifts	7	YER
Other State Transfers	8	YER
Other (SPECIFY)	9	YER

(7.15) Taking all those sources into account, approximately how much is the total monthly income of your household?

DO NOT CALCULATE

PROMT FOR ESTIMATE

YER

RESPONDENT ID:

READ OUT

I will now ask you some questions about deceased household members. Please answer as accurately as you can.

(8.01) During the past 5 years, how many household members have died?

PEOPLE

IF NONE ENTER ZERO ◀ (9.01)

(8.02) What is the name of the deceased person?

IF SMALL CHILD WITHOUT NAME ENTER 333

(8.08) What was the cause of [NAME]'s death?	(8.07) MOTHER'S ID CODE	(8.06) How is [NAME] related to the household head?	(8.05) In which year did [NAME] die?	(8.04) How old was [NAME] when he/ she died?	(8.03) What was [NAME]'s gender?	(8.02) What is the name of the deceased person?	MORTALITY CODE
1 OLD AGE 2 ACCIDENT 3 HEART PROBLEM/ FAILURE 4 CANCER 5 KIDNEY DIESEASE 6 DIAHORREA INCL. OTHER GASTRO-INTESTINAL DIESEASES 7 MALARIA 8 BAD SPELL 96 DISEASE (SPECIFY)	IF MOTHER IS NOT A HOUSE-HOLD MEMBER, CODE 98 IF MOTHER IS DEAD, CODE 100	1 HEAD 2 SPOUSE 3 CO-WIFE 4 SON / DAUGHTER 5 SPOUSE OF SON / DAUGHTER 6 GRANDCHILD 7 BROTHER / SISTER 8 FATHER / MOTHER 9 FATHER / MOTHER OF SPOUSE 10 CHILD OF RELATIVE 11 CHILD OF NON-RELATIVE 12 OTHER RELATIVE 13 OTHER NON-RELATIVE	USE GREGORIAN CALENDAR	IF LESS THAN 1 YEAR WRITE ZERO IF AGE UNKNOWN ESTIMATE	1 MALE 2 FEMALE	IF SMALL CHILD WITHOUT NAME ENTER 333	
	ID		YEAR	YEARS		NAME	
							31
							32
							33
							34
							35
							36

RESPONDENT ID:

EXCLUDE ALL RAMADAN INCENTIVES AND RELATED SPECIAL EXPENSES

(9.05)		(9.04)		(9.03)		(9.02)		(9.01)		
How much of [ITEM] does your household receive without payment? GIFTS, FOOD FOR WORK, RELIEF FOOD VALUE CONSUMED IN A TYPICAL WEEK		How much of home produced [ITEM] does your household consume? VALUE CONSUMED IN A TYPICAL WEEK		How many [UNITS] of [ITEM] does you purchase for that amount? QUANTITY CONSUMED IN A TYPICAL WEEK		How much does your household spend on [ITEM] VALUE CONSUMED IN A TYPICAL WEEK		TYPICAL WEEK [EXCLUDE RAMADAN] READ OUT FILL IN PER ROW		
	YER		YER		KG		YER	Baked Bread / Chapati	1	FREQUENT FOODS
	YER		YER		PIECE		YER	Eggs	2	
	YER		YER		LITER		YER	Milk, Cheese, Other dairy products	3	
	YER		YER		KG		YER	Meat	4	
	YER		YER		KG		YER	Fish	5	
	YER		YER		20 L BUCKET		YER	Fresh vegetables	6	
	YER		YER		20 L BUCKET		YER	Fresh fruit	7	
	YER		YER		KG		YER	Dried/preserved fruit/ vegetables	8	
	YER		YER		LITER		YER	Bottled drinks	9	
	YER		YER		PACK		YER	Tobacco	10	
	YER		YER		BUNDLE		YER	Qat	11	
	YER (INVITED)	#			MEALS		YER	Foodstalls/ Restaurant	12	

(9.10)		(9.09)		(9.08)		(9.07)		(9.06)		
How much of [ITEM] does your household receive without payment? GIFTS, FOOD FOR WORK, RELIEF FOOD VALUE CONSUMED IN A TYPICAL MONTH		How much of home produced [ITEM] does your household consume? VALUE CONSUMED IN A TYPICAL MONTH		How many [UNITS] of [ITEM] does you purchase for that amount? QUANTITY CONSUMED IN A TYPICAL MONTH		How much does your household spend on [ITEM] VALUE CONSUMED IN A TYPICAL MONTH		TYPICAL MONTH [EXCLUDE RAMADAN] READ OUT FILL IN PER ROW		
	YER		YER		KG		YER	Wheat	13	RARE FOODS
	YER		YER		KG		YER	Flour	14	
	YER		YER		KG		YER	Rice	15	
	YER		YER		KG		YER	Other cereals	16	
	YER		YER		KG		YER	Tea, coffee, Hot drinks	17	
	YER		YER		KG		YER	Sugar and its products	18	
	YER		YER		PACK		YER	Salt and Spices	19	
	YER		YER		LITER		YER	Cooking and edible oils	20	
	YER		YER		KG		YER	Other Food (SPECIFY)	21	
	YER	#		#			YER	Rent of dwelling	22	HOUSING & FUEL
	YER	#		#			YER	Maintenance and repairs	23	
	YER	#		#			YER	Garbage (solid waste) collection	24	
	YER	#		#			YER	Electricity	25	
	YER	#		#			YER	Gas	26	
	YER	#		#			YER	Kerosene/ fuel for cooking/ light	27	
	YER	#		#			YER	Firewood/Coal	28	
	YER	#		#			YER	Other housing and fuel expenditure	29	
	YER		YER		PACKS		YER	Soap/ Hand washing	30	HYGIENE
	YER		YER		KG		YER	Laundry Detergent	31	
	YER		YER		PIECE		YER	Toothpaste and toothbrushes	32	
	YER		YER		BOTTLES		YER	Beauty products/ cosmetics/ perfumes	33	
	YER		YER		PIECE		YER	Toilet paper and other tissues	34	
	YER		YER		PIECE		YER	Baby Diapers	35	
	YER		YER		PACK		YER	Insecticides, Mosquito Coils	36	
	YER		YER		PACK		YER	Candles, matches, incents	37	
	YER		YER		PIECE		YER	Batteries, lightbulbs, lighters	38	
	YER		YER		PIECE		YER	Other Hygiene expenditure	39	

EXCLUDE ALL RAMADAN INCENTIVES AND RELATED SPECIAL EXPENSES

(9.15)	(9.14)	(9.13)	(9.12)		(9.11)	
How much of [ITEM] does your household receive without payment? GIFTS, FOOD FOR WORK, RELIEF FOOD VALUE CONSUMED IN A TYPICAL MONTH			How much does your household spend on [ITEM] VALUE CONSUMED IN A TYPICAL MONTH	TYPICAL MONTH [EXCLUDE RAMADAN] READ OUT FILL IN PER ROW		
YER	#	#	YER	Fuel/ lubrication personal vehicle	40	TRANSPORT
YER	#	#	YER	Repairs personal vehicle	41	
YER	#	#	YER	Public transport, taxi	42	
YER	#	#	YER	Other transportation	43	
YER	#	#	YER	Mobile phones (INCL CREDIT)	44	COMMUNICATION
YER	#	#	YER	Landline phones	45	
YER	#	#	YER	Internet	46	
YER	#	#	YER	Postal Expenses	47	
YER	#	#	YER	Other communication	48	

(9.20)	(9.19)	(9.18)	(9.17)		(9.16)	
How much of [ITEM] does your household receive without payment? GIFTS, FOOD FOR WORK, RELIEF FOOD VALUE CONSUMED IN PAST 12 MONTHS	How much of home produced [ITEM] does your household consume? VALUE CONSUMED IN PAST 12 MONTHS	How many [UNITS] of [ITEM] does you purchase for that amount? QUANTITY CONSUMED IN PAST 12 MONTHS	How much does your household spend on [ITEM] VALUE CONSUMED IN PAST 12 MONTHS	PAST 12 MONTHS READ OUT FILL IN PER ROW		
YER	#	#	YER	School fees	49	EDUCATION
YER	#	#	YER	Textbooks	50	
YER	#	#	YER	Stationary	51	
YER	#	#	YER	School uniforms	52	
YER	#	#	YER	Other education expenses	53	
YER	#	#	YER	Medication (purchased privately)	54	HEALTH
YER	#	#	YER	Fees for doctors	55	
YER	#	#	YER	Fees for nurses, midwives	56	
YER	#	#	YER	Fees for dentists	57	
YER	#	#	YER	Fees for hospital stays	58	
YER	#	#	YER	Fees for traditional healers	59	
YER	#	#	YER	Therapeutic appliances/ Crutches	60	
YER	#	#	YER	Other health expenses	61	
IN PAST 12 MONTHS			INCLUDE CLOTHING, SHOES, SHEETS; FABRIC, REPAIRS - EXCLUDE LAUNDRY			
YER	YER	PIECE	YER	Women's clothing	62	CLOTHING
YER	YER	PIECE	YER	Children's clothing	63	
YER	YER	PIECE	YER	Men's clothing	64	
YER	YER	PIECE	YER	Treatment Filter	65	WATER
YER	YER	KG	YER	Treatment Tablets, Chemicals, etc	66	
YER	YER	KG	YER	Other water Treatment	67	
			YER	Loan repayments	68	OTHER
			YER	Contributions (Mosques, etc)	69	
			YER	Insurance (Car, Life, Health)	70	
			YER	Funerals, gifts, dowries	71	
			YER	Remittances sent	72	
			YER	Other expenses	73	

NO CALCULATION: PLEASE ESTIMATE	YER	Given all the above, how much does your household <u>approximately</u> consume per month?	(9.21)

RESPONDENT ID:

IF VALUE OR AGE UNKNOWN ASK FOR ESTIMATE.						DO NOT COUNT PERMANENTLY BROKEN ITEMS			
(10.05)		(10.04)		(10.03)		(10.02)		(10.01)	
How much would you get, if you sold [ITEM] today?		What was the value of [ITEM] at the time of purchase?		How many years ago was [ITEM] obtained?		How many pieces of [ITEM] does your household own? READ OUT	IF NONE, CROSS OUT ROW AND GO TO NEXT ITEM		
VALUE		VALUE		YEARS		PIECE			
	YER		YER				Bed	1	GENERAL ASSETS
	YER		YER				Mattress	2	
	YER		YER				Mosquito Net	3	
	YER		YER				Sofa	4	
	YER		YER				Iron	5	
	YER		YER				Radio	6	
	YER		YER				TV	7	
	YER		YER				Sattelite dish	8	
	YER		YER				DVD/VCR player	9	
	YER		YER				Telephone (mobile)	10	
	YER		YER				Telephone (landline)	11	
	YER		YER				Iron (electric/charcoal)	12	
	YER		YER				Generator	13	
	YER		YER				Ventilator	14	
	YER		YER				Computer	15	
98			YER				Internet Connection	16	
	YER		YER				Cooking Brazier	17	KITCHEN
	YER		YER				Gas stove	18	
	YER		YER				Refrigerator	19	
	YER		YER				Laundry machine	20	
	YER		YER				Private water pump	21	
	YER		YER				Sewing machine	22	TOOLS
	YER		YER				Hand saw	23	
	YER		YER				Carpentry Plane	24	
	YER		YER				Axe	25	
	YER		YER				Pick	26	
	YER		YER				Hoe	27	
	YER		YER				Hammer	28	
	YER		YER				Shovel/spate	29	
	YER		YER				Fishing net	30	
	YER		YER				Plough	31	
	YER		YER				Crop sprayer	32	
	YER		YER				Handgun / Pistol	33	
	YER		YER				Rifle/ AK47 / Kalashnikov	34	
	YER		YER				Djambiya	35	
	YER		YER				Wheel barrow	36	TRANSPORT
	YER		YER				Donkey cart	37	
	YER		YER				Bicycle	38	
	YER		YER				Motor Cycle	39	
	YER		YER				Small Truck/ Pick-up	40	
	YER		YER				Van/Minibus	41	
	YER		YER				Taxi	42	
	YER		YER				Regular Car	43	
	YER		YER				Tractor	44	
	YER		YER				Large Truck	45	
	YER		YER				Canoe	46	
	YER		YER				Boat	47	
	YER		YER				Donkey	48	
	YER		YER				Camel	49	

RESPONDENT ID:

(10.09) ◄ 1 YES 2 NO	Does your household <u>own</u> the house/ appartment that you live in?	(10.06)
1 Rented from owner 2 Rented from government 3 Given without rent specify here 96 OTHER, SPECIFY 99 DON'T KNOW	What is the tenure status of this house/ appartment? READ OUT	(10.07)
YER PER MONTH	How much rent do you pay per month for this house/ appartment? HELP RESPONDENT TO ESTIMATE MONTHLY VALUE	(10.08)
YER TOTAL	How much would you get, if you sold this house/ appartment today? ASK ALWAYS, EVEN IF RENTED	(10.09)
1 YES (10.15) ◄ 2 NO	Does your household <u>own</u> any other buidling/ house/ appartment? INCLUDES RESIDENTIAL AND NON-RESIDENTIAL	(10.10)
(10.13) ◄ IF ZERO BUILDINGS	How many <u>residential buidlings</u> does your household own?	(10.11)
YER TOTAL	How much would you get in total, if you sold these <u>residential buidlings/ appartments</u> today? ASK FOR TOTAL VALUE	(10.12)
(10.15) ◄ IF ZERO BUILDINGS	How many <u>non-residential buidlings</u> does your household own? INCLUDES SHOPS, OFFICES AND WAREHOUSES	(10.13)
YER TOTAL	How much would you get in total, if you sold these <u>non-residential buidlings</u> today? ASK FOR TOTAL VALUE	(10.14)
1 YES (10.18) ◄ 2 NO	Does your household own any land? BOTH AGRICULTURAL AND BUILDING LAND	(10.15)
LIBNA	How many Libna of land does your household own?	(10.16)
YER TOTAL	How much would you get in total, if you sold all your <u>land</u> today? ASK FOR TOTAL VALUE	(10.17)
(10.20) ◄ 1 Hut 2 House (10.20) ◄ 3 Appartment specify here 96 OTHER, SPECIFY	What type of house/appartment does your household live in? READ OUT INTERVIEWER SHOULD OBSERVE AND VERIFY	(10.18)
FLOORS	How many floors does the house have?	(10.19)
ROOMS	How many rooms does your house/ appartment have? EXCLUDING KITCHEN AND BATHROOM	(10.20)
LIBNA	How large is the ground floor of your house?	(10.21)

(10.22) What are the outer walls of your house/ appartment made of?

READ OUT

INTERVIEWER SHOULD OBSERVE AND VERIFY

IF SEVERAL TYPES, RECORD MATERIAL OF MAJORITY OF WALLS - RECORD ONLY 1 ANSWER

- 1 ☐ Straw/ Sticks/ Mud
- 2 ☐ Wood, Mud and Plastering
- 3 ☐ Natural Stone
- 4 ☐ Sun-dried bricks
- 5 ☐ Burnt bricks
- 6 ☐ Stone and cement
- 7 ☐ Cement
- 96 ☐ OTHER, SPECIFY [specify here]

(10.23) How is the floor of this house/ appartment covered?

READ OUT

INTERVIEWER SHOULD OBSERVE AND VERIFY

IF SEVERAL TYPES, RECORD MATERIAL OF MAJORITY OF FLOORS - RECORD ONLY 1 ANSWER

- 1 ☐ Clay/earthen floor
- 2 ☐ Cement
- 3 ☐ Cobble stone / cement and stone
- 4 ☐ Tiles
- 5 ☐ Carpet on Cement/ Tiles
- 96 ☐ OTHER, SPECIFY [specify here]

(10.24) What is the roof of this house/ appartment made of?

READ OUT

INTERVIEWER SHOULD OBSERVE AND VERIFY

IF SEVERAL TYPES, RECORD MATERIAL OF MAJORITY OF ROOFS - RECORD ONLY 1 ANSWER

- 1 ☐ Clay and Wood (traditional)
- 2 ☐ Cement
- 3 ☐ Metal Sheets
- 4 ☐ Straw and Sticks
- 96 ☐ OTHER, SPECIFY [specify here]

(10.25) What type of windows does this house/ appartment have?

READ OUT

INTERVIEWER SHOULD OBSERVE AND VERIFY

IF SEVERAL TYPES, RECORD MATERIAL OF MAJORITY OF WINDOWS - RECORD ONLY 1 ANSWER

- 1 ☐ Not covered / Open Holes
- 2 ☐ Wood Cover
- 3 ☐ Metal Cover
- 4 ☐ Glass in Wood Frame
- 5 ☐ Glass in Metal Frame
- 96 ☐ OTHER, SPECIFY [specify here]

What is the main source of fuel for [...]?
READ OUT

(10.27) COOKING	(10.26) LIGHTING		
1 ☐	1 ☐	Firewood	1
2 ☐	2 ☐	Charcoal	2
3 ☐	3 ☐	Kerosine	3
4 ☐	4 ☐	Gas (bottle)	4
5 ☐	5 ☐	Electricity (grid)	5
6 ☐	6 ☐	Electricity (generator)	6
7 ☐	7 ☐	OTHER, SPECIFY	7

(10.28) How long does it take from your house/ appartment to get to the main city market?

☐ MIN

(10.29) How old is the house?

☐ YEARS

(10.30) Is the house built on rocky ground?

- 1 ☐ YES
- 2 ☐ NO
- 99 ☐ DON'T KNOW

END OF INTERVIEW

KfW Development Bank Germany	Development Economics Research Group, University of Goettingen	SOUL for Development, Sana'a Yemen	Ministry of Water and Environment Yemen

REPUBLIC OF YEMEN

Water & Sanitation Survey - 2009

Household Questionnaire

BACKSIDE

QUESTIONNAIRE READS FROM RIGHT TO LEFT
CORRESPONDING WITH THE ARABIC VERSION

NOTES

Annex 8: Secondary Data Collection Questionnaire Health

AR: :Survey Facility ID		**AR: :Hospital**	
AR: :Health Center		**AR: :Health Unit**	
AR: :Health Facility Location		**AR: :Name of Health Facility**	
AR: Area of service (town, villages)		**AR: Governorate**	

AR: Bilharzias (intestal & urinary) *and Schistosomiasis*		**AR: Amoebic Dysentry** *and Giardia*		**AR: Diarrhoea**		**AR: ! Please cross-mark which calendar was used !**			
AR: female	*AR: male*	*AR: female*	*AR: male*	*AR: female*	*AR: male*	**AR: Gregorian**		**AR: Hijri**	
						AR: Jan	**1998**	*AR: Shavwal-ul-Mukkaram*	**1419**
						AR: Feb		*AR: Zilqadat-ul-Haram*	
						AR: Mar		*AR: Zilhajjat-ul-Haram*	
						AR: Apr		*AR: Moharram-ul-Harram*	
						AR: May		*AR: Saffar-ul-Muzaffar*	
						AR: Jun		*AR: Rabiul-Avwal*	
						AR: Jul		*AR: Rabiul-Akhir*	
						AR: Aug		*AR: Jamadil-Avwal*	
						AR: Sep		*AR: Jamadil-Akhir*	
						AR: Okt		*AR: Rajjab-ul-Asab*	
						AR: Nov		*AR: Shaban-ul-Karim*	
						AR: Dez		*AR: Ramazan-ul-Muazzam*	
						AR: Jan	**1999**	*AR: Shavwal-ul-Mukkaram*	**1420**
						AR: Feb		*AR: Zilqadat-ul-Haram*	
						AR: Mar		*AR: Zilhajjat-ul-Haram*	
						AR: Apr		*AR: Moharram-ul-Harram*	
						AR: May		*AR: Saffar-ul-Muzaffar*	
						AR: Jun		*AR: Rabiul-Avwal*	
						AR: Jul		*AR: Rabiul-Akhir*	
						AR: Aug		*AR: Jamadil-Avwal*	
						AR: Sep		*AR: Jamadil-Akhir*	
						AR: Okt		*AR: Rajjab-ul-Asab*	
						AR: Nov		*AR: Shaban-ul-Karim*	
						AR: Dez		*AR: Ramazan-ul-Muazzam*	

	AR: :Name of Person filling in form
	AR: :Mobile of person filling in form

AR: Bilharzias (intestal & urinary) and Schistosomiasis								**AR: Amoebic Dysentry** and Giardia								**AR: Diarrhoea**								**AR: ! Please cross-mark which calendar was used !**			
AR: female				AR: male				AR: female				AR: male				AR: female				AR: male				**AR: Gregorian**		**AR: Hijri**	
AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1				
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																								AR: Feb		AR: Zilqadat-ul-Haram	
																								AR: Mar		AR: Zilhajjat-ul-Haram	
																								AR: Apr		AR: Moharram-ul-Harram	
																								AR: May		AR: Saffar-ul-Muzaffar	
																								AR: Jun	**2000**	AR: Rabiul-Avwal	**1421**
																								AR: Jul		AR: Rabiul-Akhir	
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																								AR: Sep		AR: Jamadil-Akhir	
																								AR: Okt		AR: Rajjab-ul-Asab	
																								AR: Nov		AR: Shaban-ul-Karim	
																								AR: Dez		AR: Ramazan-ul-Muazzam	
																								AR: Jan		AR: Shavwal-ul-Mukkaram	
																								AR: Feb		AR: Zilqadat-ul-Haram	
																								AR: Mar		AR: Zilhajjat-ul-Haram	
																								AR: Apr		AR: Moharram-ul-Harram	
																								AR: May		AR: Saffar-ul-Muzaffar	
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																								AR: Jul		AR: Rabiul-Akhir	
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																								AR: Sep		AR: Jamadil-Akhir	
																								AR: Okt		AR: Rajjab-ul-Asab	
																								AR: Nov		AR: Shaban-ul-Karim	
																								AR: Dez		AR: Ramazan-ul-Muazzam	
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																								AR: Apr		AR: Moharram-ul-Harram	
																								AR: May		AR: Saffar-ul-Muzaffar	
																								AR: Jun	**2002**	AR: Rabiul-Avwal	**1423**
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AR: >12	*AR: 6-12*	*AR: 1-5*	*AR: <1*	*AR: >12*	*AR: 6-12*	*AR: 1-5*	*AR: <1*	*AR: >12*	*AR: 6-12*	*AR: 1-5*	*AR: <1*	*AR: >12*	*AR: 6-12*	*AR: 1-5*	*AR: <1*	*AR: >12*	*AR: 6-12*	*AR: 1-5*	*AR: <1*	*AR: >12*	*AR: 6-12*	*AR: 1-5*	*AR: <1*				
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																								AR: May		*AR: Saffar-ul-Muzaffar*	
																								AR: Jun		*AR: Rabiul-Avwal*	
																								AR: Jul		*AR: Rabiul-Akhir*	
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																								AR: May		*AR: Saffar-ul-Muzaffar*	
																								AR: Jun		*AR: Rabiul-Avwal*	
																								AR: Jul		*AR: Rabiul-Akhir*	
																								AR: Aug		*AR: Jamadil-Avwal*	
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																								AR: Okt		*AR: Rajjab-ul-Asab*	
																								AR: Nov		*AR: Shaban-ul-Karim*	
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																								AR: Feb		AR: Zilqadat-ul-Haram	
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																								AR: Jan		*AR: Shavwal-ul-Mukkaram*	
																								AR: Feb		*AR: Zilqadat-ul-Haram*	
																								AR: Mar		*AR: Zilhajjat-ul-Haram*	
																								AR: Apr		*AR: Moharram-ul-Harram*	
																								AR: May		*AR: Saffar-ul-Muzaffar*	
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																								AR: Aug		*AR: Jamadil-Avwal*	
																								AR: Sep		*AR: Jamadil-Akhir*	
																								AR: Okt		*AR: Rajjab-ul-Asab*	
																								AR: Nov		*AR: Shaban-ul-Karim*	
																								AR: Dez		*AR: Ramazan-ul-Muazzam*	

AR: Hepatitis A								AR: Typhoid								AR: Malaria								AR: ! Please cross-mark which calendar was used !			
AR: female				AR: male				AR: female				AR: male				AR: female				AR: male				AR: Gregorian		AR: Hijri	
AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1				
																								AR: Jan	1998	AR: Shavwal-ul-Mukkaram	1419
																								AR: Feb		AR: Zilqadat-ul-Haram	
																								AR: Mar		AR: Zilhajjat-ul-Haram	
																								AR: Apr		AR: Moharram-ul-Harram	
																								AR: May		AR: Saffar-ul-Muzaffar	
																								AR: Jun		AR: Rabiul-Avwal	
																								AR: Jul		AR: Rabiul-Akhir	
																								AR: Aug		AR: Jamadil-Avwal	
																								AR: Sep		AR: Jamadil-Akhir	
																								AR: Okt		AR: Rajjab-ul-Asab	
																								AR: Nov		AR: Shaban-ul-Karim	
																								AR: Dez		AR: Ramazan-ul-Muazzam	
																								AR: Jan	1999	AR: Shavwal-ul-Mukkaram	1420
																								AR: Feb		AR: Zilqadat-ul-Haram	
																								AR: Mar		AR: Zilhajjat-ul-Haram	
																								AR: Apr		AR: Moharram-ul-Harram	
																								AR: May		AR: Saffar-ul-Muzaffar	
																								AR: Jun		AR: Rabiul-Avwal	
																								AR: Jul		AR: Rabiul-Akhir	
																								AR: Aug		AR: Jamadil-Avwal	
																								AR: Sep		AR: Jamadil-Akhir	
																								AR: Okt		AR: Rajjab-ul-Asab	
																								AR: Nov		AR: Shaban-ul-Karim	
																								AR: Dez		AR: Ramazan-ul-Muazzam	
																								AR: Jan	2000	AR: Shavwal-ul-Mukkaram	1421
																								AR: Feb		AR: Zilqadat-ul-Haram	
																								AR: Mar		AR: Zilhajjat-ul-Haram	
																								AR: Apr		AR: Moharram-ul-Harram	
																								AR: May		AR: Saffar-ul-Muzaffar	
																								AR: Jun		AR: Rabiul-Avwal	
																								AR: Jul		AR: Rabiul-Akhir	
																								AR: Aug		AR: Jamadil-Avwal	
																								AR: Sep		AR: Jamadil-Akhir	
																								AR: Okt		AR: Rajjab-ul-Asab	
																								AR: Nov		AR: Shaban-ul-Karim	
																								AR: Dez		AR: Ramazan-ul-Muazzam	

AR: Hepatitis A								AR: Typhoid								AR: Malaria								AR: ! Please cross-mark which calendar was used !			
AR: female				AR: male				AR: female				AR: male				AR: female				AR: male				AR: Gregorian		AR: Hijri	
AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1				
																								AR: Jan	2001	AR: Shavwal-ul-Mukkaram	1422
																								AR: Feb		AR: Zilqadat-ul-Haram	
																								AR: Mar		AR: Zilhajjat-ul-Haram	
																								AR: Apr		AR: Moharram-ul-Harram	
																								AR: May		AR: Saffar-ul-Muzaffar	
																								AR: Jun		AR: Rabiul-Avwal	
																								AR: Jul		AR: Rabiul-Akhir	
																								AR: Aug		AR: Jamadil-Avwal	
																								AR: Sep		AR: Jamadil-Akhir	
																								AR: Okt		AR: Rajjab-ul-Asab	
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																								AR: Dez		AR: Ramazan-ul-Muazzam	
																								AR: Jan	2002	AR: Shavwal-ul-Mukkaram	1423
																								AR: Feb		AR: Zilqadat-ul-Haram	
																								AR: Mar		AR: Zilhajjat-ul-Haram	
																								AR: Apr		AR: Moharram-ul-Harram	
																								AR: May		AR: Saffar-ul-Muzaffar	
																								AR: Jun		AR: Rabiul-Avwal	
																								AR: Jul		AR: Rabiul-Akhir	
																								AR: Aug		AR: Jamadil-Avwal	
																								AR: Sep		AR: Jamadil-Akhir	
																								AR: Okt		AR: Rajjab-ul-Asab	
																								AR: Nov		AR: Shaban-ul-Karim	
																								AR: Dez		AR: Ramazan-ul-Muazzam	
																								AR: Jan	2003	AR: Shavwal-ul-Mukkaram	1424
																								AR: Feb		AR: Zilqadat-ul-Haram	
																								AR: Mar		AR: Zilhajjat-ul-Haram	
																								AR: Apr		AR: Moharram-ul-Harram	
																								AR: May		AR: Saffar-ul-Muzaffar	
																								AR: Jun		AR: Rabiul-Avwal	
																								AR: Jul		AR: Rabiul-Akhir	
																								AR: Aug		AR: Jamadil-Avwal	
																								AR: Sep		AR: Jamadil-Akhir	
																								AR: Okt		AR: Rajjab-ul-Asab	
																								AR: Nov		AR: Shaban-ul-Karim	
																								AR: Dez		AR: Ramazan-ul-Muazzam	

AR: Hepatitis A								AR: Typhoid								AR: Malaria								AR: ! Please cross-mark which calendar was used !			
AR: female				AR: male				AR: female				AR: male				AR: female				AR: male				AR: Gregorian		AR: Hijri	
AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1				
																								AR: Jan		AR: Shavwal-ul-Mukkaram	
																								AR: Feb		AR: Zilqadat-ul-Haram	
																								AR: Mar		AR: Zilhajjat-ul-Haram	
																								AR: Apr		AR: Moharram-ul-Harram	
																								AR: May		AR: Saffar-ul-Muzaffar	
																								AR: Jun	2004	AR: Rabiul-Avwal	1425
																								AR: Jul		AR: Rabiul-Akhir	
																								AR: Aug		AR: Jamadil-Avwal	
																								AR: Sep		AR: Jamadil-Akhir	
																								AR: Okt		AR: Rajjab-ul-Asab	
																								AR: Nov		AR: Shaban-ul-Karim	
																								AR: Dez		AR: Ramazan-ul-Muazzam	
																								AR: Jan		AR: Shavwal-ul-Mukkaram	
																								AR: Feb		AR: Zilqadat-ul-Haram	
																								AR: Mar		AR: Zilhajjat-ul-Haram	
																								AR: Apr		AR: Moharram-ul-Harram	
																								AR: May		AR: Saffar-ul-Muzaffar	
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																								AR: Sep		AR: Jamadil-Akhir	
																								AR: Okt		AR: Rajjab-ul-Asab	
																								AR: Nov		AR: Shaban-ul-Karim	
																								AR: Dez		AR: Ramazan-ul-Muazzam	
																								AR: Jan		AR: Shavwal-ul-Mukkaram	
																								AR: Feb		AR: Zilqadat-ul-Haram	
																								AR: Mar		AR: Zilhajjat-ul-Haram	
																								AR: Apr		AR: Moharram-ul-Harram	
																								AR: May		AR: Saffar-ul-Muzaffar	
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																								AR: Jul		AR: Rabiul-Akhir	
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																								AR: Sep		AR: Jamadil-Akhir	
																								AR: Okt		AR: Rajjab-ul-Asab	
																								AR: Nov		AR: Shaban-ul-Karim	
																								AR: Dez		AR: Ramazan-ul-Muazzam	

AR: Hepatitis A								AR: Typhoid								AR: Malaria								AR: ! Please cross-mark which calendar was used !			
AR: female				AR: male				AR: female				AR: male				AR: female				AR: male				AR: Gregorian		AR: Hijri	
AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1				
																								AR: Jan	2007	AR: Shavwal-ul-Mukkaram	1428
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																								AR: May		AR: Saffar-ul-Muzaffar	
																								AR: Jun		AR: Rabiul-Avwal	
																								AR: Jul		AR: Rabiul-Akhir	
																								AR: Aug		AR: Jamadil-Avwal	
																								AR: Sep		AR: Jamadil-Akhir	
																								AR: Okt		AR: Rajjab-ul-Asab	
																								AR: Nov		AR: Shaban-ul-Karim	
																								AR: Dez		AR: Ramazan-ul-Muazzam	
																								AR: Jan	2008	AR: Shavwal-ul-Mukkaram	1429
																								AR: Feb		AR: Zilqadat-ul-Haram	
																								AR: Mar		AR: Zilhajjat-ul-Haram	
																								AR: Apr		AR: Moharram-ul-Harram	
																								AR: May		AR: Saffar-ul-Muzaffar	
																								AR: Jun		AR: Rabiul-Avwal	
																								AR: Jul		AR: Rabiul-Akhir	
																								AR: Aug		AR: Jamadil-Avwal	
																								AR: Sep		AR: Jamadil-Akhir	
																								AR: Okt		AR: Rajjab-ul-Asab	
																								AR: Nov		AR: Shaban-ul-Karim	
																								AR: Dez		AR: Ramazan-ul-Muazzam	
																								AR: Jan	2009	AR: Shavwal-ul-Mukkaram	1430
																								AR: Feb		AR: Zilqadat-ul-Haram	
																								AR: Mar		AR: Zilhajjat-ul-Haram	
																								AR: Apr		AR: Moharram-ul-Harram	
																								AR: May		AR: Saffar-ul-Muzaffar	
																								AR: Jun		AR: Rabiul-Avwal	
																								AR: Jul		AR: Rabiul-Akhir	
																								AR: Aug		AR: Jamadil-Avwal	
																								AR: Sep		AR: Jamadil-Akhir	
																								AR: Okt		AR: Rajjab-ul-Asab	
																								AR: Nov		AR: Shaban-ul-Karim	
																								AR: Dez		AR: Ramazan-ul-Muazzam	

AR: Intestal Worms *(Flukes, Hookworm, Pinworm, Roundworm, Tapeworms, Whipworm, …)*								***AR: ! Please cross-mark which calendar was used !***			
AR: female				*AR: male*				***AR: Gregorian***		***AR: Hijri***	
AR: >12	*AR: 6-12*	*AR: 1-5*	*AR: <1*	*AR: >12*	*AR: 6-12*	*AR: 1-5*	*AR: <1*				
								AR: Jan	**1998**	*AR: Shavwal-ul-Mukkaram*	**1419**
								AR: Feb		*AR: Zilqadat-ul-Haram*	
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								AR: Apr		*AR: Moharram-ul-Harram*	
								AR: May		*AR: Saffar-ul-Muzaffar*	
								AR: Jun		*AR: Rabiul-Avwal*	
								AR: Jul		*AR: Rabiul-Akhir*	
								AR: Aug		*AR: Jamadil-Avwal*	
								AR: Sep		*AR: Jamadil-Akhir*	
								AR: Okt		*AR: Rajjab-ul-Asab*	
								AR: Nov		*AR: Shaban-ul-Karim*	
								AR: Dez		*AR: Ramazan-ul-Muazzam*	
								AR: Jan	**1999**	*AR: Shavwal-ul-Mukkaram*	**1420**
								AR: Feb		*AR: Zilqadat-ul-Haram*	
								AR: Mar		*AR: Zilhajjat-ul-Haram*	
								AR: Apr		*AR: Moharram-ul-Harram*	
								AR: May		*AR: Saffar-ul-Muzaffar*	
								AR: Jun		*AR: Rabiul-Avwal*	
								AR: Jul		*AR: Rabiul-Akhir*	
								AR: Aug		*AR: Jamadil-Avwal*	
								AR: Sep		*AR: Jamadil-Akhir*	
								AR: Okt		*AR: Rajjab-ul-Asab*	
								AR: Nov		*AR: Shaban-ul-Karim*	
								AR: Dez		*AR: Ramazan-ul-Muazzam*	
								AR: Jan	**2000**	*AR: Shavwal-ul-Mukkaram*	**1421**
								AR: Feb		*AR: Zilqadat-ul-Haram*	
								AR: Mar		*AR: Zilhajjat-ul-Haram*	
								AR: Apr		*AR: Moharram-ul-Harram*	
								AR: May		*AR: Saffar-ul-Muzaffar*	
								AR: Jun		*AR: Rabiul-Avwal*	
								AR: Jul		*AR: Rabiul-Akhir*	
								AR: Aug		*AR: Jamadil-Avwal*	
								AR: Sep		*AR: Jamadil-Akhir*	
								AR: Okt		*AR: Rajjab-ul-Asab*	
								AR: Nov		*AR: Shaban-ul-Karim*	
								AR: Dez		*AR: Ramazan-ul-Muazzam*	

AR: Intestal Worms *(Flukes, Hookworm, Pinworm, Roundworm, Tapeworms, Whipworm, …)*								***AR: ! Please cross-mark which calendar was used !***			
AR: female				*AR: male*				***AR: Gregorian***		***AR: Hijri***	
AR: >12	*AR: 6-12*	*AR: 1-5*	*AR: <1*	*AR: >12*	*AR: 6-12*	*AR: 1-5*	*AR: <1*				
								AR: Jan		*AR: Shavwal-ul-Mukkaram*	
								AR: Feb		*AR: Zilqadat-ul-Haram*	
								AR: Mar		*AR: Zilhajjat-ul-Haram*	
								AR: Apr		*AR: Moharram-ul-Harram*	
								AR: May		*AR: Saffar-ul-Muzaffar*	
								AR: Jun	**2001**	*AR: Rabiul-Avwal*	**1422**
								AR: Jul		*AR: Rabiul-Akhir*	
								AR: Aug		*AR: Jamadil-Avwal*	
								AR: Sep		*AR: Jamadil-Akhir*	
								AR: Okt		*AR: Rajjab-ul-Asab*	
								AR: Nov		*AR: Shaban-ul-Karim*	
								AR: Dez		*AR: Ramazan-ul-Muazzam*	
								AR: Jan		*AR: Shavwal-ul-Mukkaram*	
								AR: Feb		*AR: Zilqadat-ul-Haram*	
								AR: Mar		*AR: Zilhajjat-ul-Haram*	
								AR: Apr		*AR: Moharram-ul-Harram*	
								AR: May		*AR: Saffar-ul-Muzaffar*	
								AR: Jun	**2002**	*AR: Rabiul-Avwal*	**1423**
								AR: Jul		*AR: Rabiul-Akhir*	
								AR: Aug		*AR: Jamadil-Avwal*	
								AR: Sep		*AR: Jamadil-Akhir*	
								AR: Okt		*AR: Rajjab-ul-Asab*	
								AR: Nov		*AR: Shaban-ul-Karim*	
								AR: Dez		*AR: Ramazan-ul-Muazzam*	
								AR: Jan		*AR: Shavwal-ul-Mukkaram*	
								AR: Feb		*AR: Zilqadat-ul-Haram*	
								AR: Mar		*AR: Zilhajjat-ul-Haram*	
								AR: Apr		*AR: Moharram-ul-Harram*	
								AR: May		*AR: Saffar-ul-Muzaffar*	
								AR: Jun	**2003**	*AR: Rabiul-Avwal*	**1424**
								AR: Jul		*AR: Rabiul-Akhir*	
								AR: Aug		*AR: Jamadil-Avwal*	
								AR: Sep		*AR: Jamadil-Akhir*	
								AR: Okt		*AR: Rajjab-ul-Asab*	
								AR: Nov		*AR: Shaban-ul-Karim*	
								AR: Dez		*AR: Ramazan-ul-Muazzam*	

AR: Intestal Worms *(Flukes, Hookworm, Pinworm, Roundworm, Tapeworms, Whipworm, …)*								***AR: ! Please cross-mark which calendar was used !***			
AR: female				*AR: male*				***AR: Gregorian***		***AR: Hijri***	
AR: >12	*AR: 6-12*	*AR: 1-5*	*AR: <1*	*AR: >12*	*AR: 6-12*	*AR: 1-5*	*AR: <1*				
								AR: Jan	**2004**	*AR: Shavwal-ul-Mukkaram*	**1425**
								AR: Feb		*AR: Zilqadat-ul-Haram*	
								AR: Mar		*AR: Zilhajjat-ul-Haram*	
								AR: Apr		*AR: Moharram-ul-Harram*	
								AR: May		*AR: Saffar-ul-Muzaffar*	
								AR: Jun		*AR: Rabiul-Avwal*	
								AR: Jul		*AR: Rabiul-Akhir*	
								AR: Aug		*AR: Jamadil-Avwal*	
								AR: Sep		*AR: Jamadil-Akhir*	
								AR: Okt		*AR: Rajjab-ul-Asab*	
								AR: Nov		*AR: Shaban-ul-Karim*	
								AR: Dez		*AR: Ramazan-ul-Muazzam*	
								AR: Jan	**2005**	*AR: Shavwal-ul-Mukkaram*	**1426**
								AR: Feb		*AR: Zilqadat-ul-Haram*	
								AR: Mar		*AR: Zilhajjat-ul-Haram*	
								AR: Apr		*AR: Moharram-ul-Harram*	
								AR: May		*AR: Saffar-ul-Muzaffar*	
								AR: Jun		*AR: Rabiul-Avwal*	
								AR: Jul		*AR: Rabiul-Akhir*	
								AR: Aug		*AR: Jamadil-Avwal*	
								AR: Sep		*AR: Jamadil-Akhir*	
								AR: Okt		*AR: Rajjab-ul-Asab*	
								AR: Nov		*AR: Shaban-ul-Karim*	
								AR: Dez		*AR: Ramazan-ul-Muazzam*	
								AR: Jan	**2006**	*AR: Shavwal-ul-Mukkaram*	**1427**
								AR: Feb		*AR: Zilqadat-ul-Haram*	
								AR: Mar		*AR: Zilhajjat-ul-Haram*	
								AR: Apr		*AR: Moharram-ul-Harram*	
								AR: May		*AR: Saffar-ul-Muzaffar*	
								AR: Jun		*AR: Rabiul-Avwal*	
								AR: Jul		*AR: Rabiul-Akhir*	
								AR: Aug		*AR: Jamadil-Avwal*	
								AR: Sep		*AR: Jamadil-Akhir*	
								AR: Okt		*AR: Rajjab-ul-Asab*	
								AR: Nov		*AR: Shaban-ul-Karim*	
								AR: Dez		*AR: Ramazan-ul-Muazzam*	

AR: Intestal Worms *(Flukes, Hookworm, Pinworm, Roundworm, Tapeworms, Whipworm, …)*								AR: ! Please cross-mark which calendar was used !			
AR: female				AR: male				AR: Gregorian		AR: Hijri	
AR: >12	AR: 6-12	AR: 1-5	AR: <1	AR: >12	AR: 6-12	AR: 1-5	AR: <1				
								AR: Jan	2007	AR: Shavwal-ul-Mukkaram	1428
								AR: Feb		AR: Zilqadat-ul-Haram	
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								AR: Apr		AR: Moharram-ul-Harram	
								AR: May		AR: Saffar-ul-Muzaffar	
								AR: Jun		AR: Rabiul-Avwal	
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								AR: Okt		AR: Rajjab-ul-Asab	
								AR: Nov		AR: Shaban-ul-Karim	
								AR: Dez		AR: Ramazan-ul-Muazzam	
								AR: Jan	2008	AR: Shavwal-ul-Mukkaram	1429
								AR: Feb		AR: Zilqadat-ul-Haram	
								AR: Mar		AR: Zilhajjat-ul-Haram	
								AR: Apr		AR: Moharram-ul-Harram	
								AR: May		AR: Saffar-ul-Muzaffar	
								AR: Jun		AR: Rabiul-Avwal	
								AR: Jul		AR: Rabiul-Akhir	
								AR: Aug		AR: Jamadil-Avwal	
								AR: Sep		AR: Jamadil-Akhir	
								AR: Okt		AR: Rajjab-ul-Asab	
								AR: Nov		AR: Shaban-ul-Karim	
								AR: Dez		AR: Ramazan-ul-Muazzam	
								AR: Jan	2009	AR: Shavwal-ul-Mukkaram	1430
								AR: Feb		AR: Zilqadat-ul-Haram	
								AR: Mar		AR: Zilhajjat-ul-Haram	
								AR: Apr		AR: Moharram-ul-Harram	
								AR: May		AR: Saffar-ul-Muzaffar	
								AR: Jun		AR: Rabiul-Avwal	
								AR: Jul		AR: Rabiul-Akhir	
								AR: Aug		AR: Jamadil-Avwal	
								AR: Sep		AR: Jamadil-Akhir	
								AR: Okt		AR: Rajjab-ul-Asab	
								AR: Nov		AR: Shaban-ul-Karim	
								AR: Dez		AR: Ramazan-ul-Muazzam	

Annex 9: Secondary Data Collection Questionnaire Education

			AR: :Facility Survey ID:		AR: :Location		AR: :School Name
	AR: :Year of Construction		AR: :Highest Grade Girls		AR: :Highest Grade Boys	

					AR: Town
	AR: Girls		**AR: Boys**		**AR: 5-1 Grade**
	AR: Fail	AR: Pass	AR: Fail	AR: Pass	**AR: School year**
AR: Educational Level (Primary/ Secondary)					**2009 - 2008**
					2008 - 2007
AR: Number of teachers in school					**2007 - 2006**
					2006 - 2005
AR: Number of active teachers					**2005 - 2004**
					2004 - 2003
					2003 - 2002
AR: Name of person filling in form					**2002 - 2001**
					2001 - 2000
AR: Mobile number of person filling in form					**2000 - 1999**
					1999 - 1998

	AR: :Checked on date
	AR: :Checked by
	AR: :Checked on date

Annex 10: Water Test Chain

Test Chains

Connected	Source →	Feed Pipe →		Ground/ Roof Tank →	Tap →	Kitchen Storage Container →	Drinking Container
Remarks		At rationing points					
Non-connected	Non-connected Source →		Water Truck →	Ground/ Roof Tank →	Tap →	Kitchen Storage Container →	Drinking Container
Remarks							

Indicators to be tested

	Source	Feed Pipe	Water Truck	Ground/ Roof Tank	Tap	Kitchen Storage Container	Drinking Container
Physical Indicators							
Electrical Conductivity EC	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Total Dissolved Solids TDS	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PH Value	Yes	No	No	No	Yes	No	No
Chemical Indicators, stable							
Hardness	Yes	No	No	No	No	No	No
Calcium	Yes	No	No	No	No	No	No
Chloride	Yes	No	No	No	No	No	No
Total Iron	Yes	No	No	No	No	No	No
Fluoride	Yes	No	No	No	No	No	No
Chemical Indicators, variable							
Nitrate	Yes	No	Yes	No	No	No	No
Sulphate	Yes	No	Yes	No	No	No	No
Biological Indicator							
E.Coli Membrane Test	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Total Coliforms Membrane test	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Annex 11: Water Test Questionnaires

HOUSEHOLD - Household Head Questionnaire

FILL BEFORE INTERVIEW

ID / Signature of Interviewer	(11.03)	
Date of Interview (DAY, MONTH)	(11.02)	
Household ID (City, Cluster, EA, HH)	(11.01)	

2 FEMALE; 1 MALE	Gender of respondent	(11.04)

READ OUT

Hello, we are conducting a survey of water quality for the organization SOUL from Sana'a. We will treat your information confidential and will not share your private information with the Local Corporation. We would like to test the water quality in your household and ask you a few questions.

ASK RESPONDENT

8 FATHER / MOTHER; 9 FATHER / MOTHER OF SPOUSE; 10 CHILD OF RELATIVE; 11 CHILD OF NON-RELATIVE; 12 OTHER RELATIVE; 13 OTHER NON-RELATIVE; 1 HEAD; 2 SPOUSE; 3 CO-WIFE; 4 SON / DAUGHTER; 5 SPOUSE OF SON / DAUGHTER; 6 GRANDCHILD; 7 BROTHER / SISTER	What is your relation to the household head?	(11.05)
YEARS	What is your age?	(11.06)
(IF LESS THAN ONE WEEK AGO FILL IN 1) WEEKS; 98 NEVER	How many weeks ago did your household buy water from a water truck last (within last 12 months) ?	(11.07)
98 NOT APPLICABLE; YER	How much do you pay per liter for truck water?	(11.08)
YER	How much did you pay in total last time you bought water from a truck?	(11.09)
ID1 a NAME DRIVER; ID2 b NAME WELL OWNER; ID3 c COMPANY	From which tanker truck driver or well owner or company did you buy water last time?	(11.10)
ID; NAME OF WELL OWNER	ASK IF NOT YET ANSWERED From which well owner does the water in the truck come?	(11.11)
(IN THIS CASE REFER TO GROUND TANK IN THE FOLLOWING) ◀ 1 GROUND TANK; 2 ROOF TANK; 3 BOTH; 4 NONE; 99 DON'T KNOW	Which type of tank do you have, a ground or a roof tank?	(11.12)
LITERS	What is the capacity of your roof / ground tank?	(11.13)
REFILLS PER MONTH	How often do you refill your roof / ground tank each month?	(11.14)
3 THREE QUARTERS; 4 FULL; 1 ONE QUARTER; 2 HALF; 99 DON'T KNOW	What share of your roof / ground do you usually refill?	(11.15)
1 YES; 99 DON'T KNOW; (11.18) ◀ 2 NO	Does your roof/ ground tank get cleaned from the inside sometimes?	(11.16)
99 DON'T KNOW; WEEKS	How many weeks ago did your roof/ ground tank get cleaned from the inside?	(11.17)
1 YES; 99 DON'T KNOW; (11.20) ◀ 2 NO	Does your roof/ ground tank get desinfected from the inside sometimes?	(11.18)
99 DON'T KNOW; WEEKS	How many weeks ago did your roof/ ground tank get desinfected from the inside?	(11.19)

1 ☐ YES END OF INTERVIEW (11.31) ◄2 ☐ NO	Is your household connected to a public water-pipe-system?	(11.20)
1 ☐ YES END OF INTERVIEW (11.31) ◄2 ☐ NO	Does your household have a water meter?	(11.21)

ASK ONLY TO CONNECTED HOUSEHOLDS		
TICK YES EVEN IF RESPONDENT ANSWERS RIGHTAWAY WITH DATE 1 ☐ YES (11.24) ◄2 ☐ NO	Do you know approximately when your water meter installed?	(11.22)
MONTH ☐☐ YEAR ☐☐☐☐	ASK, THEN FILL IN AS ACCURATELY AS ANSWER ALLOWS When was your water meter installed?	(11.23)

READ OUT: Could we read your water meter settings, please?

NA ☐ NOT APPLICABLE	☐ CUBIC METRES	READ AND NOTE Water meter reading	(11.24)
	☐ YER	How much did you pay when the water meter was checked last time?	(11.25)
	1 ☐ YES, BILL CHECKED 2 ☐ NO BILL	IF POSSIBLE CHECK BILL Did you receive a bill for your pipe water?	(11.26)
99 ☐ DON'T KNOW	☐ CUBIC METRES	The sum you had to pay was for what quantity of water?	(11.27)
	☐ WEEKS	How many weeks did this payment cover?	(11.28)
99 ☐ DON'T KNOW	1 ☐ YES 2 ☐ NO	Was the public water-pipe-system connection to your house interrupted anytime during the last month?	(11.29)
99 ☐ DON'T KNOW	1 ☐ YES 2 ☐ NO	Was your water meter ever disconnected or replaced since the house was connected?	(11.30)

READ OUT: Thank you very much for your cooperation. We know proceed with the testing.

END OF INTERVIEW

OBSERVE, DO NOT ASK!		
1 ☐ VERY CLEAN 2 ☐ INTERMEDIATE 3 ☐ NOT SO CLEAN 4 ☐ NOT OBSERVABLE	What impression does the drinking cup make in terms of cleanliness?	(11.31)

MEASURE AND NOTE					
☐ PH VALUE	(11.34)	☐ ELECTRICAL CONDUCTIVITY EC	(11.33)	Time of Water Sample	(11.32)
☐ E. COLI MEMBRANE TEST	(11.36)	☐ TOTAL DISSOLVED SOLIDS TDS	(11.35)	☐☐ HOUR ☐☐ MINUTE	

WATER TRUCK - Water Salesman Questionnaire

FILL BEFORE INTERVIEW

ID	Signature of Interviewer	(13.03)

Date of Interview	(13.02)
DAY MONTH	

		Town ID (TICK)	(13.01)
1	AMRAN		
2	RAYDAH		
3	ZABID		
4	AL JARRAHI		

_	Well ID	(13.04)

2 NO 1 YES	OBSERVE Is the truck losing water from valve?	(13.05)
1 VERY CLEAN 2 CLEAN 3 DIRTY 4 VERY DIRTY	OBSERVE Hygenic condition of valve of water truck?	(13.06)

READ OUT

Hello, we are conducting a survey of water quality for the organization SOUL from Sana'a. We will treat your information confidential and will not share your private information with the Local Corporation. We would like to test the water characteristics of your truck load and ask you a few questions.

ASK RESPONDENT

ID NAME	Name (or Nickname / Pseudonym) of Truck Driver	(13.07)
ID NAME 98 NO SPECIFIC COMPANY	Name of Company or Truck Owner USE NAME USED BY CUSTOMERS TO REFER TO COMPANY	(13.08)
2 NO 1 YES	Do you fill your tanker truck at one well only?	(13.09)
ID1 a NAME OWNER WELL 1 (MAINLY USED) ID2 b NAME OWNER WELL 2 ID3 c NAME OWNER WELL 3	SORT ANSWERS BY FREQUENCY OF USE At which owners' wells do you fill your tanker truck (please give full names of well owners)?	(13.10)
a TIMES OF USE OF WELL 1 (MAINLY USED) b TIMES OF USE WELL 2 c TIMES OF USE WELL 3	<u>During the last week</u>, how many times did you take water from this well?	(13.11)
1 COVERED 2 OPEN a WELL 1 (MAINLY USED) 1 COVERED 2 OPEN b WELL 2 1 COVERED 2 OPEN c WELL 3	Is the well covered or open?	(13.12)
2 NO 1 YES	Do you fill your tank to full capacity each time?	(13.13)
99 DON'T KNOW (13.16) ◄2 NO 1 YES	Does the well owner treat the water before selling?	(13.14)
1 CHLORINE 2 FILTER 99 DON'T KNOW 96 OTHER	How does the well owner treat the water before selling? TICK ALL THAT APPLIES	(13.15)

(13.18) ◄2 ☐ NO 1 ☐ YES	Do you treat the water before selling it?	(13.16)
1 ☐ CHLORINE 2 ☐ FILTER 96 ☐ OTHER (SPECIFY)	How do you treat the water before selling it? TICK ALL THAT APPLIES	(13.17)
☐ YER PER CUBIC METRE	What price does a household have to pay for one cubic metre of water?	(13.18)
2 ☐ NO 1 ☐ YES	Do you sell water to people coming to you with buckets or canisters?	(13.19)
☐ YER PER 20L BUCKET	What price does a household have to pay for one 20 liter bucket of water?	(13.20)
☐ YER PER CUBIC METRE	How much do you pay to the well owner for the water per cubic metre?	(13.21)
☐ YER PER TRUCK LOAD	How much do you pay to the well owner for the water per truck load?	(13.22)
☐ CUBIC METRES	How much water do you sell per day on average, in cubic metres?	(13.23)
☐ TRUCK LOADS	How many truck loads of water do you sell per day on average?	(13.24)
☐ CUBIC METRES	How much water does a houshold buy in cubic metres, on average?	(13.25)
☐ CUBIC METRES	How much water fits into your tank?	(13.26)
1 ☐ SQUARE 2 ☐ ROUND	OBSERVE Tank shape	(13.27)
w ☐ WIDTH (in cm) h ☐ HEIGHTS (in cm) l ☐ LENGTH (incm)	MEASURE WITH TAPE Tank size	(13.28)
☐ MINUTES	How many minutes does it normally take to fill the water tank of your truck?	(13.29)
(13.32) ◄2 ☐ NO 1 ☐ YES	Is it possible to clean the inside of the water tank?	(13.30)
☐ NUMBER OF WEEKS 98 ☐ NEVER	How many weeks ago was the tank last cleaned from the inside? IF LESS THAN 1 ENTER 0	(13.31)
(13.34) ◄2 ☐ NO 1 ☐ YES	Is it possible to disinfect the inside of the water tank?	(13.32)
☐ NUMBER OF WEEKS 98 ☐ NEVER	How many weeks ago was the tank last disinfected from the inside? IF LESS THAN 1 ENTER 0	(13.33)

READ OUT: Thank you very much for your cooperation. We know proceed with the testing.

END OF INTERVIEW

MEASURE AND NOTE					
☐ ELECTRICAL CONDUCTIVITY EC	(13.36)	Time of Water Sample HOUR / MINUTE	(13.35)	Date of Water Sample DAY / MONTH	(13.34)
☐ TOTAL DISSOLVED SOLIDS TDS	(13.37)				
☐ NITRATE	(13.38)				
☐ SULPHATE	(13.40)	☐ E. COLI MEMBRANE TEST			(13.39)

WELL for Trucks - Well Operator Questionnaire

FILL BEFORE INTERVIEW

ID	Signature of Interviewer	(12.03)	Date of Interview	(12.02)	_	Well ID	(12.01)
			DAY MONTH				

GPS Coordinates of Well	(12.05)
N *	
E *	

		Town ID (TICK)	(12.04)
1	AMRAN		
2	RAYDAH		
3	ZABID		
4	AL JARRAHI		

1 EASY 2 DIFFICULT 3 NOT FOUND	How difficult was it to find the well?	(12.06)
2 COVERED 1 OPEN	Physical structure of well	(12.07)

Hello, we are conducting a survey of water characteristics for the organization SOUL from Sana'a. We will treat your information confidential and will not share your private information with the Local Corporation. We would like to test the water characteristics at your well and ask you a few questions.

ASK RESPONDENT

ID NAME	Name (or Nickname / Pseudonym) of Well Owner	(12.08)
NAME	Name of well (or colloquial name / name used by locals)	(12.09)
DAYS	How many days a week do you operate your waterpump?	(12.10)
b SMALL TRUCKS a LARGE TRUCKS	How many small and large trucks take water from your well? (on a normal day when is pump is operating)	(12.11)
a CUBIC METRES (LARGE TRUCKS) b CUBIC METRES (SMALL TRUCKS)	How much water do you normally sell to small and large trucks, in cubic meters per truck?	(12.12)
CUBIC METRES	In total, how much water do you sell on a normal day?	(12.13)
YER PER CUBIC METRE	How much do water truck drivers have to pay for the water?	(12.14)
(12.17) ◄2 NO 1 YES	Do you treat the water before selling?	(12.15)
1 CHLORINE 2 FILTER 96 OTHER (SPECIFY)	How do you treat the water before selling? TICK ALL THAT APPLY	(12.16)
END OF INTERVIEW (12.22) ◄2 NO 1 YES	Do you use a storage tank?	(12.17)
END OF INTERVIEW (12.22) ◄2 NO 1 YES	Is this tank cleaned from the inside from time to time?	(12.18)
NUMBER OF WEEKS	How many weeks ago was this tank cleaned from the inside?	(12.19)
END OF INTERVIEW (12.22) ◄2 NO 1 YES	Is this tank desinfected from the inside sometimes?	(12.20)
NUMBER OF WEEKS	How many weeks ago was this tank desinfected from the inside?	(12.21)

READ OUT: Thank you very much for your cooperation. We know proceed with the testing.

END OF INTERVIEW

MEASURE AND NOTE					
	ELECTRICAL CONDUCTIVITY EC	(12.24)	Time of Water Sample HOUR / MINUTE	(12.23)	Date of Water Sample DAY / MONTH	(12.22)
	PH VALUE	(12.25)				
	TOTAL DISSOLVED SOLIDS TDS	(12.26)				
	HARDNESS	(12.28)		CALCIUM	(12.27)
	TOTAL IRON	(12.30)		CHLORIDE	(12.29)
	FLUORIDE	(12.32)		NITRATE	(12.31)
	E. COLI MEMBRANE TEST	(12.34)		SULPHATE	(12.33)

WATER WORKS - Local Corporation Manager Questionnaire

FILL BEFORE INTERVIEW

ID	Signature of Interviewer	(14.03)

Date of Interview		(14.02)
DAY	MONTH	

		Town ID (TICK)	(14.01)
1	AMRAN		
3	ZABID		

READ OUT

Hello, we are conducting a survey of water characteristics and related issues for the organization SOUL from Sana'a. Within the last twelve months, please think of an average month, including all problems and achievements.

ASK RESPONDENT

NAME	Name (or Nickname / Pseudonym) of Manager	(14.04)
CUBIC METRES 97 ANSWER REFUSED 99 DON'T KNOW	How much water do you pump and process in a normal month?	(14.05)
CUBIC METRES 97 ANSWER REFUSED 99 DON'T KNOW	How much water do you sell in a normal month?	(14.06)
DAYS PER MONTH 97 ANSWER REFUSED 99 DON'T KNOW	How many <u>days per month</u> is a single household supplied with water in a normal month?	(14.07)
HOURS PER DAY 97 ANSWER REFUSED 99 DON'T KNOW	How many <u>hours per day</u> is a single household supplied with water in a normal month?	(14.08)

READ OUT: Thank you very much for your cooperation. We know proceed with the testing.

END OF INTERVIEW

MEASURE AND NOTE

Time of Water Sample		(14.10)
HOUR	MINUTE	

Date of Water Sample		(14.09)
DAY	MONTH	

TOTAL DISSOLVED SOLIDS TDS	(14.12)	ELECTRICAL CONDUCTIVITY EC	(14.11)
HARDNESS	(14.14)	PH VALUE	(14.13)
CHLORIDE	(14.16)	CALCIUM	(14.15)
FLUORIDE	(14.18)	TOTAL IRON	(14.17)
SULPHATE	(14.20)	NITRATE	(14.19)
		E. COLI MEMBRANE TEST	(14.21)

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