AMERICAN UNIVERSITY OF BEIRUT

A HOLISTIC PARTICIPATORY APPROACH TO WATER AND SANITATION IMPROVEMENT IN DISADVANTAGED URBAN SLUMS

by
RANIA ANTOINE MAROUN

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AN ABSTRACT OF THE DISSERTATION OF

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Major: Environmental and Water Resources Engineering

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Safe drinking water, adequate sanitation, and proper hygiene practices constitute preconditions for health improvement and livelihood enhancement in disadvantaged urban areas and contribute to poverty alleviation. The importance of incorporating local knowledge of health and environmental conditions and of household preferences and behavior into decisions on water and sanitation improvement options is well acknowledged. In this context, a poor and deprived urban area was selected as a pilot, whereby a community-based collaborative approach to water and sanitation improvement was tested with the aim of easing environmental burdens through a better understanding of how poor environmental services can exacerbate poverty. A multi-disciplinary research framework combining quantitative and qualitative methodologies was adopted to document the existing conditions, analyze and interpret the social and cultural factors that determine or influence the situation, identify and assess current prevention and intervention strategies, and develop and implement new pilot interventions and evaluate them.

Field surveys revealed that the pilot area suffers from water pollution at the building/household level due to deteriorated water and wastewater plumbing systems. A high incidence of diarrhea (33.1 percent), nearly 6.5 folds the national annual incidence, was estimated using household and hospital/dispensary surveys. Statistical modeling estimated the baseline probability of contracting diarrhea in a household in Tebbaneh at 83.5%, given that there are two members in the household, the age of the female household head is 20, the household is unable to secure 100 USD within one week, there is no wastewater accumulation in the basement, network water is not used for cooking, and the household is not located in Zone 2, to the southwest of Tebbaneh. The annual economic burden of increased morbidity and premature mortality resulting from reported diarrhea alone was estimated to range between 3.4 to 17.1 percent of the total annual area income. The implementation of simple low cost household interventions, namely replacing attic tanks with roof top ones and installing new water piping systems appeared to be promising with a Benefit to Cost ratio reaching 25.3, and a return on investment within as low as 2 years. Challenges faced in the implementation of pilot interventions emphasized the need to adopt a sustainable urban development framework with a clear action plan to improve the existing situation and alleviate the burden on an already impoverished urban area. The framework encompasses prioritized social and physical interventions at the municipality level, urban area level and at the building/household level. It identifies stakeholders at various levels and depicts linkages between them and their role in the implementation process.

Keywords: Water and sanitation, urban slum, comparative assessment, statistical modeling, social cost benefit analysis, sustainable management framework

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ABBREVIATIONS

AUB	American University of Beirut
AB	Averted Behavior
B/C	Benefit to Cost Ratio
CBA	Cost Benefit Analysis
CSR	Corporate Social Responsibility
DALY	Disability Adjusted Life Year
EERC	Environmental Engineering Research Center
FC	Fecal Coliform
HCA	Human Capital Approach
SCBA	Social Cost Benefit Analysis
TC	Total Coliform

TO MY LATE FATHER

CHAPTER 1

INTRODUCTION

1.1 Background

Inferior and sometimes absent urban infrastructure service provision present a major environmental and health concern in poor urban areas. Globally, premature mortality, particularly amongst infants and children, as well as waterborne diseases are well documented and acknowledged by various international organizations with nearly 750 million people lacking safe drinking water and 2.5 billion people lacking adequate sanitation facilities (WHO/UNICEF 2014), many of whom (30 to 40%) are considered dwellers of impoverished urban areas or slums in inner cities (Sclar *et al.* 2005; WASH 2005). These conditions are directly linked to the livelihoods and incomes of the urban poor and impact their health and ability to earn, thus exacerbating poverty (IRC 2005; 2007b). While the biological relationship between water-related and water-washed pathogens and diarrhea morbidity and mortality is well established, the association between various types of interventions and diarrheal outcome is less clear, and evidence on the efficacy and cost-effectiveness of environmental health interventions that could prevent diarrheal diseases is still weak (Kremer and Zwane 2007). Furthermore, the socio-economic component to water supply and sanitation is seldom considered when evaluating interventions for improvement (Cameron *et al.* 2011), which is delaying action by decision-makers in this respect and leaving the urban poor to misfortune in a vicious cycle of pollution, poverty and disease.

1.2 Research Objectives

The presented research aims at easing environmental burdens in slums through a better understanding of how poor environmental services exacerbate poverty as well as piloting interventions that improve such services. The ultimate objective is to examine the effectiveness of a holistic community-based participatory approach to water and sanitation improvement in defining the needs of disadvantaged communities and addressing them successfully by tailoring scientific and epidemiological knowledge to the local particularities of the community under study. More specifically, the objectives of the research include:

1. Defining priority needs in a poor urban slum and corresponding social, economic, and cultural determinants contributing to poverty, health and environmental problems, while involving the local community and municipality and relying on social field surveys, and a comparative analysis with a near similar community in the region. The focus will be on water and sanitation needs.

2. Identifying, evaluating, and implementing pilot interventions using a holistic and adaptive community-based participatory approach that considers the social, economic, and health impacts of interventions within local peculiarities of the slum.

3. Develop a sustainable environmental management framework in collaboration with the municipality and the local community and define arrangements needed to improve environmental management and services provision.

1.3 Scope of work and research methodology

The work described in this thesis comprises the following tasks:

- Review of the literature on water, sanitation and poverty in urban slums
- Identifying study areas
- Collaborative planning and stakeholder involvement
- Data collection through field surveys
- Data analysis using various qualitative and quantitative methods, including:
    - Comparative assessment between two slums (Tebbaneh and An-Nasr)
    - Statistical modeling for diarrhea prediction in the targeted slum
    - Assessment of the socio-economic burden of water pollution
    - Social Cost Benefit Analysis
- Implementing and monitoring pilot interventions with performance assessment
- Development of a sustainable urban management framework

Fig. 1.1 depicts the general methodology followed in implementing the scope of work outlined above. The details of the methodology are described in Chapter 3.

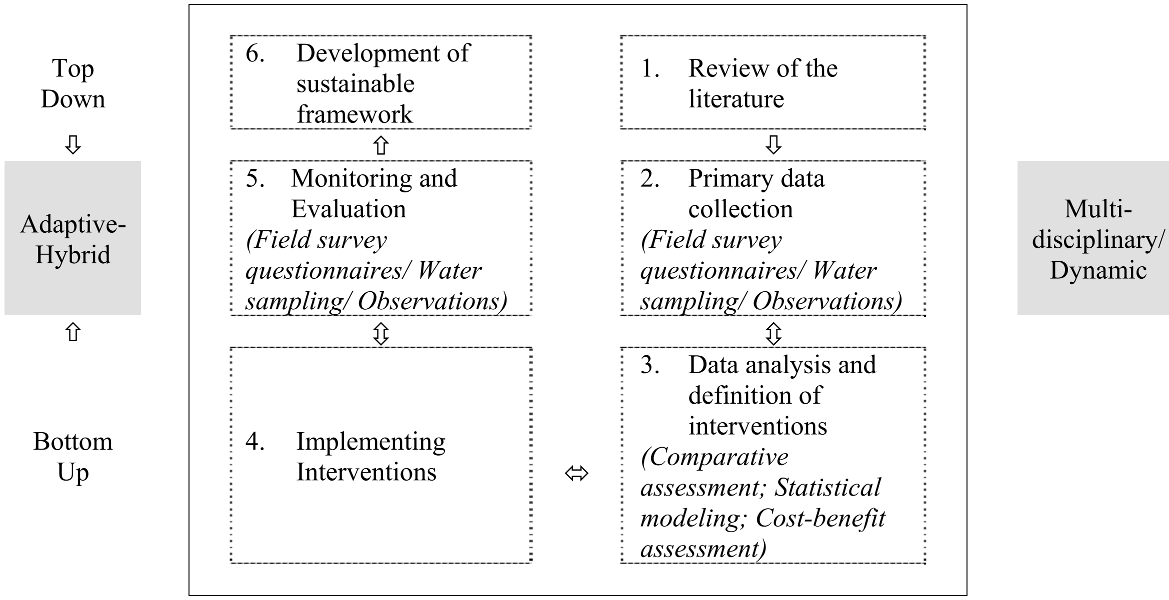


Fig. 1.1. Flow chart of the adopted methodology

1.4 Dissertation structure

The dissertation consists of six chapters designed for a clear presentation of the relevant theory, research findings, fieldwork, data analysis, and conclusions and recommendations. Besides this introductory Chapter (1), the literature review and application aspects dealing with water and sanitation in poor urban slums are presented in Chapter 2; whereas the holistic research performed using a participatory approach and comprising various quantitative and qualitative methodologies is presented in Chapters 3 and 4. Chapter 5 presents the proposed Sustainable Urban Development Framework as a closure and Chapter 6 presents a summary of outcomes and limitations, respectively.

1.5 Research Innovation

Fueled by the Millennium Development Goals, much has been reported in the field of water and sanitation towards providing clean water without achieving aspired targets to date (WHO/UNICEF 2014). Various approaches have been adopted and different interventions have been implemented, with varying degrees of success and cost-effectiveness (Kremer and Zwane 2007). The present research relies on a holistic community-based approach that probes into various social, economic, and environmental factors defining slums with emphasis on wedding science to the community and attempts to ensure sustainability, by highlighting the need for considering local conditions and obstacles that demonstrated the prevalence of alarming rates of water-related diarrhea despite 'improved water and sanitation infrastructure', as defined by international aid organizations. The research incorporates the socio-economic burden of disease in the assessment of the feasibility of interventions and formulates an evidence-based sustainable environmental management framework to allow informed decision-making and effective investment in solutions that can be locally managed and maintained.

CHAPTER 2

LITERATURE REVIEW

Rapid urbanization in a context of poor economic performance and governance has led to an increase in the number of people living in urban slums, particularly in developing countries (Fotso *et al.* 2007; UN-HABITAT 2003). Estimates suggest that around 1 billion people are currently living in slum communities which are usually defined as unplanned settlements with inadequate access to safe water, sanitation, quality housing, and other infrastructure as well as overcrowding and insecure residential status (Keraka and Wamicha 2003; UN-HABITAT 2003). In these types of settings and living conditions, slum dwellers become more susceptible to various health problems (APHRC 2002; Zulu *et al.* 2002) including mal-nutrition (Huq-hussain 1996; Hussein *et al.* 1999; Pryer *et al.* 2003), skin and respiratory infections (Bloomfield *et al.* 2007), and diarrhea (Rahman and Shahidullah 2001; Sclar *et al.* 2005) with the latter representing a key public health challenge due to the unsanitary nature of these settlements (Pahwa *et al.* 2010). Globally, diarrhea contributes annually to 1 billion illnesses and 1.5 million deaths of children aged less than 5 years (UNICEF/WHO 2009). Early childhood diarrhea (between 0 and 2 years of age) has been associated with diminished performance on physical fitness, and growth and cognitive functions (Berkman *et al.* 2002; Guerrant *et al.* 1999, 2002; Kosek *et al.* 2003; Moore *et al.* 2000, 2001; Niehaus *et al.* 2002).

#

A meta-regression analysis of studies from 145 low- and middle income countries by Pruss-Ustun *et al.* (2014) reported that, in terms of exposure to inadequate water, sanitation, and hygiene (WASH), 31% of households resort to boiling or filtering water, another 31% use piped water to premises, 27% use a non-piped or community water source, and only 12% use an improved water source with no filtration or boiling (similar to the Tebbaneh study area). On the sanitation side, 58% of households use an improved sanitation facility (Pruss-Ustun *et al.* 2014). This exposure was estimated to result in a total of 842,000 diarrhea deaths, or 1.5 percent of the total burden of disease. Furthermore, a recent systematic review of 319 studies in low- and middle-income countries by Bain *et al.* (2014) revealed that even improved sources of drinking water such as piped water into dwelling, yard, or plot, standpipe, borehole, protected dug well or spring, although better than unimproved sources, are not consistently safe, with over a quarter of samples from such sources exhibiting fecal contamination in 38% of the studies.

Understanding the determinants of diarrhea in a community and their interactions is fundamental for understanding morbidity and mortality and the development of strategies for the improvement in water-related health needs (UNICEF/WHO 2009). Hatt and Waters (2006) developed a conceptual framework illustrating the types and interactions of the various determinants of diarrhea morbidity in children (Fig. 2.1). The framework differentiates between the ‘distal’ factors (economic status, education, cultural norms, and government policies) that influence exposure to the ‘proximate factors’, such as environmental pollution and susceptibility (age, gender, genetic factors, nutrient intake, etc.), which have a direct impact on the risk of morbidity. It further articulates the interaction among these factors. The framework also identifies behavior as an intermediate factor that intervenes between certain distal and proximate processes.

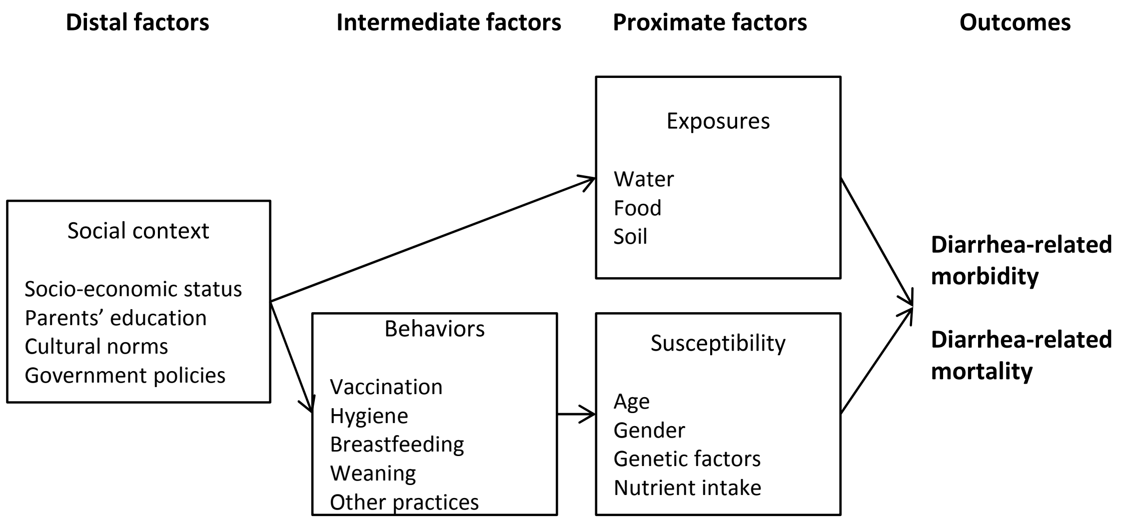


Fig. 2.1. Conceptual framework for determinants of diarrhea-related morbidity and mortality (Hatt and Waters 2006)

Studies based on Demographic Health Surveys (DHS) have shown that the interactions of behavioral, socioeconomic and environmental factors and their influence on child morbidity and mortality vary across countries and between communities of the same countries (Mihrete *et al.* 2014; Woldemicael 2001). Hence, when working in a particular community, it is important to explain the relationships and interactions of these factors within this community, guided by literature reported findings in other similar communities.

Even though the determinants of diarrhea are well known, the relationship between improvement interventions and diarrheal morbidity and mortality is less clear (Kremer and Zwane 2007), with evaluations of prevention efforts producing varying results (Wolf *et al.* 2014). In a meta-analysis by Fewtrell *et al.* (2005), improvement in water supply, water quality, and sanitation, reduced the risk of diarrhea-related morbidity by 25, 31, and 32 percent, respectively. Similarly, point-of-use water disinfection, safe water storage and behavior change techniques have consistently been reported to reduce the risk of diarrhea by 25-85 percent in areas with different environmental and living conditions (CDC 2000; Garrett *et al.* 2008; Luby *et al.* 2004; Lule *et al.* 2005; Quick *et al.* 1999, 2002; Semenza *et al.* 1998; WHO UNICEF JMP 2008). Equally important, hygienic behavior alone was found to decrease diarrheal morbidity significantly (Boyce and Pittet 2002; Cairncross *et al.* 2005; Halvorson 2004; Pande *et al.* 2008; UNICEF/WHO 2009). A recent study by Wolf *et al.* (2014) combined meta-regression analysis to derive overall and intervention-specific risk estimates of diarrhea. They reported an overall summary risk ratio of all observations of 0.66 and 0.72 from water and sanitation interventions, respectively. At the household level, a point of use filter combined with safe water storage was reportedly the most effective intervention while at the community level, the provision of high-quality piped water supplied continuously to the household is most effective. Chlorination at the point of use was found to have the lowest impact on diarrhea reduction, which was attributed to either the fact that chlorine disinfection is not effective on pathogens causing diarrhea in a particular setting, and/or the low rate of uptake or consistent application of such an intervention. With regards to sanitation, a greater effect was reported for sewer connections as compared to household sanitation improvements (Wolf *et al.* 2014). Finally, the impact of interventions for preventing water-related diarrhea is quite variable and often impacted by the local context, thus highlighting the importance of understanding the links between water supply, sanitation, health related behavior, and hygiene in the particular community under study, for the development of sustainable and successful strategies for improvement (Herbst *et al.* 2008).

Concurrently, the quantitative valuation of the burden of waterborne diarrheal diseases is gaining great attention (WHO 2002; Neumann *et al.* 2005; Bleisch 2006). This is particularly important in impoverished urban areas or slums of inner cities where the lack of access to safe water supply and adequate sanitation services is linked to livelihoods and incomes of the urban poor and is exacerbating poverty by affecting health and the ability to earn (IRC 2007b; Hutton *et al.* 2007). As a result of poor water quality, the urban poor in particular incur additional expenditure on medicines and medical treatment for waterborne diseases like diarrhoea, gastro-enteritis, or cholera, causing children to miss school and adults to miss work with loss of income.

Growing evidence suggests that improving access to safe water will reduce the risk of diarrhea-related morbidity by decreasing the number of incidental diarrhea cases (Hunter *et al.* 2010) and hence contribute to poverty alleviation. Yet, the soundness of investing in such improvements is often linked by decision makers to potential economic benefits. In this context, applying cost-benefit analyses (CBA) to water and sanitation interventions, that assign values to all costs and benefits (health gains, increased incomes, time saved) regardless of whether they have a clear market price, has been increasingly advocated (Cameron *et al.* 2011). According to Haller *et al.* (2007), increasing access to improved water supply and sanitation facilities, increasing access to in house piped water and sewerage connection, and providing household water treatment, in ten sub-regions of the world were all found to be cost-effective, especially in developing countries with high mortality rates. The estimated cost-effectiveness ratio (CER) varied between US$20 per disability adjusted life year (DALY) averted for disinfection at point of use to US$13,000 per DALY averted for improved water and sanitation facilities. Similarly, Whittington *et al.* (2012) compared the benefit to cost ratio of six interventions for improving water, sanitation and preventive health interventions in developing countries. They concluded that behavioral factors, such as uptake and usage of the interventions, influence significantly their economic feasibility, yielding negative B/C ratios under many circumstances.

On another front, the importance of incorporating local knowledge of health and environmental conditions and of household preferences and behavior into decisions on water and sanitation improvement options is acknowledged (Collman 2014; Whittington *et al.* 2012; Montgomery and Elimelech 2007). This highlights the need for a community-based collaborative approach to water and sanitation improvement that values the input of researchers, community members, and governmental representatives, thus ensuring the adoption of sustainable interventions that are tailored to local peculiarities (Gentry and Metz 2013).

CHAPTER 3

RESEARCH METHODOLOGY

The scope of work follows an adaptive or hybrid approach that reconciles top-down and bottom-up approaches, based on community-based participatory communication with the locals (municipality, NGOs, and the community). In addition, this approach benefits from a comparative analysis with another community in Jordan with nearly similar cultural and demographic characteristics and where water and sanitation issues have been improved in recent years. Accordingly, the research sought an in-depth understanding of the reasons behind poor environmental services and subsequent environmental degradation while working on devising appropriate pilot interventions. For this purpose, a multi-disciplinary research methodology combining quantitative and qualitative approaches was adopted to document existing conditions, analyse and interpret the social and cultural factors that determine or influence the situation, identify and assess current prevention and intervention strategies, develop and implement new pilot interventions and evaluate them, which finally culminated in the development of a strategy for the sustainable urban improvement of the slum area. Accordingly, a series of interrelated activities were implemented, as detailed below, starting with a description of the study areas.

3.1 Study areas

The main study area, the Tebbaneh area, consists of a disadvantaged urban community located at the outskirt of the city of Tripoli, Lebanon (Fig. 3.1). It is considered as one of the poorest urban areas in Tripoli. Besides being disadvantaged at various socio-economic levels, it suffers from the absence of proper hygienic sanitation, inadequate access to clean water and quality housing, and poor waste management practices, satisfying the characteristics of a slum area. An-Nasr area in the Northern region of the city of Irbid, Jordan, is equally an urban slum of similar social fabric, cultural background, and economic characteristics as Tebbaneh.

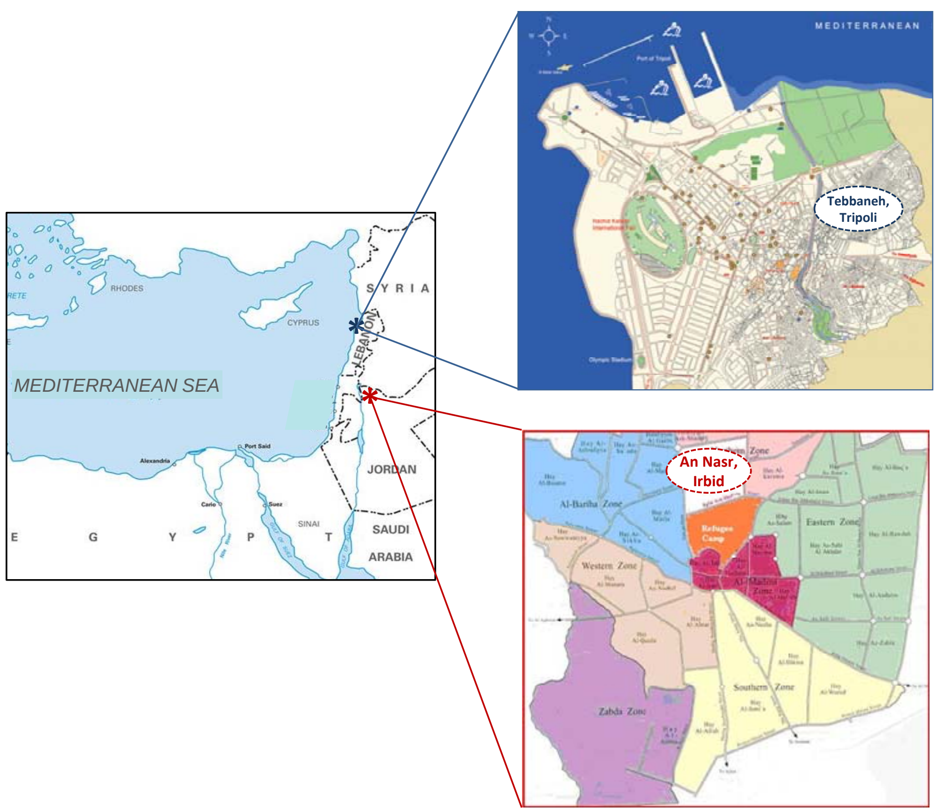


Fig. 3.1. Location of study areas

Both slums are overcrowded with population densities reaching 10 times that of any other urban area within their respective countries. They both have similar religious background with the predominant population composed of Sunni Muslims and a Christian minority. In addition, both regions are facing several urban challenges commonly associated with poverty and congestion in urban slums. Table 3.1 summarizes the main demographic characteristics of the two slums.

Table 3.1. Demographic characteristics of An-Nasr and Tebbaneh areas

Parameter	*An-Nasr, Irbid*	*Tebbaneh, Tripoli*
Project area	1.9 Km^2	0.4 Km^2
Population	8,875	27,804
Average family size	6.2 capita/family	6 capita/family
Average number of households	1432	4634
Population density	4,671/Km^2	69,510/Km^2
Local monthly income	< 200 USD/ capita	< 200 USD/ capita

3.2 Data Collection

3.2.1 Survey questionnaire in An-Nasr, Irbid, Jordan

In coordination with a team from the Jordan University of Science and Technology (JUST), meetings were first held with the Irbid Municipality as well as local stakeholders to appraise them about the research project and its objectives. A household survey was then conducted in An-Nasr area in September 2008. It consisted of face-to-face interviews using a structured questionnaire to collect primary data on the demographic and socio-economic status of the population, water and wastewater services, health indicators including incidence of diarrhea morbidity in the past three months, the age distribution of the cases, and the type of medical services they sought (Appendix 1). Data was also collected on the use of bottled water as an alternative water source, hygiene practices, solid waste disposal, and the prioritization of environmental and health problems. Survey teams were formed from qualified women specialists from the study area with relevant background. Around three hundred households were visited and surveyed at an average of 4 to 5 visits per day. Initial data processing was conducted by the JUST team, using Excel spreadsheets, to define basic statistics from the surveys, as well as some recommendations and guidelines on how to refine the questionnaire and improve its administration in the Tebbaneh area. Further data processing was conducted at AUB to allow for a comparative assessment with the Tebbaneh slum, as outlined below.

3.2.2 Field surveys in Tebbaneh, Tripoli, Lebanon

Since the early stages of the project, the research team established an active partnership with the community representatives in order to build a sustainable and long-term relationship. This allowed the team to better identify the problems in the community, involve the people in the planning process, and interpret the findings and generate appropriate solutions.

As a first step, an initiation meeting was held at the Municipal Cultural Center in Tripoli with the objective to introduce the research project and associated activities to local stakeholders and solicit the participation of interested active Non Governmental Organizations (NGOs) who were invited to attend the meeting in coordination with the municipality. In addition to the Head of the Tripoli Municipality, a representative from the Ministry of Social Affairs, and a representative from the Lebanese University, around 10 local NGOs attended the meeting. Appendix 2 provides a list of attendees with selected photos taken during the meeting.

A follow-up meeting was conducted at the Tripoli municipality with three local NGOs who expressed the strongest interest in participating in the project implementation including: Women's Work Organization (جمعية العمل النسوي), *With You* Charitable Organization (جمعية معكم الخيرية الاجتماعية), and Women's Group Charitable Organization (جمعية اللقاء النسائي الخيري). After reminding the participants of the project objectives, activities, and schedule, consultation with the NGOs and the Municipality of Tripoli resulted in the delineation of the survey area in the Tebbaneh region which was then divided into 5 zones, containing almost equal numbers of buildings, using GIS (Fig. 3.2. and Table 3.2). A group of field surveyors was formed from these NGOs as well as the municipality consisting of 5 female surveyors who work and/or live in the study area and are social workers with prior experience in questionnaire administration. The AUB Team worked directly with the group and monitored the questionnaire testing and administration process.

Fig. 3.2. Delineation of survey zones in the Tebbaneh area

Table 3.2. Summary description of zones

Zone	*Land Use*	*General Observed Conditions*
1	▪ Residential buildings ▪ Commercial areas (hosts the retail vegetable market, part of the wholesale vegetable market, small diversified shops)	▪ Very old buildings (inappropriate living conditions) ▪ Very small housing units ▪ Significant hygiene problems apparent within households ▪ High population density ▪ Pest and rodent infestation ▪ Wastewater accumulation in building basements ▪ Wastewater overflow on streets ▪ Solid waste littering on the streets and within buildings
2	▪ Residential buildings ▪ Commercial areas (small grocery shops) ▪ Zone divided by Syria street into 2 areas: Jabal Mohsen and Tebbaneh	▪ Relatively big housing units ▪ Most buildings are renovated ▪ Moderate population density
3	▪ Residential buildings ▪ Small grocery shops ▪ Zone divided by Syria street into 2 areas: Jabal Mohsen and Tebbaneh	▪ Relatively small housing units ▪ Poorly maintained buildings ▪ Low population density

Table 3.2. Summary description of zones *(cont'd)*

Zone	*Land Use*	*General Observed Conditions*
4	▪ Residential buildings ▪ Small industries (car repair shops, carpentry shops) ▪ Small restaurants and retail and grocery shops	▪ Large buildings, but mostly poorly maintained ▪ Dust and VOC emissions from industries
5	▪ Residential buildings ▪ Small industries (car repair shops, carpentry shops) ▪ Commercial areas (wholesale vegetable market, big stores and supermarkets)	▪ Neighborhood in relatively better conditions ▪ Large buildings (> 5 floors) with relatively big housing units

The next step was the implementation of the social survey in Tebbaneh in close coordination with interested NGOs, with the aim of assessing and validating the needs in Tebbaneh and completing the comparative assessment with An-Nasr in Irbid. The questionnaire was first revised, based on the recommendations from the Irbid Team. Training sessions for the survey team were then conducted and followed with pilot testing, whereby 30 questionnaires were administered by the surveyors and the AUB team. The pilot test results were processed and the questionnaire was revised a second time (Appendix 3). The full survey was then implemented in July-August 2009, over a period of 6 weeks, whereby around 325 questionnaires were administered. The sample size was estimated based on a 90% confidence interval, a 5% margin of error, and a probability of success, p of 0.5 for maximum variability, using the following equation (Daniel, 1995):

$$n = \frac{[(z)^2 \times p \times q]}{d^2}$$

Where n: Household sample size;
z: Confidence interval;
p: Probability of success;
q: Probability of failure; and
d: Margin of error

To facilitate the sampling process, each of the five local surveyors was assigned a zone, from which 60 to 70 households were randomly selected. The local surveyors were accompanied by members of the AUB team during their household visits. The number of sampled households was almost evenly distributed between the five zones that constitute the Tebbaneh study area, as illustrated in Fig. 3.3. The respondents were very cooperative, translating into a high response rate of about 86 percent. The collected data were entered into SPSS by the AUB Team, cleaned and analyzed.

Fig. 3.3. Distribution of sampled households in the Tebbaneh Study Area

Alongside the social survey, a survey of medical facilities frequented by Tebbaneh residents was also conducted. As a first step, the Lebanese Ministry of Health was contacted to explore the type of official data that might be present on waterborne diseases, particularly diarrhea and typhoid. However, due to significant under-reporting, it was decided to collect the data directly from the health facilities in the Tebbaneh study area. According to the data collected in the needs assessment survey, nearly 77 percent of surveyed households in Tebbaneh resorted to dispensaries for medical care. Furthermore, more than 90 percent of these households frequented five main dispensaries in the area, namely, Al Rahmah, Al Azm Wal Saadah, Al Daawah, Al Hariri, and Al Hamidi. As such, the survey of medical facilities targeted these five dispensaries, with three of them located within Tebbaneh (Al Rahmah dispensary having an additional branch for illnesses requiring therapy using intravenous fluids (IVF)) and the other two outside Tebbaneh (Fig. 3.4).

Fig. 3.4. Location of surveyed dispensaries within Tebbaneh

For this purpose, a questionnaire was developed and administered to responsible personnel at the five dispensaries (Appendix 4). The questionnaire inquired about the number of diarrhea and typhoid cases recorded in each dispensary during the period extending between September 2008 and September 2009. It also solicited information about common medications prescribed for diarrhea and typhoid cases, as well as the average cost of treatment. The sources of data used regarding the number of diarrhea and typhoid cases differed from one dispensary to the other. Data were obtained from physicians' daily log books, patients' medical files, or from the dispensary's admittance records. The AUB team along with the local surveyors assisted in collecting data on the number of diarrhea and typhoid cases in certain dispensaries. Note that data from some dispensaries contained some gaps. Finally, a face-to-face interview was conducted with local pharmacists and physicians to collect data on the types of medications used and the cost and duration of the treatment of water-related diarrheal cases in the study area.

The household survey identified a general community perception that the drinking water reaching the Tebbaneh area is of low quality. As such, a water sampling program (Fig. 3.5.) was initiated in Tebbaneh to assess the quality of drinking water in the study area and the validity of the recorded perception, and to understand the risk of exposure to waterborne illnesses within the study population.

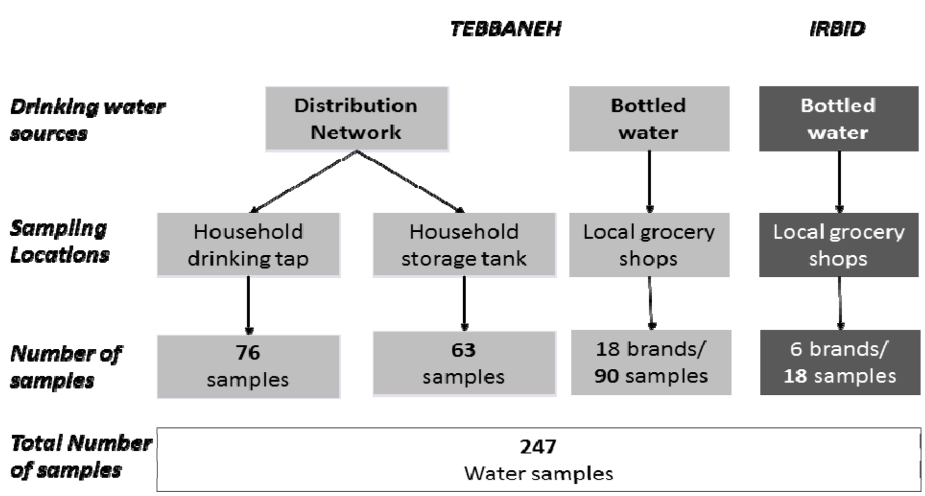


Fig. 3.5. Water sampling program in Tebbaneh and Irbid

The sampling program thus targeted the drinking water at the point of use, namely the supply network within households as well as the bottled water commonly used by residents. A total of 76 water samples were collected between December 2009 and January 2010 from the drinking water tap within households in Tebbaneh, where diarrhea cases had been reported during the social survey. The number of samples to be collected was determined based on the WHO (2008) recommendations for water sampling within a distribution network of peri-urban communities with a maximum of 30,000 served population. Another 63 water samples were collected from stored water taps at the same households within the study area, to assess stored water quality, shed light on the quality evolution after supply, and detect possible contamination at the level of water storage tanks. A balanced approach was followed to ensure a uniform distribution of the samples for all zones (Fig. 3.6).

Fig. 3.6. Distribution of buildings in Tebbaneh from which water samples were collected

The samples were analysed for selected physico-chemical (pH, color, turbidity, total dissolved solids, and nitrate) and microbiological parameters (fecal coliform and total coliform) (Table 3.3.) at the AUB Environmental Engineering Research Center Laboratory. Temperature and residual chlorine were measured on site. These physico-chemical parameters are most commonly tested as indicators for drinking water quality in terms of aesthetics (color, turbidity, and TDS), effectiveness of disinfection (residual chlorine) and pollution from agricultural sources (nitrates) (Merrington *et al.* 2002; OECD and WHO 2003; 2008). Coliforms are also universally used as microbiological indicators for drinking water quality and the presence of fecal contamination (Bordalo *et al.* 2007; WHO 2008).

Table 3.3. List of analyzed parameters and adopted analytical procedures

Parameter	*Type of analysis*	*Method reference*[1]
pH	Potentiometry	4500-H^+ B
Color	Colorimetry, Pt-Co	SM 2120C
TDS	Electrometry	SM 2510B
Turbidity	Nephelometry	SM 2130B
Nitrate	Colorimetry: Cd reduction	SM 4500 NO3-B
Residual chlorine	Colorimetry, DPD	SM 4500 Cl G
Fecal coliform	Membrane filtration technique	SM 9222B
Total coliform	Membrane filtration technique	SM 9222D

[1]APHA *et al.* 2012

Note that in August 2010, around 34 samples from the drinking water network and 40 samples from household tanks were collected from households that were not covered in the initial water sampling campaign and where diarrhea cases were reported during the social field survey. The samples were analyzed for Fecal and Total Coliform only. The purpose was to cover most households where diarrhea was reported, and thus increase the number of eligible buildings for pilot intervention.

For bottled water, five batches of 18 bottled water brands commonly sold in the area were collected and analysed for nitrates, fecal and total coliforms. The bottled water brands included in the sampling were selected based on the reported preference of the population under consideration as well as the consistent availability of these brands within the local market during the sampling period.

For the comparative assessment, the sampling program was expanded to Jordan whereby bottled water samples from six brands commonly sold in Jordan were collected and analysed for the same parameters. Samples from surveyed households in Jordan were not obtained since regulatory enforcement is strong and monitoring of compliance with national water quality standards is restricted to the Jordanian Water Authority (JWA). Hence, water quality analysis results reported by the JWA were relied upon to define the water quality in the public network and household storage systems in An-Nasr.

Note that survey questionnaires were approved by the Institutional Review Board (IRB) at the American University of Beirut. Informed consent was verbally obtained from respondents before conducting interviews or collecting water samples.

3.3 Data analysis

3.3.1 Comparative assessment between the Tebbaneh and An-Nasr slums

The collected household survey data was entered into the Statistical Package for Social Sciences (SPSS 16.0) software, cleaned, and analysed. For both study areas data sets, descriptive statistics including measures of central tendency (mean) and measures of dispersion (standard deviation) were computed for continuous data, and frequency distributions were computed for categorical data. This allowed for a primary exploration and understanding of the basic characteristics of each study area, as well as the identification of variables that differed significantly between the two study areas including (a) socio-economic characteristics such as age, educational level, household ownership, and working members, (b) water usage such as water storage tanks, measures for drinking water treatment, bottled water consumption, wastewater problems, and (c) environmental management conditions and hygiene behaviour, such as wastewater and solid waste disposal, and hand-washing hygiene practices. This was followed by inferential statistical analysis, namely Analysis of Variance (ANOVA) and Pearson's Chi-Square tests to assess the significance of those differences between both study areas, and to evaluate their possible correlation with the occurrence of diarrhea episodes in Tebbaneh. The Pearson's Chi Square test was also used to test statistical correlations between the results of the water quality analysis in Tebbaneh and potential water pollution inducing factors such as the type of storage tanks and the presence of wastewater problems. In addition, two inferential statistical tests were conducted to compare the microbiological quality of bottled water in Tebbaneh to that of network drinking water. The first consisted of the Independent T-test, which compared the mean FC count and the mean TC count in the analyzed bottled water samples to the mean FC count and the mean TC count in the analyzed network water samples, respectively. The second test consisted of the Pearson's Chi Square Test, which compared the percentage of bottled water samples with FC and TC counts to the percentage of network drinking water samples with FC and TC counts, respectively. Finally, the Kendall tau-b statistic was employed to measure the sign and the strength of the association between the variables, whenever it was found to be statistically significant.

3.3.2 Statistical modeling of diarrhea occurrence in the Tebbaneh slum

Data from the household survey were used to develop a predictive model to predict the probability of contracting diarrhea in the households of the main target study area, the Tebbaneh slum.

Generalized linear models were developed to assess the association between diarrhea incidence and various known determinants. Independent variables related to the social context of the household (demographics, socio-economic status, parental education), behaviours (hygiene, buying bottled water) and exposure (water and sanitation infrastructure) were considered as potential predictors of contracting diarrhea (Table 3.4). Diarrhea incidence was explored using four modifications of the outcome variable (Table 3.5). Note that while there was an attempt to focus on diarrhea among children less than five years of age, as is common in the literature (Mihrete *et al.* 2014; Woldemicael 2001; Kale *et al.* 2004), the sample size was not large enough to detect strong associations and develop a representative model. The Poisson model did not prove to be promising, given that most households experienced a limited number of cases (max of 3). As such, only the logistic regression models were pursued.

Table 3.4. List of analyzed independent variables

	Independent Variable
Socio-demographic	Number of rooms in household
	Number of household members
	Average age of male household head
	Average age of female household head
	Zone in study area
	Level of education of male household head
	Level of education of female household head
Socio-economic	Household ownership
	Ability of a household to secure 100 USD within one week
	Ownership of household appliances
WASH/ Water	Use of Network Water for drinking
	Use of Network Water for washing fruits and vegetables
	Use of Network Water for cooking
	Use of Bottled Water for drinking

Table 3.4. List of analyzed independent variables *(cont'd)*

	Independent Variable
WASH/ Water (cont'd)	Use of Bottled Water for washing fruits and vegetables
	Use of Bottled Water for cooking
	Volume of network water consumed per household in Liters/capita/week
	Volume of bottled water consumed in Liters/capita/week
	Type of water storage tanks
	Water tank cleaning
	Use of water from tank for drinking
	Applying measures to improve water quality
WASH/ Sanitation	Existence of problems in wastewater network and fixtures
	Number of problems in wastewater network and fixtures
	Wastewater accumulation in the basement
WASH/ Hygiene	Score out of 10 for hand-washing
	Location of hand washing station
	Presence of sink close to toilet facility

Table 3.5. List of modeled outputs

Output variable	*Total sample size*	*Sample size with diarrhea*	*Model type*
1. Incidence of at least one diarrhea case among members of a household, in a three-month period	325	125	Logistic regression
2. Number of cases of diarrhea among all members in a household, in a three-month period	325	125	Poisson regression
3. Incidence of at least one diarrhea case among children less than 5 years of age within households with children aged 10 years or younger, in a three-month period	213	50	Logistic regression
4. Incidence of at least one diarrhea case among children less than 10 years of age within households with children aged 10 years or younger, in a three-month period	213	71	Logistic regression

The logistic generalized linear model is of the form:

$$\text{logit } P(X) = \ln (P_i/(1-P_i)) = \beta_0 + \beta_1 X_{1i} + \dots \beta_m X_{mi}$$

Where P_i is the probability of a household member being ill with diarrhea during the reference period of 3 months; β_0 is the baseline constant, X_{1i} to X_{mi} are m independent variables, and β_1 to β_m are model coefficients. All model parameters were estimated using the maximum likelihood procedure, using the glm function in R.

A preliminary set of predictors were first defined through single variable logistic regression analysis. All variables that were found significant at the 90 % CI were considered for the multiple regression models. The multiple logistic regression models were developed through a forward step wise selection process based on AIC scores. The final model was used to better understand the correlation between diarrhea risks in a household within the Tebbaneh slum and the measured predictors.

Note that the above analysis was conducted at two levels. The household was first considered as the statistical unit to model; while the second explored looking at the individual as the statistical unit. It was decided to build the statistical model around the household rather than the individual for three main reasons: (1) most determinants of diarrhea pertain to the household as a whole, (2) both methods yielded similar results in terms of which of these factors were found to be statistically significantly associated with diarrhea prevalence, (3) improvement interventions will be identified and implemented at the household level. Individual-level results were only used to explain individual susceptibility to diarrhea, in terms of age and gender.

3.3.3 Assessment of the socio-economic burden of water pollution

The data from the field surveys provided the basis to quantify the economic burden associated with diarrhea morbidity and mortality due to contaminated water using several methods (Table 3.6.) including the Human Capital Approach for mortality valuation, the Cost of Illness (WHO 2009) and the Disability Adjusted Life Years for morbidity valuation (Murray and Lopez 1996), as well as the Aversive Behaviour approach.

Table 3.6. Adopted morbidity and mortality valuation methods

Valuation Technique	*Description*	*Assumptions*	*Equations*	*Limitations*
		MORBIDITY VALUATION		
Cost of Illness (COI) Approach	Assesses the costs incurred by the population in the pilot area suffering from diarrhea, in terms of medical expenditures (Direct COI) and days lost from work (Indirect COI): – Direct COI is calculated based on the type of medical service (hospital, dispensary, private physician, pharmacy, none) sought as determined from the household field survey. It accounts for medical consultation and hospitalization fees and cost of medications, as obtained from the surveys of pharmacies, dispensaries, and hospitals in the area – Indirect COI: corresponds to lost productivity, or the opportunity cost of days missed from work due to sickness	– 88 % of reported diarrheal cases are attributed to unsafe water supply, inadequate sanitation and hygiene (Wilkinson 2009) – Cases are distributed uniformly throughout the year, with no seasonal variations – Age distribution of cases follows that reported in the household survey – Each clinically reported diarrhea case aged 18-65 misses 4 days from work, for both treatment and recovery – Diarrhea cases, who are members of the labor force, work 26 days per month with an average wage of 150 $/month (CDR 2006) – Lost productivity of caregivers is not accounted for since around 84 % of them are housewives	$COI_T = COI_D + COI_I$ $COI_D = \Sigma(n_i \times c_i)$ $COI_I = N \times D_L \times D_I \times E_R$ COI_D : Direct COI COI_I : Indirect COI n_i : number of cases seeking a particular type of medical service c_i : cost of medical expenditure per type of medical service per case ($/ case) N : number of sick productive people D_L : days lost (4 d/case) (El Fadel *et al.* 2003) D_I : daily income ($5.8/day) (CDR 2006) E_R : Employment rate (0.88) (CDR 2006)	– Does not account for unreported cases – Does not account for the cost of pain and suffering – Does not account for improved quality of life

Table 3.6. Adopted morbidity and mortality valuation methods *(cont'd)*

Valuation Technique	Description	Assumptions	Equations	Limitations
Disability Adjusted Life Years (DALYs) Approach	Quantifies the number of years lost of 'healthy life' due to water-related diarrhea. It accounts for the cost of pain and suffering from illness but in terms of local income.	– Based on an average duration of 4 days per diarrhea case, a severity weight of 0.11 (Murray and Lopez, 1996), and an average monthly income of 150 $/ capita (CDR 2006). – Limited to years of life lost due to disability (YLD). Years of life lost due to premature mortality (YLL) are incorporated in the Human Capital Approach calculations below.	YLL = I x DW x L x GDP I : Number of incident cases avoided DW : Disability weight for diarrheal diseases L : Average duration of disability (years) GDP: Gross Domestic Product based on local income (1800 $/ Capita/ year) (CDR 2006)	– Does not account for improved quality of life – Uses age weighting
MORTALITY VALUATION				
Human Capital Approach (HCA) using DALYs	Focuses on capturing tangible impacts such as direct loss of productivity and related income as a result of premature mortality, through the quantification of one statistical year lost in terms of GDP per capita using DALYs.	– 6 to 17 child deaths per 100,000 every year from diarrhea diseases associated with inadequate potable water, sanitation and hygiene (CBS/UNICEF 2001; Ministry of Public Health 2001; Sarraf *et al.* 2004) – The death of a child under five represents the loss of 33 DALYs (Murray and Lopez 1996; WHO 2004) – The willingness to pay (WTP) as well as the Value of a Statistical Life (VSL) approaches were not adopted because no WTP and VSL data are available for the country and since these approaches are expected to result in a significant overestimation of the damage cost of water pollution when used for a significantly poor area	HCA_C = I x YLL x GDP HCA_C : Human Capital Approach Cost ($) I : Number of incident cases avoided (1-5 cases) YLL : Years of life lost due to death of a child under 5 yrs (33 DALYs) GDP : Gross Domestic Product based on local income (1800 $/Capita/year) (CDR 2006)	– Usually provides a lower bound estimate, as it does not account for pain and discomfort accompanying a death and ignores non-market activities.

Table 3.6. Adopted morbidity and mortality valuation methods *(cont'd)*

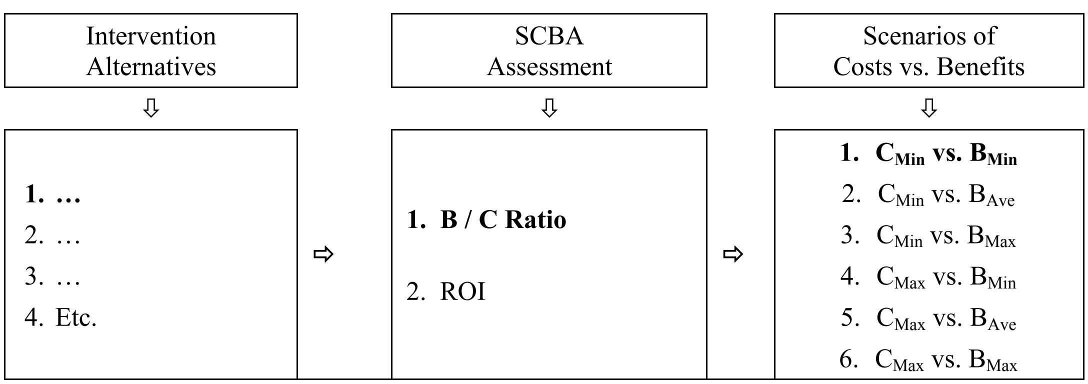
Valuation Technique	Description	Assumptions	Equations	Limitations
AVERTED BEHAVIOR				
Averted Behavior (AB) Approach	Considers additional economic losses associated with behavioral changes adopted or actions taken in response to water quality degradation (Asafu-Adjaye 2005; Bolt *et al.* 2005).	– The purchase of bottled water as a 'clean' alternative water source is the main aversive behavior noted in the field survey. Other sets of behaviors were rare. – Data on expenditures on vended bottled water were obtained from the social field survey.	$AB_C = P \times V \times C$ AB_C : Averted Behavior Cost ($/day) P : Population (capita) V : Average daily consumption of bottled water (L/capita/day) C : Average cost of bottled water ($/L)	– Assumes that bottled water consumption is related to water quality and health issues

3.3.4 Pilot intervention definition

Pilot interventions were defined based on the outcome of the field surveys in the An-Nasr and Tebbaneh areas and the results of the comparative and statistical analyses, as well as consultations with local stakeholders, with the aim of reducing the risk of waterborne diseases. Given the presence of water and wastewater networks in the slum, considered structural interventions focused on water quality to protect or treat the water and/ or ensure its safe storage at source or at the point of use including filtration, chlorination, flocculation, solar disinfection, boiling and pasteurizing. Hygiene interventions included hygiene and health education and the encouragement of hand washing. Selection criteria included minimization of risks of water contamination, cost effectiveness, technical feasibility, ability to achieve health and developmental benefits, as well as constraints associated with property rights and accessibility. The definition of the structural pilot interventions was an extensive, iterative process, whereby various modifications to the original idea were required due to community and physical constraints, as detailed below.

3.3.5 Social Cost Benefit Analysis

The various interventions defined above for improving water and sanitation in the Tebbaneh slum were then evaluated using a social cost-benefit analysis (SCBA). The capital and operation expenditures (CAPEX) associated with these interventions were estimated based on field enquiries with annual operation and maintenance (O&M) costs estimated at 10 percent of the capital costs, and an annual discount factor of 8 percent. Potential benefits of implementing the interventions were considered to be mostly in terms of improved health (Hutton *et al.* 2007; Haller *et al.* 2007) resulting in savings associated with averted morbidity and premature mortality, as outlined above. An improvement in water quality and sanitation can reportedly lead to 17 to 30 percent reduction in water-related diarrhea mortality (Esrey *et al.* 1991; Cairncross *et al.* 2010) and 6 to 39 percent reduction in water-related diarrhea morbidity (Esrey *et al.* 1991; Fewtrell *et al.* 2005; Clasen *et al*. 2007). The range of benefits for each type of intervention was assumed to be the same because it is not possible to assign 'dose-response' relationships between the two, given that there is limited understanding of the effectiveness of water and sanitation interventions, hygiene, and health education and their impact on individual behavioral change (Kraemer and Zwane 2007; Wolf *et al.* 2014). The SCBA examined the impacts of the selected interventions according to 6 scenarios that combine ranges of minimum to maximum CAPEX costs per intervention with those of minimum to maximum benefits. The selected scenarios (Fig. 3.7) were analyzed using benefits/costs (B/C) ratio and the Return on Investment (ROI) analysis.



B = Benefits; C = Costs; NPV = Net Present Value; ROI = Return on Investment
Min = Minimum; Ave = Average; Max = Maximum

Fig. 3.7. Combinations of scenarios and assessment methods for various intervention alternatives

The B/C ratio represents cumulative benefits over a 10-year period after implementing an intervention divided by cumulative cost of implementation. Ratios greater than one are good indicators of economic viability / attractiveness. The ROI defines the number of years after which an alternative can achieve positive cumulative benefits, while allowing for a yearly discount factor of 8 percent based on local interest rate conditions. Note that incremental analysis was not used to compare between intervention alternatives, since the benefits were considered to be uniform across the alternatives.

3.3.6 Pilot intervention implementation and monitoring

In summary, the SCBA allowed for the identification of the most economically beneficial interventions, while the statistical analysis and modeling allowed for the definition of households that are in greatest need of these interventions. These outcomes were shared with the local partners (municipality, NGOs, residents) to help select the households that are most suited for implementing the pilot interventions, given local constraints such as house/ building ownership, resident acceptance, etc.

The pilot intervention focused on the replacement of old tanks in the attic with new tanks to be placed on roof-tops (with associated pumps, piping system, and disconnection of storage tanks located in attics) to eliminate potential pollution from leaking sewage pipes within the buildings. The process led to interventions in 29 households distributed over 19 buildings where diarrhea cases were reported during the social surveys in 2009 and had exhibited bacteriological pollution in water samples collected from their storage tanks.

This was followed by a performance assessment of implemented interventions based on (1) a water quality monitoring program to compare water quality at the households before and after implementation, and (2) a post-intervention survey to capture possible improvements in diarrhea incidence and public perception of water quality.

3.3.6.1 Water Quality Monitoring

One month following the implementation of the pilot intervention, the water quality monitoring program was resumed to assess the level of improvement in water quality. Accordingly, water samples were collected on a bi-monthly basis over a period of 9 months, from March until December 2011, to cover both wet and dry seasons, and thus account for the seasonal variation in water quality. Overall, 14 sampling rounds were performed, whereby water samples were collected from three sources per household where the intervention took place, namely from the tap connected directly to the public network, the tap connected to a newly installed storage tank, and directly from the storage tank. Note that this sampling plan was often interrupted by security-related incidents and was faced with unexpected logistical problems such as power cuts that prevented water pumps from functioning, thus resulting in gaps in the results.

The collected samples were analyzed for selected indicators in the field (free residual chlorine) and at the AUB Environmental Engineering Research Center Laboratory (microbiological parameters: fecal and total coliform). Chlorine was selected to indicate the effectiveness of disinfection from source to consumer (WHO 2006). Total Coliform levels were expected to mirror water treatment effectiveness, cleanliness and integrity of the distribution system and the potential presence of biofilms. These bacteria are sensitive to disinfection, and thus their presence indicates inappropriate disinfection, existence of biofilms and/or soil and growing plants in the water (WHO 2006). As for Fecal Coliform (FC), they are indicators of the presence of Escherichia Coli, the parameter of choice used in drinking water quality surveillance (WHO 2006), which are present in wastewater from human origin and thus indicate cross-contamination with domestic wastewater via leakages in the wastewater plumbing system or network and infiltration into the water pipes or network. The results were assessed continuously to provide feedback into the performance of interventions. Complementary improvements to original interventions were implemented where needed.

The free residual chlorine levels were not used as a primary indicator of the intervention's performance. Instead, they were only assigned to imply water quality at the sampling time in order to shed light on potentially needed onsite investigations to explain the source for bacterial contamination if it existed. The chlorine level was reported as percent of sampling episodes where residual chlorine was within the acceptable range set by international standards, in each of the sampling points. Note that in some cases, both free residual chlorine levels and coliform levels were high in the same sample. This can be attributed to either coliform bacteria that were protected from inactivation through aggregation with other particles or that water became contaminated through local intrusion or sloughing or scouring of biofilms (Kumpel and Nelson 2013).

As for the bacterial water quality monitoring results, they were used to assess the success of the interventions in terms of:

1. Percent improvement in water quality at the households, in comparison with pre-intervention water quality

2. Percent of times microbiological water quality in the households where the interventions took place complied with drinking water quality standards (WHO 2006; USEPA 2012).

For each household, the evolution of microbial pollution from the drinking water network to the storage tank and then the tap connected to the tank were analyzed. Peculiar results were followed up with residents to detect existing problems in the household plumbing, and with the Water Establishment to identify any incidental defects in the public water supply system. Note that attempts for statistical analysis of mean levels of water quality indicators (TC and FC) before and after the intervention failed to reveal reliable results because 1) there were 14 post-intervention sampling episodes compared to only 1 pre-intervention sampling episode, and 2) TC and FC concentrations exceeding 500 CFUs/ 100 mL were reported as “Too Numerous to Count” which prevented the accurate computation of the actual means (though this may be resolved to a certain extent using the right censorship approaches).

3.3.6.2 Post Intervention Household Survey

Towards the end of the post-intervention water monitoring program, a structured questionnaire was developed to target the 29 households where interventions took place. The questionnaire was extracted from the main household survey and enquired about the general health status of residents, incidence of waterborne diarrhea in the past three months, types of water sources used, residents’ perceptions regarding the quality of the water supplied from these sources, and perceived improvement in water quality after intervention implementation (Appendix 5). The data was collected through face-to-face interviews and was entered into SPSS and cleaned and analyzed with the objective of (1) comparing between pre- and post- intervention survey results for relevant parameters using Pearsons' Chi Square Test, and (2) investigating the residents' perception of water quality at the household, following intervention implementation, using descriptive statistics.

3.3.7 Development of a sustainable urban management framework

All activities of the research project, namely public consultations and community surveys, socio-economic burden and SCBA, coupled with the comparative and statistical analyses and the pilot interventions monitoring and evaluation, culminated in the development of a framework that brings community contribution to urban planning, service provision and local policy making. This framework is intended as a standalone record that will serve the municipality and/or community organizations as a guide for current and future urban environmental planning specifically in the Tebbaneh region with potential extension to other similar urban areas. Accordingly, the Sustainable Urban Development Framework was developed to constitute an overview of the Tebbaneh slum highlighting the main environmental problems and needs of the area, followed by action plans that the municipality or other organizations can implement or seek funding from the central government or donor agencies, to improve the existing situation and alleviate the burden in such a poor urban slum.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Comparative Assessment of the Determinants of Diarrhea Prevalence in the Tebbaneh and An-Nasr Slums

This section presents the results of the systematic community-based comparative assessment that was adopted to define determinants of diarrhea prevalence in the Tebbaneh and An-Nasr urban slums. It discusses the analysis of the incidence of water-related diarrhea in the two slums with nearly similar cultural and demographic characteristics and where water and sanitation management have been improved in one area with the aim to assist in defining interventions to reduce the incidence of diarrhea in the other slum.

4.1.1 Socio-Demographics and Economic Indicators

The descriptive statistical analysis of the main socio-demographic indicators revealed strong similarities between the Tebbaneh and An-Nasr areas in many indicators, including the mean number of rooms per household (3 rooms), the mean number of household members (6 members per household) and families (84.2 percent in Tebbaneh and 93.0 percent in An-Nasr with one family) within the household, and the mean age of male (45 and 44.3 years in Tebbaneh and An-Nasr respectively) and female (41.5 and 38.8 in Tebbaneh and An-Nasr respectively) household heads (Table 4.1).

Table 4.1. Socio-demographic indicators as per survey results

Indicator	Tebbaneh Lebanon		An-Nasr Jordan	
Average age of household heads (years)	Male	Female	Male	Female
Mean	45.0	41.5	44.3	38.8
Standard Deviation	13.02	12.57	11.03	9.25
Number of household members				
Mean	5.7		6.1	
Median	6.0		6.0	
Standard Deviation	2.52		2.45	
Number of rooms in household				
Mean	3.2		3.4	
Median	3.0		3.0	
Standard Deviation	1.22		1.02	
Number of families living within each household:				
One family	84.2%		93.0%	
Two related families	14.2%		6.0%	
One husband with different families	0.3%		0.7%	
More than two families	1.2%		0.3%	

However, at $\alpha = 0.05$, using Pearson's Chi-Square Test, a striking statistical difference was noted in the level of education of both male and female household heads ($p < 0.001$), whereby around 42 percent of An-Nasr male household heads had a university education compared to only 1.2 percent of those at Tebbaneh. For females, more than 75 percent of housewives at An-Nasr had a secondary degree or higher as compared to only 4 percent of housewives in Tebbaneh (Fig. 4.1).

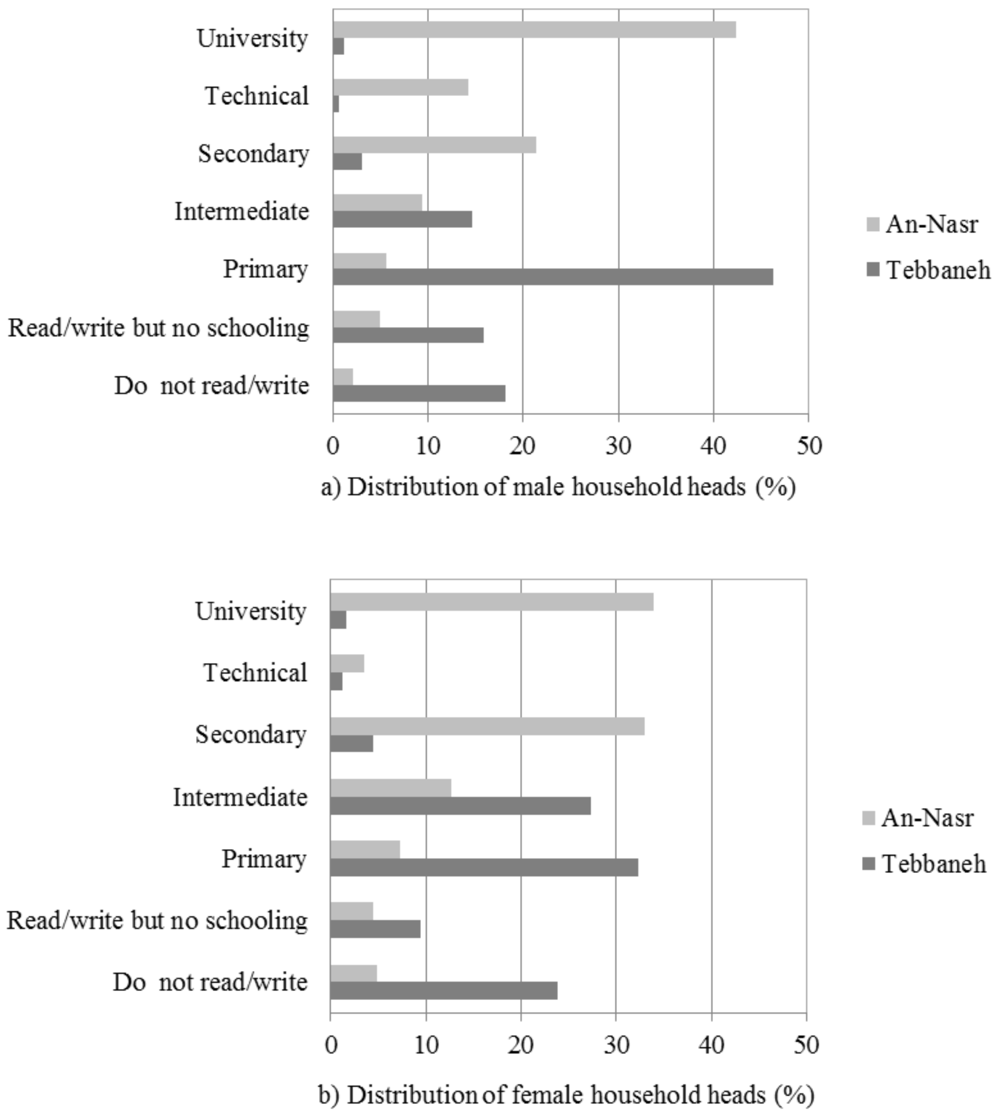


Fig. 4.1. Level of education of male (a) and female (b) household heads

In comparing economic indicators, the descriptive statistics presented in Table 4.2 showed that the majority of household heads in both areas are self-employed or employees with no secondary jobs, and that more than 65 percent of respondents in both areas depend upon the household head's main job as their source of income. However, at $\alpha = 0.05$, statistically significant differences between Tebbaneh and An-Nasr ($p < 0.001$) were observed in the number of household members working and generating income, in their ability to secure 100 USD within one week, and in household ownership, whereby these economic indicators appeared better at An-Nasr. For instance, ~48 percent of surveyed households at Tebbaneh are owned compared to a 66.3 percent ownership at An-Nasr. Furthermore, although respondents in both areas depend mainly on their savings and on family or friends to secure an amount of 100 USD within one week, at $\alpha = 0.05$ a statistically significant difference was observed ($p < 0.001$) in the percentage of respondents capable of securing the amount (~35 percent of respondents in Tebbaneh compared to 82 percent in An-Nasr).

Table 4.2. Economic indicators as per survey results

Indicator	Tebbaneh Lebanon (%)	An-Nasr Jordan (%)
Job position of male household head		
Self-employed	53.9	29.3
Employee	29.3	64.2
Business owner	16.2	3.3
Other	0.7	3.3
Availability of a secondary job		
No secondary job	96.9	88.7
Number of household working members other than male household head		
None	63.2	39.0
1	25.7	27.7
2	8.4	25.0
3 to 5	2.7	8.3
Ability of a household to secure 100USD within one week	34.6	82.0
Ways by which by a household is able to secure 100 USD		
Savings	43.9	52.7
Organizations	4.7	1.0
Friends and family	49.5	42.0
Selling some belongings	1.9	1.5
Savings + family and friends	-	2.4
Family and friends + selling some belongings	-	0.5

Table 4.2. Economic indicators as per survey results *(cont'd)*

Indicator	Tebbaneh Lebanon (%)	An-Nasr Jordan (%)
Household perception of level of income as compared to other households in their respective areas		
Much better	0.3	5.7
Better	20.3	16.8
Same	46.6	62.5
Worse	21.9	13.2
Much worse	10.9	1.8
Household ownership	47.8	66.3

Other economic indicators were also manifested in the higher percentage of available appliances at An-Nasr households (Figure 3). For instance, more than 99 percent of surveyed families at An-Nasr owned mobile lines and more than 50 percent had personal computers, whereas at Tebbaneh only 56.9 percent owned mobile lines and 16.9 percent had personal computers. Though both study areas are characterized as very low income communities, 80 percent of An-Nasr respondents perceived they were at the same economic level or better than the others in their area. In contrast, ~80 percent of Tebbaneh respondents believed they are at the same economic level or worse.

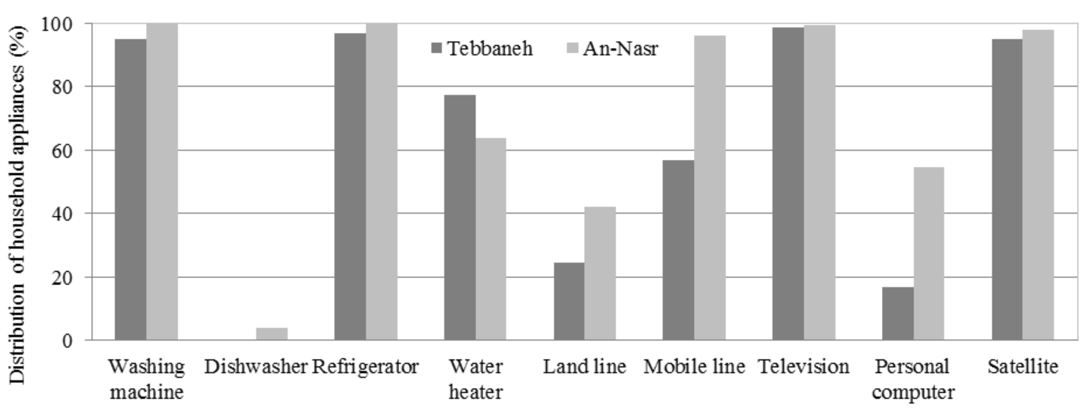


Fig. 4.2. Survey results on availability of household appliances

4.1.2 Incidence of Diarrhea

The survey results revealed a statistically significant difference at $\alpha = 0.05$ regarding the incidence of diarrhea in the two urban slums whereby, during the last three months prior to administering the questionnaire, 14.8 percent of households in An-Nasr reported the occurrence of one or more cases of diarrhea, as compared to 38.5 percent of households in Tebbaneh ($p < 0.001$), using Pearson's Chi-Square Test. The analysis of the age distribution of those reported cases indicated that An-Nasr had 56 incidents of diarrhea per 1,000 children (< 1 year of age) and 34 incidents of diarrhea per 1,000 children (1-10 years of age). In comparison, the prevalence of diarrhea among children in the Tebbaneh region in the last three months were reported at 3 to 5 folds higher with 281 incidents per 1,000 children (< 1 year of age) and 113 incidents per 1,000 children (1-10 years of age). Note that the results of the survey of dispensaries in Tebbaneh yielded a lower incidence of diarrhea in Tebbaneh estimated at 61 per 1000 population, which can be attributed to the fact that only severe cases of diarrhea resort to a dispensary for treatment. Many are self-treated at home, using medication prescribed by local pharmacists.

Systematic reviews of epidemiological evidence suggest that drinking-water quality plays a key role in fecal-oral transmission, though the degree of the effect has been challenged (Fewtrell and Colford 2005; Clasen *et al.* 2006; Cairncross *et al.* 2010). In fact, it is difficult to isolate the effects of one component of the multiple and interrelated fecal-oral pathways, which are highly context-specific (Bain *et al.* 2014). According to Wilkinson (2009), 88% of diarrheal cases can be attributed to unsafe water supply, inadequate sanitation and hygiene. Assuming that incidences are distributed uniformly throughout the year, with minimal seasonal variations, the annual incidence of diarrhea in the Tebbaneh study area was estimated at ~33 percent amounting to a total of ~9,200 cases. This incidence rate is significant, being more than six fold the national annual incidence of diarrhea of 6 percent (IPSOS 2004), and is comparable with heavily populated poor urban areas in China and India, where waterborne diarrheal incidence rates were estimated at ~35 and 57 percent, respectively (Jadhav *et al.* 2011; World Bank and SEPA 2007). Since the wastewater infrastructure has been recently rehabilitated in the Tebbaneh area similar to An-Nasr area, as outlined below, this difference in diarrheal incidence can be attributed more to water sources, water supply systems, or hygienic practices at the household level rather than direct wastewater management at the community level.

4.1.3 Water Supply and Sanitation

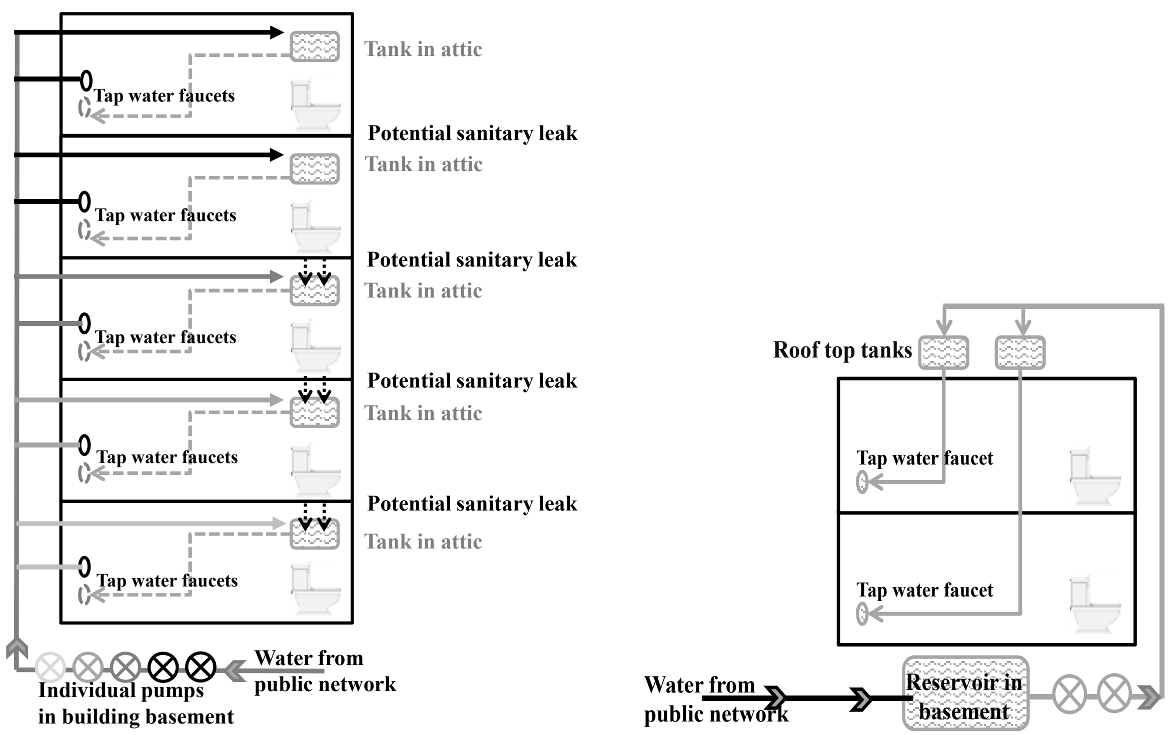
In Tebbaneh, the water distribution network is a branched system consisting of two interconnected old networks. Treated drinking water is mostly supplied via gravity distribution to the served population. More than 99 percent of surveyed households in both areas are connected to the public water network (Table 4.3), with an average reported water consumption rate of 96 L/capita/day in summer and 151 L/capita/day in winter. The higher consumption rate in winter as compared to summer can be attributed to water shortage during the dry season. Although the water supply is almost continuous in the Tebbaneh study area, people store water in tanks (96 percent of respondents) whereby each household has an individual water pump located at the building entrance to pump water directly from the network to household storage tanks (Fig. 4.3).

Table 4.3. Water supply and sanitation as per survey results

Indicator	Tebbaneh Lebanon (%)	An-Nasr Jordan (%)
Connection to the public water supply	99.1	99.7
Wastewater disposal		
Connection to the wastewater network	99.4	93.8
Septic tank	0.6	5.5
Open canal	-	0.7
Use of water tanks	96.0	99.3
Type of water storage tanks		
Attic	45.0	-
Roof	54.7	62.3
Ground	-	37.4
Water tank cleaning frequency		
None	39.9	17.2
Once every two or more years	5.2	26.1
Yearly	31.2	50.2
More than once per year	23.1	5.4
Other	0.6	1.1
Applying measures to improve water quality	17.9	33.6
Water sources for household chores		
Water supply network	99.1	99.7
Well water	-	12.7
Purchased water from water tankers	-	99.3
Other	3.4	5.2
Sources of water for drinking purposes		
Network water	80.8	69.8
Tank water	3.85	66.2
Bottled water always	25.9	52.6
Bottled water only when a house member is sick	25.2	47.4


Fig. 4.3. Water pumps in basements of or entrance to buildings in the Tebbaneh area

The stored water is not used for drinking purposes but usually used for common household chores such as cleaning, bathing, washing fruits and vegetables, etc. The survey revealed that household storage tanks were located either in the attic (45 percent of respondents) or on the building's roof. Most storage tanks are not well covered and often not covered at all. The uncovered attic storage tanks, which are usually located below sanitary plumbing systems of upper floors, are prone to water contamination from leaking pipes, particularly that a significant number of households had reported the presence of wastewater problems in their buildings (Fig. 4.4).



a) Existing system in Tebbaneh b) Existing system in An-Nasr

Fig. 4.4. General layout of water supply systems within buildings in study areas

Though the majority of respondents in both areas are connected to new sewage networks, respondents from Tebbaneh complained about wastewater problems of which 57 percent were within buildings such as wastewater accumulation in basements, clogging of pipes, foul odors, fissures and leakages (Fig. 4.5). Fig. 4.6 shows the distribution of buildings reporting one or more wastewater problems.

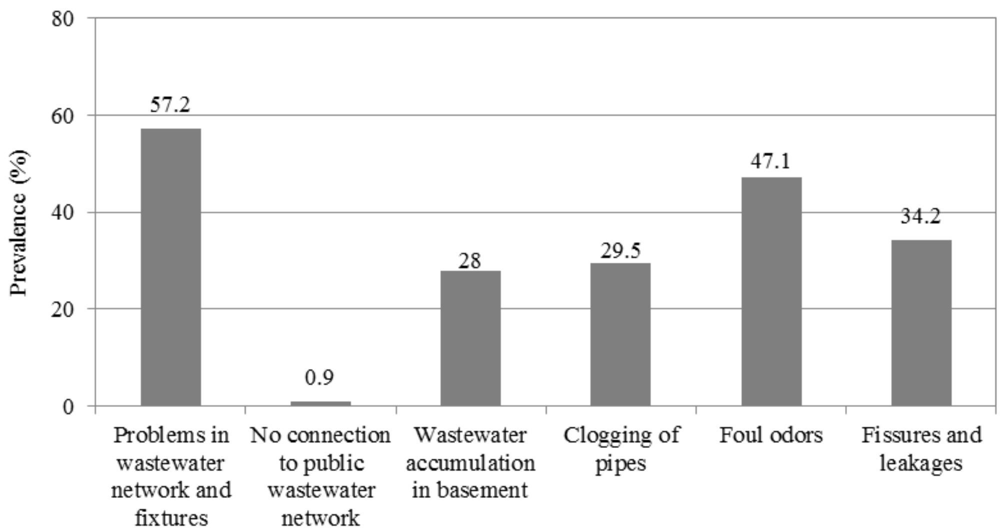


Fig. 4.5. Reported prevalence of problems in wastewater network and fixtures in Tebbaneh

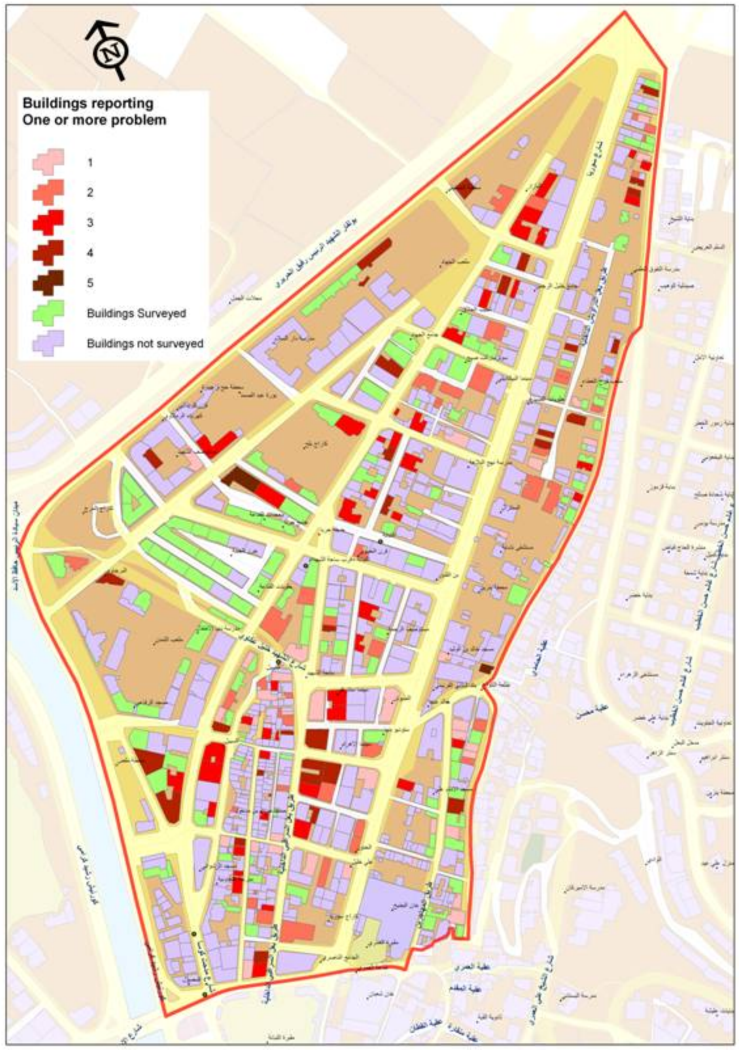


Fig. 4.6. Map showing the distribution of buildings reporting one or more wastewater-related problem (buildings in red) during the Social Survey

Around 99 percent of households in An-Nasr area are connected to the drinking water network with an estimated average water consumption rate of 36.5 L/capita/day which is relatively low because of water scarcity in Jordan as a whole. At An-Nasr, the public water supply reaches consumers at an acceptable pressure and is either stored in a reservoir at ground level from where it is pumped to roof-top storage tanks, or it reaches the roof top storage tanks directly. No attic storage tanks are present (Fig. 4.4) thus eliminating cross contamination from potential sanitary leakage. In addition, buildings in An-Nasr seldom exceed three stories. Since the water supply is intermittent, all An-Nasr respondents reported supplementing the network water supply by purchasing water tankers with ~13 percent relying on well water. In both areas, more than 90 percent of respondents withdraw water from water storage tanks using the household pipe system and without additional treatment. However, at $\alpha = 0.05$, a statistically significant difference was discerned in the percentage of respondents cleaning their water storage tanks and in the percentage implementing measures to improve the drinking water quality ($p < 0.001$). Nearly 40 percent at Tebbaneh reported never cleaning water tanks compared to 17 percent at An-Nasr. Also, while water quality is better at An-Nasr, more households (34 percent) were implementing measures to improve drinking water quality than at Tebbaneh (18 percent).

In addition, a statistically significant difference at $\alpha = 0.05$ was found in the sources of drinking water between Tebbaneh and An-Nasr ($p < 0.001$) whereby only 3.85 percent of Tebbaneh households use the tank water for drinking as compared to 66.2 percent at An-Nasr. Bottled water use in Tebbaneh, in terms of both, the average bottled water consumption rate (p-value < 0.001) and the percentage of households purchasing bottled water (p-value < 0.001) was found to be statistically significantly different from bottled water use in An-Nasr, at $\alpha = 0.05$. Regarding bottled water consumption, around 52 percent of households in An-Nasr reported always purchasing bottled water, with an average consumption rate of 5.5 L/capita/day, compared to 26 percent in Tebbaneh, with an average consumption rate of 1 L/capita/day, as it is often supplemented by drinking water from the network. However, an additional 48 percent in An-Nasr and 25 percent in

Tebbaneh reported purchasing bottled water only when a member of the household is sick. For both areas, Fig. 4.7 shows that more than 85 percent of respondents are satisfied with the quantity of water supply during the winter season. In contrast, during the summer, the percentage of satisfied respondents drops to ~60 percent for Tebbaneh and to ~30 percent for An-Nasr. Hence, during summer less water might be available for basic hygiene and consequently the risk for waterborne diseases such as diarrhea increases.

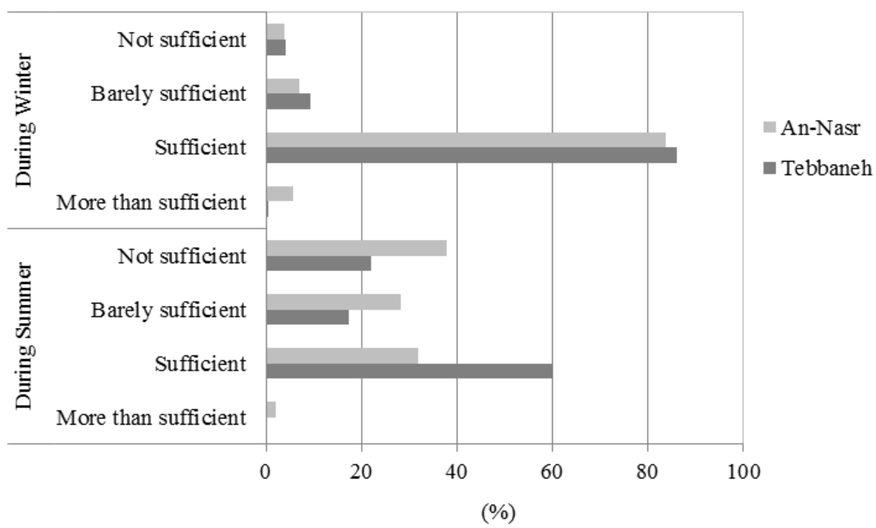


Fig. 4.7. Sufficiency of water supply

4.1.4 Water Quality

In Jordan, the whole area is well connected by a water supply network whose water quality is treated and monitored by the Jordanian Water Authority (JWA) to ensure compliance with national drinking water quality standards. More specifically, out of 3,455 samples (with 2,342 samples from the public network, and 1,113 samples from storage tanks) of drinking water throughout Jordan, about 1.3 percent did not comply with national and international regulations for water quality standards (JWA 2006).

In Tebbaneh, water supply is managed by the North of Lebanon Water Establishment (NLWE). The main source for municipal drinking water supply in the study area is the 'Hab' spring after being treated in the Bahsas water treatment plant where the water undergoes screening, followed by coagulation (only in winter season), sedimentation, filtration and finally chlorination. Treated water is stored in reservoirs before being supplied to the network. Two open reservoirs, located in the Kobbeh area, are also used to supply drinking water to the study area, namely the 'Water Castle' reservoir and the 'Daher Al Mogher' reservoir. Water stored in both reservoirs undergoes chlorination before being supplied to the study area (NLWE 2009). During the summer season, 'Hab' spring's water is supplemented by the 'Al Mallouleh' well water, located at the North-Eastern side of the study area. Water extracted from this well undergoes chlorination as the only form of treatment. Chlorination is applied directly on the outflowing water, without prior storage in a reservoir, thus not allowing for sufficient chlorine contact time to efficiently disinfect the water before distribution (Sayadi 2011).

As part of the municipal water quality monitoring performed in Tripoli by the NLWE (NLWE 2009), 3 samples are collected on a daily basis from Tebbaneh and analyzed for several physico-chemical (pH, turbidity, residual chlorine) and microbiological (Fecal coliform, Total coliform, E-coli, and Enterococcus) parameters at the Manar Laboratory in Tripoli under the supervision of the concerned water establishment (NLWE 2009). The monitoring program also covers the supply reservoirs whereby samples are taken on a daily, weekly, and seasonal basis, depending on the monitored parameter. Laboratory results for samples collected between September 2008 and September 2009 indicated the absence of microbiological contamination in the potable water supplied to the study area. The water establishment further ascertained the absence of weak points within the network (NLWE 2009).

Similarly, the water quality monitoring in the Tebbaneh, conducted as part of this study, revealed that water is of relatively acceptable quality with few contamination occurrences at deteriorated sections of the distribution network (Table 4.4). However, the residual chlorine was relatively low (mean = 0.11 mg/l) indicating that by the time the water reaches the consumer, its disinfection ability has been exhausted, thus increasing the potential of the water of getting contaminated within the household. Color and turbidity in the water were detected in 22 and 10 percent respectively of both network and stored water, which was consistent with complaints reported by residents in the household survey. Total coliforms were detected in water from 44 surveyed households of which 23 percent had their storage tanks in the attic. Low fecal coliform levels in both network water and stored water are considered to present a “low risk” of fecal-oral transmission (Bain *et al.* 2014). Risk factors for microbial contamination of piped supplies, including intermittent supply leading to infiltration into non-pressurized distribution systems, and inadequate chlorination associated with recontamination during household storage (Wolf *et al.* 2014; Kumpell and Nelson 2013; Hrudey *et al.* 2006), appear to be common in the Tebbaneh study area. Refer to Appendix 6 for detailed results.

Table 4.4. Summary of water quality results for water from both campaigns in Tebbaneh

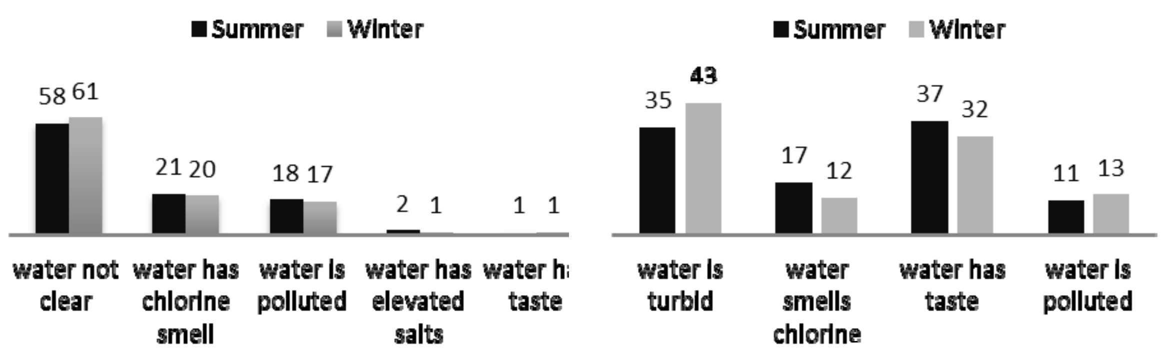
Parameter	*Range*	*Standard (EPA/ EU/ WHO)*[a]	*Standard Exceedance*			
			Drinking Network		*Storage Tanks*	
			Number	*(%)*	*Number*	*(%)*
Fecal coliform (CFU/100 ml)	0-3	0	6	(5)	9	(9)
Total coliform (CFU/100 ml)	0-500	0	36	(33)	44	(43)
Nitrate (mg/L NO_3)	6.1-27.8	40-50	0	(0)	0	(0)
pH	6.04-7.84	6.5-8.5	0	(0)	1	(0)
Residual chlorine (mg/L Cl_2)	0.01-0.3	> 0.5	76	(100)	-	-
TDS (mg/L)	208-862	500	24	(32)	26	(44)
Color (PtCo APHA)	0-67	15	14	(22)	14	(24)
Turbidity (NTU)	0.98-1.6	1	6	(10)	6	(10)

[a] EPA: Environmental Protection Agency; EU: European Union; WHO: World Health Organization

While a new water distribution network has been recently installed at Tebbaneh, it was still non-operational at the time of conducting this study because associated appurtenances including water meters and cabinets were vandalized (Karam 2009; Sayadi 2011). Thus, the old network with some corroded pipes situated below the wastewater network at some locations, continues to be used. The most evident instances of contamination were noted immediately following power cutoffs, which occur on a daily basis, when negative pressure in the network allows the seepage of wastewater into corroded water pipes. This negative pressure is exacerbated by the presence of individual water pumps directly connected to the network. Also, uncovered attic storage tanks, which are usually located below sanitary plumbing systems of upper floors, and deteriorated water pipes within the building, increase the threat of water contamination from potential leakage.

Evidently, such inadequate water supply, which is better labeled as ‘basic piped water supply’, instead of ‘improved water supply' (Wolf *et al.* 2014), is associated with significant health risks experienced most strongly by the poorest households (Herbst *et al.* 2008; Hunter 2010).

Despite the relatively acceptable quality of the network water, respondents in both areas expressed dissatisfaction during both, the summer and winter seasons. Fig. 4.8 depicts the main reasons reported by residents for the distrust or dissatisfaction with the quality of the public water supply in both areas with slight differences between the summer and winter seasons. The main complaint reported in An-Nasr area was turbidity of the water followed by chlorine smell and general water pollution. Few reported elevated salts and distaste as reasons for dissatisfaction (~ 1 percent). In Tebanneh, the two most reported reasons for dissatisfaction are the taste and the turbidity of water. A considerable number of respondents complained about chlorine smell and pollution in general.



(a) (b)

Fig. 4.8. Distribution of reported reasons for dissatisfaction with the quality of the public water supply during the summer and winter seasons in (a) An-Nasr and (b) Tebbaneh

With regards to bottled water sold in Tebbaneh, two brands out of a total of 18 revealed positive indication of fecal coliform, with counts ranging between 1 and 27 CFU/100 mL. Moreover, 7 bottled water brands exhibited positive indication of total coliform, with counts ranging between 1 and 147 CFU/100 mL, which may be attributed to the lack of quality control, source contamination and/or an inefficient treatment process. Bottled water quality in Tebbaneh, in terms of the percentage of samples exhibiting Total Coliform contamination, was found to be statistically significantly different from that in An-Nasr at $\alpha = 0.05$ (p-value = 0.02), while the difference in Fecal Coliform contamination was not (p-value = 0.398). Naturally, the fact that a number of bottled water samples were contaminated with total and/or fecal coliform bacteria may also explain a higher incidence of diarrhea in Tebbaneh. Residents of Tebbaneh perceive the quality of bottled water to be acceptable and better than that of the network water, thus resorting to it when a household member is sick, hence most vulnerable. As for bottled water in An-Nasr, none exhibited fecal or total coliform bacteria, and the levels of nitrate complied with standards. Thus, the decision to purchase bottled water in An-Nasr is influenced mainly by water scarcity particularly that the public water supply is intermittent and not sufficient. Dissatisfaction with the perceived water quality appears to be a less prominent factor.

Nitrate concentrations of bottled water samples in Tebbaneh ranged between 2.3 and 49.5 mg/L, with almost all brands complying with national and international drinking water quality standards, although relatively high indicating that groundwater in an agricultural zone is the potential source of the bottled water. One sample exhibited nitrate levels of 49.5 mg/l, thus exceeding the Lebanese Standards Institution (LIBNOR), Food and Drug Administration (FDA) and International Bottled Water Association (IBWA) standards (44-45 mg/L). On the other hand, the levels of nitrate in all water samples collected from the public drinking water network complied with the standards with values ranging between 6.1 and 27.8 mg/L.

Table 4.5 summarizes the results of the statistical analysis conducted to compare the microbiological quality of bottled water in Tebbaneh to that of network drinking water. According to the Independent T-test, at α = 0.05, no statistical difference between the means in the two water sources (p-value = 0.417 for FC; p-value = 0.201 for TC) can be discerned. In addition, the Pearson's Chi Square Test revealed that, at α = 0.05, there was no statistical difference between the percentage of polluted sample from the two water sources (p-value = 0.974 for FC; p-value = 0.922 for TC).

Table 4.5. Summary of the statistical analysis comparing the microbiological quality of bottled water and network drinking water

Statistical analysis	*Tested Hypotheses*		*p-value*	*Conclusions at α = 0.05*
Independent T-test	Null Hypothesis 1:	Mean FC count in Bottled Water is equal to Mean FC count in Network Water	0.417	Do not reject null hypothesis
	Alternative Hypothesis 1:	Mean FC count in Bottled Water is different from the Mean FC count in Network Water		Means are equal
	Null Hypothesis 2:	Mean TC count in Bottled Water is equal to Mean TC count in Network Water	0.201	Do not reject null hypothesis
	Alternative Hypothesis 2:	Mean TC count in Bottled Water is different from the Mean TC count in Network Water		Means are equal
Pearson's Chi Square test	Null Hypothesis 3:	Percent of bottled water samples with FC pollution is equal to the percent of network water samples with FC pollution	0.974	Do not reject null hypothesis Percentages are equal
	Alternative Hypothesis 3:	Percent of bottled water samples with FC pollution is different from the percent of network water samples with FC pollution		
	Null Hypothesis 4:	Percent of bottled water samples with TC pollution is equal to the percent of network water samples with TC pollution	0.922	Do not reject null hypothesis Percentages are equal
	Alternative Hypothesis 4:	Percent of bottled water samples with TC pollution is different from the percent of network water samples with TC pollution		

Accordingly, it can be concluded that the microbiological quality of the sampled bottled water is statistically similar to that of the network drinking water, in terms of both, mean FC and mean TC counts, as well as the percentage of polluted samples.

In summary, the drinking water supply in Tebbaneh is almost continuous, despite its low pressure, and thus the decision to purchase bottled water depends heavily on the satisfaction with its perceived quality. The mistrust is exacerbated by salespersons marketing household water filters and presenting questionable demonstrations that undermine the perception of the quality of the water supplied through the network. Residents of Tebbaneh do not differentiate among different brands of bottled water and believe that all of them are of similar superior quality in comparison to public drinking water. Yet, laboratory results and statistical analysis revealed that bottled water that is available in the Tebanneh area is of comparable quality to that of the drinking water supplied via the public network system. Thus, in Tebbaneh bottled water is contaminated at times and not safer as believed in the community. Indeed, several brands are not authorized and/or not stored properly or are contaminated. There is no tangible benefit of bottled water use over the network water. On the contrary, the consumption of bottled water diverts resources from other social necessities emphasizing the need for regulatory enforcement of quality standards for bottled water as well as awareness raising and trust building in the public water supply.

4.1.5 Environmental Management and Hygienic Practices

Finally, it was observed that, in general, in Tebbaneh, significantly low hygiene practices persist on streets and within households, which may also contribute to diarrhea and other water borne illnesses (Fig. 4.9).

Fig. 4.9. Some observations illustrating low hygiene

Solid waste management was considered to be another important environmental issue in Tebbaneh that required attention, whereby excessive littering was noted in building stairways and on empty land, despite the adequate distribution of solid waste collection bins in the area (Fig. 4.10).

Fig. 4.10. Some observations illustrating solid waste dumping and littering

The survey results showed that ~65 percent of respondents in Tebbaneh reported solid waste and pest infestation, including mosquitoes and rats, as their first environmental concern. Nearly 54 percent reported gastroenteritis as their first most important health problem. Though respondents at An-Nasr complained from similar environmental problems as in Tebbaneh (solid waste, pests, and wastewater), only 0.7 percent complained from gastroenteritis as a primary health problem.

Fig. 4.11 illustrates responses to hand washing, dishwashing and availability of continuous hot water in both areas. Though Tebbaneh had lower percentage of households with sinks close or within the bathroom, it had higher percentage of respondents with access to continuous hot water which is encouraging for personal hygiene. However, the results of the evaluation of hand washing practice, which is critical in the case of diarrhea, showed that the majority (89.8 percent) of the scores ranged between 3 and 7 out of 10, and only around 7.5 percent scored between 8 and 10. Note that The handwashing score is calculated based on the number of handwashing activities practiced by the female household head. Each practice is given 1 point. These include, 5 instances when hands are washed (after using the toilet, after changing diapers, before eating, before preparing food, and before feeding the children) and 5 on-site observed handwashing practices (using water only, using water and soap, washing both hands, rubbing hands at least three times, and drying hands with a clean cloth).

Still, all respondents in Tebbaneh reported washing their hands after use of bathroom and changing diapers, and before preparing food, eating, and feeding the children.

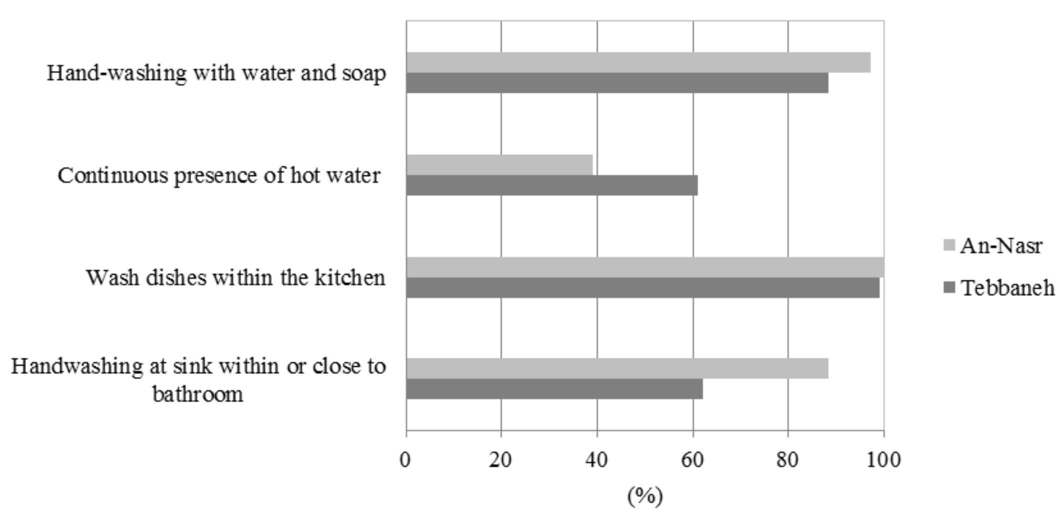


Fig. 4.11. Survey responses on household hygiene practices in Tebbaneh and An-Nasr

4.1.6 Factors Affecting Diarrhea Prevalence

Several indicators exhibited statistically significant differences between Tebbaneh and An-Nasr areas including the educational level of the female and male household heads, household ownership, the ability to secure an amount of 100 USD within one week, type of water storage tanks, the frequency of cleaning these tanks, and the use of purchased bottled water (Table 4.6).

Table 4.6. Variables exhibiting statistically significant differences between Tebbaneh and An-Nasr areas

Variable	*Pearson's Chi Square (X^2)*	*p-value*
Diarrhea incidences in the three months before questionnaire administration	43.11	<0.001
Educational level of male household head	355.7	<0.001
Educational level of female household head	269.6	<0.001
Household ownership	21.19	<0.001
Ability to secure an amount of 100 USD within one week	140.3	<0.001
Type of water storage tanks (roof versus attic)	243.0	<0.001
Frequency of water tank cleaning	124.4	<0.001
Measures to improve drinking water quality	19.32	<0.001
Use of purchased bottled water	193.2	<0.001
Use of water tank for drinking	261.6	<0.001

Each factor showing a statistically significant difference between Tebbaneh and An-Nasr was correlated with the occurrence of diarrhea in Tebbaneh. Statistically significant associations were found for educational level of the female household head, household ownership, the ability to secure an amount of 100 USD within one week, type of water storage tanks (attic versus roof), frequency of water tank cleaning, and the use of bottled drinking water (Table 4.7). These associations were significant at $\alpha = 0.05$ except for correlation of diarrhea cases with frequency of tank cleaning and type of water tank which were found to be significant at $\alpha = 0.1$. The type of storage tank and the frequency of tank cleaning were also found to be associated with diarrhea incidence. A significant relationship was equally discerned between bottled water use for drinking purposes and diarrhea. These parameters were further scrutinized, in terms of the magnitude and direction of their association with diarrhea prevalence, as part of the logistic regression analysis and statistical modeling, detailed in below.

Table 4.7. Association between variables identified as statistically significant relative to An-Nasr and occurrence of diarrhea cases at Tebbaneh

Dependent variable	*Independent Variable*	*Association*	*Pearson's Chi Square (X^2)*	*p-value*
Reporting of diarrhea cases in the past three months	Educational level of female household head	Yes	11.47	0.009
	Household ownership	Yes	4.04	0.044
	Ability to secure 100 USD within one week	Yes	4.89	0.027
	Type of water storage tank (roof versus attic)	Yes	2.90	0.089
	Frequency of water tank cleaning	Yes	6.99	0.072
	Use of bottled water for drinking purposes	Yes	6.65	0.036
	Educational level of male household head	No	3.08	0.379
	Use of tank water for drinking purposes	No	0.489	0.484
	Measures to improve drinking water quality	No	2.294	0.807
	Reporting wastewater problems	No	1.35	0.246
Presence/ absence of Total Coliform	Type of water storage tank (roof vs. attic)	Yes	3.39	0.066
	Wastewater problems	No	2.62	0.105
Presence / absence of Fecal Coliform	Type of water storage tank (roof vs. attic)	Yes	4.62	0.032
	Reporting wastewater problems	No	1.36	0.243

The main variable of interest from the water sampling program was the presence/absence of fecal and total coliforms. At $\alpha = 0.05$, a significant association was evident between the type of storage tank used (attic vs. roof top) and the presence of fecal coliforms ($p = 0.032$). The association between the type of storage tank and the presence of total coliforms in the water was significant at $\alpha = 0.1$ ($p = 0.066$). The Kendall tau-b (τb) statistic revealed a relatively strong positive correlation between attic tanks and fecal coliform (+0.279), supporting the hypothesis that wastewater is likely to leak into water stored in attic tanks as illustrated in Fig. 4.4.

The overall analyses of the statistically significant correlations imply that the condition of the water system at the household level is an equally strong factor impacting the incidence of diarrhea. This situation is aggravated by poor hygienic practices influenced by a low educational level of housewives and the lack of enforced monitoring of bottled water quality emphasizing the need for interventions to improve water supply network, storage, and handling. Recent studies have shown that drinking water treatment at the point of use have a higher impact on diarrheal outcome than source quality since deterioration of microbiological drinking water quality could also occur during storage (Herbst *et al.* 2008) which is more representative of the situation in the subject area. A better water source alone may not accomplish full health benefits if it is not accompanied with improved water storage practices and hygienic habits at the household level (Checkley *et al.* 2004; Mafuya and Shukla 2005).

4.2 Statistical modeling of diarrhea occurrence in the Tebbaneh slum

This section presents and discusses the results of the logistic regression analysis conducted to further probe into the risk factors of diarrhea in the Tebbaneh study area and assesses their impact on the prevalence of diarrheal morbidity in the Tebbaneh households.

The single variable logistic regression analysis of potential predictor variables of diarrhea yielded results that were consistent with those of the ANOVA and Pearson's Chi-Square tests conducted as part of the comparative assessment analysis, presented above. Out of all variables that were tested (Table 3.4), the demographic variables that were found to be significantly associated with diarrheal morbidity in the Tebbaneh households ($\alpha \leq 0.10$) , included the number of household members, the age of male and female household heads, the educational level of the female household head (though the correlation was inconsistent) , and the zone in which the household is located (Table 4.8). The significant socio-economic variables included the ability to secure 100 USD within one week and household ownership. As for the WASH related variables that were found to be statistically significantly associated with diarrhea prevalence in Tebbaneh included the type of water storage tank, water tank cleaning, the use of network and bottled water for cooking, and wastewater accumulation in building basements.

Table 4.8. Bivariate and multivariate analysis of determinant factors of childhood diarrhea in Tebbaneh in 2009

Characteristics	*Diarrhea*		*Bivariate Analysis*	*Multivariate analysis*		
	Yes	*No*	*Crude Odds Ratio (95% CI)*	*Adjusted Odds Ratio (95%CI)*	*p-value*	*Probability of reporting diarrhea in a household*[1]
Model Intercept	-	-	-	5.06 (0.88-43.06)	0.090	0.835
Number of household members	-	-	1.13 (1.03, 1.24)***	1.19 (1.05-1.38)	0.009	0.858
Age of male household head	-	-	0.98 (0.96, 1.00)**	-	-	-
Age of female household head	-	-	0.98 (0.96, 1.00)**	0.98 (0.95-1.00)	0.077	0.832
Education of female household head						
Lower than primary education	29	77	0.47 (0.61, 1.05)***	-	-	-
Primary education and above	95	118	1.00			
Zone[2]						
1 (Very poor; Worst infrastructure)	30	35	1.00	1.00	0.054	0.719
2 (Better infrastructure)	14	50	0.33 (0.15, 0.69)***	0.50 (0.25-1.00)		
Ability of a household to secure 100 USD						
Yes	34	78	0.58 (0.35, 0.94)**	0.51 (0.23-1.09)	0.088	0.723
No	91	121	1.00	1.00		
Household ownership						
Yes	51	104	0.63 (0.40, 0.99)**	-	-	-
No	74	95	1.00			
Water tank cleaning						
Yes	63	122	0.66 (0.41, 1.05)*	-	-	-
No	54	69	1.00			
Type of water storage tank						
Roof	58	112	0.67 (0.42, 1.06)*	-	-	-
Attic	61	79	1.00			
Use of network water for cooking						
Yes	113	195	0.17 (0.04, 0.58)***	0.10 (0.01-0.50)	0.01	0.342
No	10	3	1.00	1.00		
Use of bottled water for cooking						
Yes	15	8	2.85 (1.14, 7.63)**	-	-	-
No	44	67	1.00			
Wastewater accumulation in the basement						
Yes	45	46	1.96 (1.08, 3.57)**	2.74 (1.39-5.54)	0.004	0.933
No	31	62	1.00	1.00		

* p-value less than 10%; ** Less than 5%; *** Less than 1%

[1] During a 3-month reference period and when controlling for all other variables

[2] Refer to Table 3.2 for zone description

However, when the multivariate analysis was conducted using forward stepwise regression to assess the relative effect of the identified statistically significant variables on the prevalence of diarrhea in a household in Tebbaneh, fewer variables remained in the final selected model, giving the best model statistics. These included, (a) the number of household members, the age of the female household head, and the zone, as socio-demographic variables, (b) the ability to secure 100 USD within one week, as a socio-economic variable, and (c) the use of network water for cooking, and wastewater accumulation in the basement, as WASH variables. The final model was of the form:

$$logit\ P(X) = \ln (P_i/(1-P_i)) = 1.62 + 0.18(NumberOfMembers\text{-}2_i) - 0.02(MaternalAge\text{-}20_i) - 0.66(Securing100USD_i) + 1.01(WastewaterInBasement_i) - 2.27(NetworkWaterCooking_i) - 0.68(Zone2_i)$$

Where,

P_i = the probability of a household member being ill with diarrhea during the reference period of 3 months

NumberOfMembers – 2 = the number of members in a household above 2

MaternalAge – 20 = the age of the female household head above 20 years

Securing100USD = the ability of a household to secure 100 USD within one week

WastewaterInBasement = wastewater accumulation in the building basement

NetworkWaterCooking = using network water for cooking

Zone2 = the location of a household in Zone 2, which is one of the better areas in terms of infrastructure

According to the above model, the baseline probability of contracting diarrhea in a household in Tebbaneh is 83.5%, given that there are two members in the household, the age of the female household head is 20, the household is unable to secure 100 USD within one week, there is no wastewater accumulation in the basement, network water is not used for cooking, and the household is not located in Zone 2. This further highlights the alarmingly high rate of potential diarrhea incidence in the Tebbaneh slum.

The generated multivariate model accounted for 0.518 and 0.787 of the proportion of the total variability of the outcome, the prevalence of diarrhea within a household for the past three months, depending on the pseudo R^2 equation used (Table 4.9).

Table 4.9. Pseudo R^2 of the generated model

Pseudo R^2	*Value*
McFadden R^2	0.52
ML (Cox-Snell) R^2	0.72
CU (Cragg-Uhler) R^2	0.79

Looking at individual variables, the number of household members was found to have the strongest association with diarrhea incidence (p-value < 0.01). A one-unit increase in the number members led to a slight increase in the likelihood of a member contracting diarrhea in the household [COR = 1.13, 95% CI (1.03, 1.24)]. This risk increased slightly when controlling for all other variables in the multivariate model [AOR = 1.19, 95% CI (1.05, 1.38)]. This positive correlation be attributed to increased crowding in the household and the associated decrease in the quality of care and attention from parents, as reported by similar cross-sectional studies (Mihrete *et al.* 2014; El-Gilany and Hammad 2005; Woldemicael 2001). It could also be simply due to an increase in the exposure term.

As for the age of male and female household heads, it was also found to have a strong association with diarrhea incidence (p-value < 0.05), whereby a one-year increase in their age led to a slight decrease in the likelihood of a household member contracting diarrhea [COR = 0.98, 95% CI (0.96, 1.00)]. In the multivariate model, only the age of the female household head was retained, for simplicity and to avoid redundancy and covariance. This variable maintained the same risk upon controlling for all other variables [AOR = 0.98, 95% CI (0.95, 1.00)]. This was consistent with a study conducted by Finley *et al.* (2011), looking into the association between maternal age and various child health outcomes, including diarrhea, in 55 low to middle income countries. This relationship was more attributed to social mechanisms, rather than biological mechanisms, particular for mothers above 20 years of age, as is the case in Tebbaneh.

When considering the five different zones in Tebbaneh, there was no statistically significant difference between the location of the households in these zones and the incidence of diarrhea, except for Zone 2. Households in Zone 2 appeared to be 67 percent less likely to report diarrhea, as compared to Zone 1, where the vegetable market is located. In fact, Zone 1 was identified by field observations as the worst in terms of solid waste dumping and wastewater accumulation on the streets, very high population density, and relatively old and deteriorated buildings. As for Zone 2, which included a part of Jabal Mohsen, buildings there were renovated and streets were in better conditions. This could explain the statistically significant decrease in diarrhea prevalence in Zone 2, where both building and street infrastructure is expected to be better, as compared to Zone 1.

Regarding socio-economic determinants, both household ownership and the ability to secure 100 USD in one week were statistically significantly correlated with diarrhea prevalence in a household at $\alpha = 0.05$. Owning the household or being able to secure 100 USD within one week decreased the likelihood of contracting diarrhea by around 40 percent as compared to not owning the household or not being able to secure 100 USD within one week [$COR_{\text{House ownership}} = 0.63$, 95% CI (0.40, 0.99)) and $COR_{\text{Ability to secure 100 USD}} = 0.58$ (0.35, 0.94)]. The ability to secure 100 USD was maintained in the final model whereby its impact on diarrhea prevalence decreased slightly when controlling other variables [$AOR_{\text{Ability to secure 100 USD}} = 0.50$ (0.25, 1.00)]. Better economic conditions are often associated with better environmental and sanitary conditions within a household, as well as better nutritional status of household members, particularly children (Arif and Naheed 2012; Woldemicael 2001).

Several household environmental variables related to water, sanitation and hygiene were found to be statistically significantly related to diarrhea prevalence in the Tebbaneh households. The univariate analysis identified two variables related to water tanks to be statistically significantly associated with diarrhea incidence at $\alpha = 10$ percent. The presence of a storage water tank on the roof-top appeared to reduce the risk of diarrhea among household members by around 40 percent, as compared to households with storage tanks in the attic [COR = 0.67, 95% CI (0.42, 1.06)]. Similarly, the practice of water tank cleaning also tended to reduce diarrhea among household members by around 40 percent [COR = 0.66, 95% CI (0.41, 1.05)], as compared to households that did not clean their tanks. However, after adjusting for the influence of other variables, these two variables did not show any significant effect in the multiple regression generalized linear model. Nevertheless, the practice of poor household water storage in the Tebbaneh area should not be overlooked when considering improvement alternatives. This is emphasized by the evidence of coliform contamination in water collected from household storage tanks throughout the slum (Table 4.4), as well as the statistically significant positive association between attic tanks and fecal coliform, discussed in the previous section.

The source of water used for cooking was statistically significantly associated with diarrhea in the Tebbaneh households. The use of network water for cooking reduced the risk of diarrhea by around 80 percent [COR = 0.17, 95% CI (0.04, 0.58)] at $\alpha < 1\%$. The impact of this variable on the risk of diarrheal morbidity slightly increased in the final model, whereby the use of network water for cooking reduced the risk of diarrhea by 90 percent [AOR = 0.10, 95% CI (0.01, 0.50)]. Alternatively, the use of bottled water for cooking increased the risk of diarrhea in a household by almost 3 times [COR = 2.85, 95% CI (1.14, 7.63)]. The latter variable was not included in the final model due to its confounding effect with the previous one. These results could be explained by the general misperception of the households in Tebbaneh that bottled water quality is better than network water quality. However, statistical analysis had revealed that the quality of both sources is not statistically significantly different, with incidents of pollution detected in both (Table 4.5). Hence, it could be that when network water is used in cooking, it is used with more caution than bottled water, leading to a reduction in diarrhea prevalence.

As for wastewater related problems, the accumulation of wastewater in the basement of buildings was found to be statistically significantly associated with diarrhea in the Tebbaneh study area at ($p\text{-value} < 0.05$). Residents of households in buildings suffering from wastewater accumulation in the basement are two times more at risk of contracting diarrhea than those in buildings not reporting this problem [COR = 1.96, 95% CI (1.08, 3.57)]. The impact of this variable increased significantly in the final model, with the risk of contracting diarrhea reaching almost three times in households within building where wastewater accumulates in the basement, as compared to buildings with no wastewater accumulation in the basement. This could be attributed to potential wastewater infiltration into old and deteriorated water pipes coming into the building, thus polluting the incoming network water.

Note that the limited number of WASH variables found to be statistically significantly related to diarrhea prevalence in the Tebbaneh households could be explained by the fact that the study area is relatively homogeneous in terms of having improved water supply and wastewater infrastructure. More than 99 percent of the surveyed household reported being connected to the public water and wastewater networks, and having a private flush-toilet and a sink within the household (Table 4.3), in comparison to most studies reported in the literature where communities of interest have non-improved water and sanitation provisions.

Finally, regarding individual susceptibility to diarrhea, the prevalence of diarrhea was not influenced by gender, with male to female ratio of diarrhea cases being 1.04 to 1.00. However, age group appeared to be a statistically significant factor in determining diarrhea prevalence in the Tebbaneh slum (Table 4.10). The most vulnerable age group appeared to be children less than 1 year of age, with a probability of contracting diarrhea of 31 percent (p-value < 0.10). For the age group 1 to 3 years of age, the probability of contracting diarrhea was not statistically different from that for children less than 1 year of age. The likelihood then decreases with age group. For the age group 3-10, the likelihood of contracting diarrhea decreases by 63 percent as compared to children less than 1 year of age. For the age group 19-65 the likelihood of contracting diarrhea decreases by 85-89 percent (p-value < 0.001) as compared to that of children less than 1 year of age. As for the elderly, more than 65 years of age, their likelihood of contracting diarrhea decreases by 81 percent as compared to children less than 1 year of age. The fact that children less than 1 year of age appeared to have the highest risk of contracting diarrhea contradicts with studies reported in the literature where children less than 1 year of age in poor slums are usually protected from diarrhea by exclusive breastfeeding (Lamberti *et al.* 2011). Unfortunately, no information is available in the Tebbaneh study area on breastfeeding practices of mothers to be able to further investigate this finding.

Table 4.10. Bivariate analysis of age as a determinant of childhood diarrhea in Tebbaneh in 2009

Age group	*Diarrhea*		*Odds Ratio*
	Yes	*No*	
Less than 1 yr (Intercept)	10	22	0.45 (0.21-0.93)*
1 to 3 yrs	24	73	0.76 (0.32-1.89)
3-10 yrs	53	313	0.37 (0.17-0.86)*
11-18 years	16	324	0.11 (0.04-0.27)***
19-30 yrs	26	384	0.15 (0.06-0.36)***
31-65 yrs	38	517	0.16 (0.07-0.38)***
65+ yrs	5	57	0.19 (0.05-0.61)**
Total	172	1690	

* p-value less than 10%; ** Less than 5%; *** Less than 1%

In conclusion, identifying the causes of diarrhea is fundamental for the effective implementation of health improvement programs for policy formulation and the general assessment of resource requirements and intervention prioritization in the Tebbaneh slum (Mihrete 2014). Based on the statistical analysis of the data in terms of both, comparative assessment and statistical modeling, the determinants of high prevalence of diarrhea in the Tebbaneh urban slum include the existing water supply and sanitary systems at the building level, namely attic water storage tanks, tank cleaning frequency, deteriorated water pipes, and wastewater accumulation in the basement. The high number of household members, and the young age of female household members, along with the limited economic means were equally correlated with high incidence of diarrhea. Simple structural interventions (replacing attic tanks with roof tanks, rehabilitation of water and sanitary pipes at the household and building levels, maintenance of roof tanks, avoiding direct pumping from the network) coupled with enforcement of monitoring programs of network and bottled water as well as targeted awareness campaigns on proper hygienic practices may constitute effective and low cost measures for reducing diarrhea incidence in similar slums. This further discussed in the following sections.

4.3 Assessment of the socio-economic burden of water pollution

The elevated incidence rate of waterborne diarrhea among all age groups in the Tebbaneh slum, along with evidence of water pollution at the point of use, warranted the need to assess the socio-economic burden of water quality in this poor urban area in terms of increased morbidity and premature mortality, as detailed below. This was envisaged as the economic foundation and justification of any proposed improvement program. Various economic tools were used including the Cost of Illness (COI), the Averted Behavior (AB), and the Disability Adjusted Life Years (DALY) approaches for morbidity valuation, and the Human Capital (HC) approach for mortality valuation.

4.3.1 Morbidity Valuation

Based on the assumption that 88% of the reported diarrheal cases are attributed to unsafe water supply, inadequate sanitation and hygiene (Wilkinson 2009), and that the cases are distributed uniformly throughout the year, with no seasonal variations, the annual incidence of diarrhea in the study area for the year 2009 was estimated from the household survey results at 33.1 percent, which amounts to a total of 9,200 cases. The age distribution of the reported cases is presented in Table 4.11, whereby ~32 percent of the cases are less than 5 years of age and ~34 percent are in the productive age of 18 to 65.

Table 4.11. Distribution of expected annual diarrheal morbidity cases by age group.

Age group	*Reported cases (%)*	*Estimated cases (n)*
1 to 5	32	2940
6 to 18	30	2760
19 to 65	34	3130
66+	4	370
Total	**100**	**9200**

The direct COI approach, which consists of all medical expenditures associated with the onset of water-related diarrhea within the study area, was estimated to range between 0.36 and 1.44 million USD in the area for the year 2009 (Table 4.12).

Table 4.12. Direct cost of illness by type of medical service sought in the study area

Type of Medical Service	*Percent distribution of cases[c]*	*Number of cases*	*Cost of Illness per case (USD)*	*Total cost of illness (USD/year)*
Hospital	17	1570	225.7 – 779[a]	354350- 1223030
Dispensary	26	1800 – 2390	0.67 – 50[b]	1210 – 119500
Private clinic	11	1010	1.7 - 59.3[c]	1720 – 59590
Pharmacy	19	1750	1.6 - 22.3[d]	2970 – 38500
None	27	2480	0	0
Total	100	9200		360250 – 1440620

[a] Based on the survey of hospitals throughout Lebanon
[b] Based on the survey of dispensaries in the study area
[c] Based on the household social survey
[d] Based on interviews with pharmacists

As for the indirect cost of illness, which corresponds to lost productivity, or the opportunity cost of days missed from work due to sickness, it was estimated at 0.064 million USD. Accordingly, the total COI for the year 2009 associated with poor drinking water quality within the study area ranged between 0.42 and 1.50 MUS$/year.

Cost-of-Illness studies do not account for pain and suffering or the value of lost leisure time. Measuring the burden of water-related illnesses, more specifically diarrhea, through the adoption of the DALY approach can compensate for such a burden. Following the methodology detailed in Table 3.6, the total number of DALYs lost because of pain and discomfort resulting from diarrhea is estimated at 10.1 years and the estimated cost of years lost due to disability caused by diarrhea is 18,210 USD.

Based on these estimations, the yearly total cost of morbidity resulting from diarrhea ranged between 0.44 and 1.52 million USD (Table 4.13), which constitutes 1.93 to 6.65 percent of the total income in the study area for the year 2009. Note that the average income for the study area was used in the estimations instead of the national GDP, since it was considered to better reflect the poverty level there.

Table 4.13 Summary of estimated damage cost from morbidity associated with inadequate water, sanitation and hygiene (base year 2009).

Parameter	*Value*	*Percent of total area income*
Number of cases considered	8 610-9 200	-
Cost of illness	0.42-1.50 million USD	1.85-6.57 %
Cost of years lost due to disability	0.018 million USD	0.08 %
Total morbidity cost	**0.44-1.52 million USD**	**1.93-6.65 %**

4.3.2 Premature mortality valuation

Regarding child mortality associated with diarrhea, and based on data from the Ministry of Public Health (2001), a CBS/UNICEF report (2001), and estimates reported by the World Bank (2004), it is estimated that about 260 children die (10 percent of all child deaths) every year in the country from diarrhea diseases associated with inadequate potable water, sanitation and hygiene, which would result in an average of 6 child deaths per 100,000. The population in the study area is estimated at around 27,800 which corresponds to 2 child deaths associated with sub-standard water quality, sanitation and hygiene. Another reported valuation by the United Nations Development Program (UNDP, 1995) estimated that in 1990 each child under five is exposed, on average, to 3.5 incidents of diarrhea each year, causing the death of 750 children per year. This would correspond to 17 child deaths per 100,000 or to 5 cases in the study area. Note that the estimated mortality rates are considered as an underestimation since the study area is one of the poorest in the country and is expected to have a child mortality rate that is higher than the national average child mortality rate.

According to the Global Burden of Disease approach (Murray and Lopez, 1996), the WHO (2004b) estimated that the death of a child under five represents the loss of 33

DALYs. Using the human capital approach (HCA), if one year of a person's life is lost, society loses, at the very least, the contribution of this person to production, approximated by the average monthly income per capita in the study area for the year 2009, for income during the ages of 18 to 65 years. Thus, the loss of DALYs due to children mortality ranges between 0.12 and 0.30 million USD.

4.3.3 The Averted Behavior Approach

This approach valuates the costs incurred due to behavioral changes adopted in response to environmental damages, which is water pollution in this case. The main aversive behavior noted in the study area involved the purchase of bottled water as a 'clean', alternative water source. According to the social survey, around 26 percent of the households purchase bottled water as the exclusive source of drinking water, whereas 70 percent of the households reported resorting to bottled water either during sickness or whenever water quality is perceived as polluted. The average rate of bottled water consumption for the whole of the study area was also estimated from the social survey at around 0.31 L/capita/day. Given that the cost of bottled water in the study area ranges between 0.07 and 0.67 USD/Liter, depending on the brand and the volume of the containers, the annual cost of purchasing bottled water by the local population is estimated to range between 0.22 and 2.10 Million USD. Note that the health benefits incurred from drinking bottled water were not accounted for, since bottled water in the study area is not regulated and was found to be polluted on several occasions.

In total, the socio-economic burden incurred by the population in the study area due to morbidity and premature mortality resulting from water-related diarrhea, was estimated to range between 0.78 and 3.91 million USD for the year 2009, thus constituting 3.4 to 17.0 percent of the total annual income in the project area (Table 4.14).

Table 4.14 Summary of estimated damage cost from morbidity and mortality associated with inadequate water and wastewater management (base year 2009)

Parameter	*Cost (Million $)*	*Percent of pilot area annual income (%)*
Morbidity	**0.66-3.62**	**1.93-6.65**
Cost of Illness	0.42-1.50	1.85-6.57
Cost of DALYs lost	0.018	0.08
Mortality		
Human Capital Approach	0.12-0.30	0.52-1.3
Aversive behavior	0.22-2.10	0.96-9.14
Total	**0.78-3.90**	**3.4-17.01**

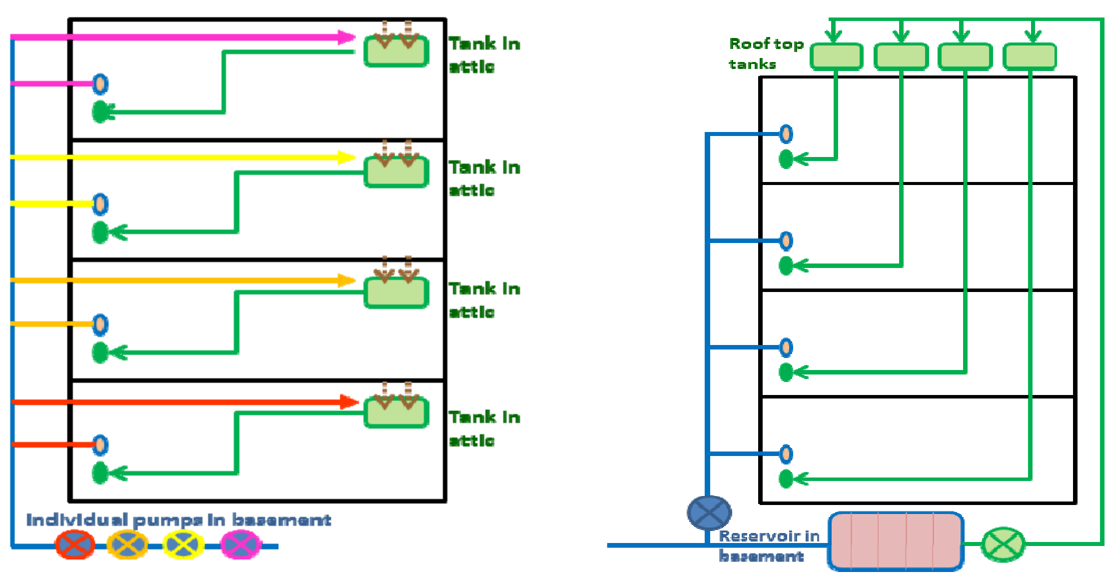
4.3.4 Concluding remarks

Sub-standard water quality, sanitation and hygiene are associated with an elevated incidence of diarrhea. In the study area, it was estimated at 33.1 percent for the year 2009 with around 32 percent of the cases impacting children 5 years of age or less. This incidence rate is more than six fold the national annual incidence of diarrhea of 6 percent (IPSOS 2004), but is comparable with heavily populated poor urban areas in China and India, where waterborne diarrheal incidence rates were estimated at around 35 and 57 percent, respectively (World Bank 2007). Increased morbidity and premature mortality impose a socio-economic burden on the local population constituting 3.4 to 17.1 percent of the total annual income in the area, in addition to the water and sewage bills that are being paid to the Water Establishment and the Municipality. The average water and sanitation charges worldwide as percentage of net disposable income range between 0.2 and 1.4 percent, and increase to 0.8 and 10.3 percent when considering the lowest decile of the population (OECD 2009). Hence, considerable economic benefits are expected from improving the water quality and sanitation systems in Tebbaneh, which appear to be comparable to, if not higher than water and sanitation charges incurred by the poor worldwide, and can be considered in a Cost Benefit Analysis (CBA) of potential mitigation alternatives.

4.4 Pilot intervention definition

Based on the outcome of the field surveys in the An-Nasr region of Jordan and the Tebbaneh region in Lebanon, and the comparative and statistical analyses, pilot interventions for improvement of environmental and health conditions in the Tebbaneh study area were defined in close coordination with the community and the municipality as described below.

Consistent with the results of the comparative assessment between An Nasr region of Jordan and the Tebbaneh region in Lebanon, it was evident that pilot interventions need to target water supply in Tebbaneh, rather than wastewater disposal, whereby a new sewage network was already in place. Furthermore, the deterioration of water quality with the households in Tebbaneh highlighted the need to focus on water piping and storage inside the households/buildings, rather than the public water network. Safe water storage in the household is an important component to prevent contamination and maintain adequate water quality (WHO 2013). It was believed that the high incidence rate of diarrhea in Tebbaneh as compared to that reported in Irbid was likely to be associated with the uncommon aspects of the water supply system observed in Tebbaneh, including the absence of storage reservoirs in the building basement, the presence of individual water pumps installed in the basement and the old storage tanks located in attics. In Irbid, incoming water in a building was stored in a common, sometimes compartmentalized reservoir, before being pumped to roof-top tanks (Fig. 4.4). The negative pressure created by the individual water pumps as well as the use of attic water storage tanks increase the risk of water pollution in Tebbaneh. Accordingly, the first proposed intervention targeted the water supply system at the building level and involved collecting the incoming water for the whole building in a common reservoir at ground level. Water can then be pumped to roof-top into individual storage tanks (Fig. 4.12).



a) Existing condition

b) First proposed intervention (commonly encountered in Irbid)

Fig. 4.12. Existing water supply conditions in Tebbaneh and the first proposed intervention

The initial selection of the buildings where the proposed intervention may be implemented was done based on the results of the statistical analysis described in Section 4.1.6, whereby tanks in attics were statistically significantly associated with elevated levels of fecal and total coliform. Hence, buildings exhibiting diarrhea cases, elevated total coliforms, and storage tanks in the attic were short-listed (10 buildings). Since no association was found between wastewater problems as a whole and diarrhea cases, this variable was not included in the selection process.

A meeting was then held at the Tripoli Municipality with representatives from the municipality and the local NGOs who were cooperating with the AUB team, including Women's Work Organization (جمعية العمل النسوي), *With You* Charitable Organization (جمعية معكم الخيرية الاجتماعية), and Women's Group Charitable Organization (جمعية اللقاء النسائي الخيري). During this meeting, the results of the social surveys and comparative assessment were presented and the proposed type of pilot intervention was discussed. The participants communicated their interest in the survey results and their willingness to assist in the implementation of the pilot intervention.

Following the meeting with the local NGOs, the buildings were inspected in the field by the AUB team and NGO representatives to explore the possibility of implementing the proposed intervention. Physical constraints such as the number of floors per building, the presence of space in the basement for the water reservoir, and social acceptability were naturally taken into consideration in the selection process. Appendix 7 presents a summary of the characteristics of the inspected buildings as well as photos taken of these buildings during the inspection. Two buildings were found to meet the above mentioned selection criteria, particularly in terms of space availability: building TJ0002 and building TB0539.

Building TB0539 turned out to be located in Jabal Mohsen, although geographically it appears to be part of Tebbaneh. Hence, detailed field exploration for implementing the pilot project in building TJ0002 was initiated. The selected building has a free space of around 4x4m^2 at ground level as well as a basement. The ground level space was filled with solid waste and the basement was full of water leaking from deteriorated pipelines. A meeting was held with the residents of the building and the proposed pilot project was presented. While the residents expressed great interest and consent to the proposed project, two constraints surfaced out during the discussions and field inspections:

1. The building's system is practically connected to an adjoining building increasing the total number of apartments to be rehabilitated

2. The building is owned by someone who recently passed away. His inheritance consisted of seven individuals who may have different plans about the building

The AUB team contacted the new owners of the building to seek their permission before proceeding with the implementation of pilot project. However, the building owners did not allow the installation of water storage tanks in basements.

Thus, to avoid building and household ownership constraints, including limited space in old building basements and the need to obtain the consent of the building owner or co-owners who usually do not live in the building and have no incentive to improve it, which were expected to be a common issue in Tebbaneh, it was decided to shift the focus of the interventions to the household level, rather than the building level. The aim was to implement interventions that required the approval of tenants only and that contributed to the elimination of pollution sources and the improvement of the quality of water at the point of use within the households. Intervention alternatives included (Fig. 4.13): (1) the replacement of old tanks in the attic with new tanks to be placed on roof-tops (with associated pumps, piping system, and disconnection of storage tanks located in attics), (2) the installation of new water piping systems, starting from the pump at the basement, to the roof top tank and to all taps within the household, and (3) the installation of a new wastewater plumbing system. Note that while chlorination is reportedly a cost effective measure (Clasen and Haller 2008; Hunter *et al.* 2010), it was not considered because of safety concerns related to lack of community knowhow and commitment to proper application in terms of dosage, detention time and flushing. Furthermore, pipe cleaning for the removal of soft deposits and biofilms was not considered due to its elevated costs, intricacy, and due to evidence that after pipe cleaning, new deposits developed rapidly inside the pipeline (Lehtola *et al.* 2004).

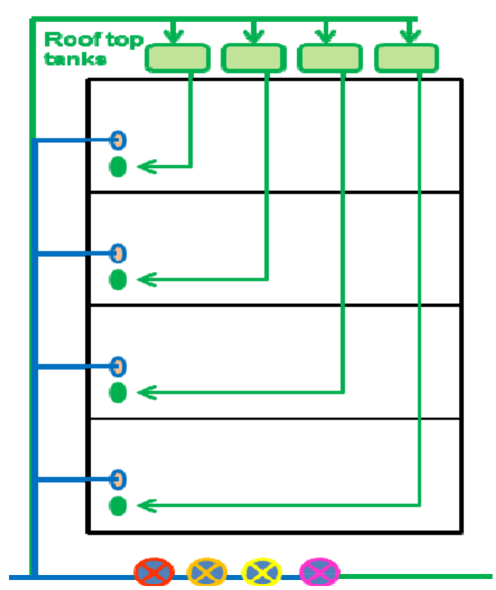


Fig. 4.13. The second proposed intervention

4.5 Social Cost-Benefit Analysis

A social cost-benefit analysis (CBA) for the interventions defined above was conducted with the objective of selecting pilot projects on the short run, and assisting decision-makers and planners in justifying the allocation of investment funds for much needed infrastructure interventions and proper service provision in Tebbaneh in the future. The capital and recurrent costs of five alternative options for intervention implementation were examined (Table 4.15). It was assumed that 20 % of the households in Tebbaneh are in relatively good condition, and will therefore be excluded from all proposed interventions.

Table 4.15. Alternative interventions with corresponding costs (2009 base year)

Alternative	Description	Percent of households	Unit Capital Cost ($/ Household)	Total Capital Cost (M $)	Annual Recurrent Cost (M $)
I	*New plastic rooftop water storage tank* in 50 to 80 percent of households, considering that around 50 percent of the households in the pilot area still have tanks in the attic which need replacement, and assuming that 60 percent of the existing roof top tanks are old, unmaintained and require replacement.	50-80	500 – 1,000	1.2 – 3.9	0.005 – 0.02
II	The installation of a *new water piping system* in 80 percent of the households within the pilot area to eliminate the risk of wastewater infiltration into the water pipes and to protect the supplied water from recontamination.	80	500 – 1,000	1.9 – 3.9	0.008 – 0.02
III	The installation of a *new wastewater plumbing system* in 80 percent of the households within the pilot area to eliminate the problems of leakages, clogging, and broken pipes and the associated risk of wastewater infiltration into the water piping system or accumulation in basements.	80	2,000 – 4,000	7.8 – 15.6	0.03 – 0.06
IV	The implementation of both *Alternatives 1 and 2*, thus replacing the whole water piping system along with the storage tanks in 50 to 80 percent of the households.	50-80	1,000 – 2,000	3.1 – 7.8	0.01 – 0.03
V	The implementation of *Alternatives 1, 2 and 3*, thus replacing the attic water storage tanks and both the water piping and wastewater plumbing systems in 50 to 80 percent of the households.	50-80	3,000 – 6,000	10.9 – 23.4	0.04 – 0.09

As for the benefits gained from such interventions, they were estimated based on the socio-economic burden incurred by the population in Tebbaneh due to morbidity and mortality resulting from water-related diarrhea (Refer to Section 3.3.3). These costs were translated into potential benefits associated with improved water supply and sanitation using the averted cost approach. Accordingly, considerable economic benefits were expected, ranging between 0.2 and 2.8 million USD per year, which constitute 0.85-12.25 percent of the area annual income.

Table 4.16. Estimated incurred and averted damage costs associated with inadequate water supply and sanitation in the Tebbaneh area

Impact	*Damage cost of water pollution and inadequate sanitation (M $)*	*Economic benefit from improved water supply and sanitation*		
		Percent reduction in cases (%)	*Benefit (M $)*	*Percent of pilot area annual income (%)*
Morbidity	**0.66-3.62**	**6-39**[a]		
Cost of Illness	0.42-1.50		0.02- 0.6	0.11-2.55
Cost of DALYs lost	0.018		0.001 - 0.007	0.005-0.03
Mortality		17-30[b]		
Human Capital Approach	0.12-0.30[c]		0.06 - 0.1	0.26-0.52
Aversive behavior	0.22-2.10	50-100[c]	0.1-2.1	0.48-9.14
Total	**0.78-3.90**	**-**	**0.2 – 2.8**	**0.85 – 12.25**

[a] Reduction in water related child mortality by 17 to 30 percent (Cairncross *et al.* 2010; Esrey *et al.*, 1991)
[b] Reduction in water-related morbidity cases by 6 to 39 percent (Clasen *et al.* 2007; Esrey *et al.*, 1991; Fewtrell *et al.* 2005)
[c] Assumption

The results of the social CBA, presented in Table 4.17, indicated that Alternatives I (roof top tanks) and II (water piping) are the most economically viable. Since the benefits were considered to be uniform across the interventions, the alternatives with the least capital cost are expected to be the most economically attractive. Nevertheless, the social CBA sheds light on the return on investment of the various scenarios to better inform decision-makers and investors and assist them in selecting the most suitable scenarios, and not necessarily the most economically feasible.

Table 4.17. Social CBA results

Scenarios[1]	*Parameters*	*Alternatives*				
		I (Roof top tanks)	*II (Water piping)*	*III (Wastewater plumbing)*	*IV (Roof top tanks & water piping)*	*V (Roof top tanks, water piping, & wastewater plumbing)*
(a) C_{Min} vs. B_{Min}	B/C ratio (ROI in yrs)	0.9 (14)	0.6 (>25)	0.1 (>25)	0.3 (>25)	0.1 (>25)
(b) C_{Min} vs. B_{Ave}	B/C ratio (ROI in yrs)	6.6 (1)	4.2 (2)	1.0 (11)	2.4 (4)	0.7 (>25)
(c) C_{Min} vs. B_{Max}	B/C ratio (ROI in yrs)	12.4 (1)	7.8 (1)	1.8 (4)	4.4 (2)	1.2 (7)
(d) C_{Max} vs. B_{Min}	B/C ratio (ROI in yrs)	0.3 (>25)	0.3 (>25)	0.1 (>25)	0.1 (>25)	0.0 (>25)
(e) C_{Max} vs. B_{Ave}	B/C ratio (ROI in yrs)	2.0 (4)	2.0 (4)	0.5 (>25)	1.0 (11)	0.3 (>25)
(f) C_{Max} vs. B_{Max}	B/C ratio (ROI in yrs)	3.8 (2)	3.8 (2)	0.9 (11)	1.8 (5)	0.6 (>25)

[1] B = Benefits; C = Costs; Min = Minimum; Ave = Average; Max = Maximum

For Alternatives I, II and IV, the B/C ratio was greater than 1 for all scenarios except when minimum benefits were considered (Scenarios (a) and (c)). As for Alternative III (Wastewater plumbing), it exhibited a B/C ratio greater than 1 whenever C_{Min} was coupled with either B_{Ave} or B_{Max} (Scenarios (b), (c)). Overall, the benefits for every 1 $ invested ranged between 1.0 and 12.4 $ after a 10 year period, considering viable scenarios. The highest B/C ratios were obtained for scenarios that compare C_{Min} to B_{Ave} and B_{Max} (Scenarios (b) and (c)), reaching 12.4 for Alternative 1 (roof top tanks) and 7.8 for Alternative 2 (water piping). This is close to ranges of benefits reported in the literature of 5 to 46 $ (Hunter *et al.* 2010), 5 to 12 $ (Hutton *et al.* 2007; Cameron *et* *al.* 2011b), and 5 to 28 $ (Hutton and Haller 2004). The return on investment for alternatives I (roof top tanks) and II (water piping system) ranged between 1 and 3 years for all scenarios except when minimum benefits are considered, as compared with 4 to >25 years for the remaining alternatives. Implementing both alternatives simultaneously, which constitutes Alternative IV, is also economically feasible for all scenarios (except those involving minimum benefits), but the corresponding B/C ratio is lower and the return on investment is longer. Yet, this alternative exhibited better economic indicators than Alternative III (installing a new wastewater plumbing system) for all scenarios. While Alternative V, combining alternatives I, II, and III may be desired for the sake of completeness, it is least preferred in a CBA context, being economically viable only when maximum benefits are coupled with minimum costs (Scenario (c)). Hence, installing roof top tanks and new water piping appears adequate under a CBA analysis. In addition to their advantage in terms of CBA indicators, they are relatively of low cost and can be implemented by household tenants with minimal logistics. In most cases, except when assuming minimal benefits, water improvement interventions are cost beneficial and effective (Edwards 2011).

4.6 Pilot intervention implementation and monitoring

Finally, based on stakeholder consultations, the results of the social CBA, and time and resource constraints, Alternative 1, the replacement of deteriorated concrete or metallic attic and rooftop water storage tanks with plastic rooftop tanks was selected as the most suitable pilot intervention. It was implemented in 29 households located within 20 buildings where diarrhea cases were reported during the social surveys in 2009 and had exhibited bacteriological pollution in water samples collected from their storage tanks in 2009 and 2010. More than half of the buildings were located in Zone 2, where households appeared to be at a higher risk of reporting diarrhea according to the statistical modeling (Section 4.2). The pilot intervention was implemented over 8 days during February 2010 with an average of 4 houses per day. It consisted of disconnecting all existing taps in-house from the old water reservoir (on attic, rooftop or in house), and reconnecting them to the new plastic water tank on the rooftop. Fig. 4.14 illustrates the distribution of the buildings where the interventions were implemented, and Table 4.18 shows photos from selected interventions. Details of each pilot intervention with corresponding photographic documentation are included in (Appendix 8).

Fig. 4.14. Distribution of buildings in Tebbaneh with pilot intervention

Table 4.18. Illustrations from the pilot intervention

Building ID	*Old tank replaced*	*New tank*
TJ 1145		
TB 0089		
TJ 0002 – Flr 1		
TB 0029		
TJ 0002 – Flr 2		
TJ 0113 – Flr 1		
TJ 0113 – Flr 3		

Post intervention and during monitoring, some problems arose and were observed during the sampling period to potentially interfere with the success of the pilot intervention. Accordingly, urgent corrective actions were deemed necessary, including:

- Water pumps were needed in some household where there were no pumps initially, or where the existing pump is no longer suitable for pumping water to the newly installed tank on the rooftop.
- Locks were needed to protect the tanks from being opened by roof visitors, especially during summer, where many would open the tank and put their hands inside to retrieve some water for personal uses.

4.6.1 Water quality monitoring

Following the implementation of the pilot intervention, the water quality monitoring program was continued to assess the level of improvement in water quality in the households under study. The analysis of the water quality monitoring results was complex, with the data showing no clear spatial or temporal trends due to the various pollution sources and incidents, as discussed below. Appendix 9 presents the detailed results of the post-intervention water quality monitoring program.

4.6.1.1 Free residual chlorine

As mentioned earlier, the free residual chlorine levels were not considered as primary indicators of the interventions' performance, but rather as guides to water quality at the sampling time. Table 4.19 shows the percentage of times the analyzed samples from a particular household exhibited free residual chlorine levels within the WHO drinking water quality standard (0.2-0.5 mg/L Cl_2). The results revealed that, overall, free residual chlorine levels in the collected samples were within the acceptable range in 57 percent of the sampling episodes from the network water, in 55 percent of the sampling episodes from the newly installed tank directly, and in 25 percent of the sampling episodes from the tap connected to the tank. The relatively low levels of residual chlorine in the network water highlight the prevailing risk of water recontamination within the network before reaching the buildings/households. This contamination could be from backflow (e.g. intrusion from the environment or backsiphonage from cross-connections) into pipe networks when supply is off or during low-pressure events when the supply is on, resuspension or scouring of particulate matter harboring bacteria from pipe walls, or release from biofilms (Kumpel and Nelson 2013; Lehtola *et al.* 2004; Karim *et al.* 2003). Lower levels of free residual chlorine are expected in the tank and the tank tap, (1) due to the instability of chlorine as a molecule, particularly in warm climates and following mixing (APHA/AWWA 2012) and (2) due to possible further water recontamination at the building/ household level.

Table 4.19. Percent of sampling episodes where residual chlorine was within standard

Household ID		*Network Tap*		*Tank*		*Tank Tap*	
		N	*%*	*N*	*%*	*N*	*%*
1	TJ1154-1	7	64	5	42	2	22
2	TJ1154-2	5	63	7	88	1	25
3	TB0110	6	86	6	67	1	25
4	TJ1128	2	33	8	62	4	57
5	TJ1158	5	42	5	2	0	0
6	TB0070	6	46	5	36	0	0
7	TB0113-1	7	64	7	54	2	22
8	TB0113-2	2	33	5	56	1	17
9	TB0113-3	4	50	7	54	1	13
10	TB0029	7	58	2	29	0	-
11	TB0118	3	60	3	43	0	-
12	TB0115	5	63	6	67	0	0
13	TB0119	4	67	4	50	1	33
14	TB0034	8	73	5	38	0	-
15	TA0089	6	55	11	85	7	78
16	TK0437	6	46	5	38	1	13
17	TK0408-2	5	45	6	50	1	11

Table 4.19. Percent of sampling episodes where residual chlorine was within standard *(cont'd)*

Household ID		*Network Tap*		*Tank*		*Tank Tap*	
		N	*%*	*N*	*%*	*N*	*%*
18	TK0408-3	5	42	4	33	2	25
19	TJ0002-1	9	75	8	62	1	14
20	TJ0002-2	5	50	7	58	2	25
21	TJ0002-3	7	70	6	46	1	13
22	TJ0002'	4	50	6	60	1	17
23	TJ0104-1A	8	62	9	82	2	25
24	TJ0104-1B	5	45	8	73	5	63
25	TJ0104-2A	8	73	7	58	4	50
26	TJ0104-2B	7	64	9	75	4	67
27	TJ0103	5	50	6	55	1	20
28	TJ1107	7	88	5	50	1	17
29	TJ1236	4	40	6	43	1	14
Average			**57**		**55**		**25**

4.6.1.2 Microbiological quality

The first analytical method for microbial water quality consisted of computing the percent of sampling episodes where the tap water flowing from the tank to the tap inside the house (referred to as Tank Tap) exhibited lower TC and lower FC levels than those registered before implementing the intervention (Table 4.20). Note that the results are limited to 21 households, since no pre-intervention data were available for 8 households.

The results revealed that on average, in 53 and 92 percent of all the sampling episodes, the levels of TC and FC, respectively, at the tap connected to the tank, decreased after replacing the attic water tanks with rooftop plastic tanks. Only one household showed 100 percent improvement in both TC and FC concentrations throughout the whole sampling period. The significantly higher levels of improvement in FC levels, as compared to TC levels, may be attributed to the fact that before the intervention, fewer households had exhibited FC counts. Thus, the households that had no FC contamination and still maintained this quality were considered to show 100 percent improvement. Nevertheless, the improvement in FC levels endorses the hypothesis that many attic tanks were exposed to wastewater leakages from overlying worn-out pipes, which was improved by the intervention.

Table 4.20 Percent episodes with improved TC and FC concentrations in the tank tap relative to the pre-intervention results

Household ID		*TC*		*FC*	
		N	*%*	*N*	*%*
1	TJ1154-1	8	67	12	100
2	TJ1154-2	4	50	8	100
3	TB0110	8	89	9	100
4	TJ1128	11	85	13	100
5	TJ1158	9	75	12	100
6	TB0070	12	86	14	100
7	TB0113-1	0	0	12	92
9	TB0113-3	9	69	10	77
10	TB0029	5	62	8	100
12	TB0115	6	67	8	89
13	TB0119	0	0	9	100
14	TB0034	0	0	11	85
15	TA0089	6	46	9	69
16	TK0437	14	100	14	100
17	TK0408-2	3	23	12	92
18	TK0408-3	5	42	11	92
20	TJ0002-2	7	55	10	83
26	TJ0104-2B	10	77	11	85
27	TJ0103	7	58	10	83
28	TJ1107	6	60	9	90
29	TJ1236	0	0	13	93
Average			**53**		**92**

The replacement of attic tanks with rooftop tanks had a lesser impact on the risk of TC contamination, which can be attributed to either water pollution at the source, and/or recontamination in the network, outside and/or within the household/building. Potential pollution of incoming water will therefore mask the true impact of the intervention on tap water flowing from the tank. This called for further investigations that account for the quality of the incoming network water and that assesses compliance with drinking water quality standards.

Accordingly, the second analytical method assumed that each sampling incident is considered an improvement only if it yields water with microbiological quality that complies with drinking water standards; i.e. 0 CFU/100 mL for TC and FC (WHO 2006; USEPA 2012). Water quality was examined at three sampling points within the households, namely (1) the network tap connected directly to the incoming network pipe, usually used for drinking and cooking, (2) the tank water stored at the roof top, and (3) the tank tap connected to the storage tank and usually used for household chores and hygiene purposes (Table 4.21).

Table 4.21. Percent of incidents where TC and FC complied with drinking water quality standards

Household ID		*TC*						*FC*					
		Network Tap		*Tank*		*Tank Tap*		*Network Tap*		*Tank*		*Tank Tap*	
		N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
1	TJ1154-1	6	55	6	67	5	42	9	82	8	89	12	100
2	TJ1154-2	5	63	2	50	4	50	7	88	4	100	8	100
3	TB0110	7	100	4	100	4	40	7	100	4	100	9	100
4	TJ1128	1	17	3	43	10	77	4	80	6	86	11	85
5	TJ1158	8	67	3	50	8	67	12	100	6	100	12	100
6	TB0070	6	46	6	67	4	29	13	100	9	100	14	100
7	TB0113-1	5	45	4	44	0	0	9	82	9	100	12	92
8	TB0113-2	4	67	0	0	1	11	5	83	5	83	7	78
9	TB0113-3	4	50	3	38	2	15	6	75	8	100	10	77
10	TB0029	3	25	0	-	4	50	8	73	0	-	8	100
11	TB0118	4	80	0	-	4	57	5	100	0	-	7	100
12	TB0115	7	88	1	25	5	56	8	100	4	100	8	89
13	TB0119	5	71	1	33	2	22	7	100	3	100	9	100
14	TB0034	9	82	1	100	2	15	11	100	1	100	11	85
15	TA0089	5	45	4	44	4	31	10	100	9	100	9	69
16	TK0437	11	79	7	88	8	57	13	100	9	100	14	100
17	TK0408-2	5	42	3	33	3	23	11	100	8	100	12	92

Table 4.21. Percent of incidents where TC and FC complied with drinking water quality standards *(cont'd)*

Household ID		*TC*						*FC*					
		Network Tap		*Tank*		*Tank Tap*		*Network Tap*		*Tank*		*Tank Tap*	
		N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
18	TK0408-3	4	31	4	50	5	42	12	100	8	100	11	92
19	TJ0002-1	6	50	5	63	7	54	10	91	6	86	12	92
20	TJ0002-2	5	50	4	57	5	42	9	90	6	86	10	83
21	TJ0002-3	6	60	5	56	6	46	9	100	6	86	12	92
22	TJ0002'	2	25	3	50	1	10	8	100	4	80	9	90
23	TJ0104-1A	7	50	5	56	4	33	13	93	7	88	12	100
24	TJ0104-1B	5	42	4	44	3	25	11	92	8	100	10	83
25	TJ0104-2A	5	38	6	67	4	29	12	92	7	88	12	86
26	TJ0104-2B	7	54	3	43	5	36	12	92	5	83	11	85
27	TJ0103	8	73	3	60	4	33	10	91	5	83	10	83
28	TJ1107	6	75	4	67	4	40	8	100	4	80	9	90
29	TJ1236	9	90	5	71	9	57	10	100	4	83	13	93
Average		**-**	**57**	**-**	**54**	**-**	**38**	**-**	**93**	**--**	**93**	**-**	**91**

Based on Table 4.21, it is clear that the percent sampling episodes with compliant TC and FC concentrations varies between households and between the different sampling points and different sampling episodes within each household. While the initial analytical method revealed that 53 percent of the sampling episodes showed improved water quality in the tank tap water in terms of TC (Table 4.20), only 38 percent of the episodes exhibited water quality that complied with drinking water quality standards. Hence, even if water quality had improved as compared to pre-intervention, in many instances, TC levels did not comply with drinking water standards. For FC levels, the difference between the first method (92 percent improvement) and the second method (91 percent improvement) was negligible, which implies that when there was an improvement in FC levels, the levels were zero, thus compliant with drinking water quality standards.

Probing into the quality of the incoming network water, the results revealed that TC levels complied with drinking water quality standards only in 57 percent of the episodes. This percentage dropped further as water travelled from the network pump (57 percent) to the tank (54 percent) and finally to the tank tap (38%). This supports the hypothesis that the incoming water is either polluted within the street network or it gets polluted after it gets pumped into the building, with the risk of pollution increasing inside the building, and more specifically in the pipes connecting the tank to the tank tap. It is also consistent with the decreasing levels of free residual chlorine discussed above. Thus, despite the fact that during the initial needs assessment it was established that network water quality in Tebbaneh was of acceptable quality with few pollution incidences, the post-intervention water quality monitoring revealed recurrent pollution episodes that warranted consideration. This was consistent with studies reporting coliform contamination in “improved water supply” systems (Bain *et al.* 2014) and raising concerns regarding their safety. Following consultations with the North Lebanon Water Establishment as well as field observations, various possible sources of pollution were identified. It was found that during the summer, water from the Al-Mallouli well is used to supplement the dwindling water supply from the spring sources, namely Hab and Rashine. While water from the springs is treated by filtration and chlorination before distribution, water from the Al Mallouli Well is chlorinated as it is pumped into the network, not allowing for adequate contact time for effective disinfection. This resulted in the supply of polluted network water to various buildings being monitored. Another issue at the level of the network was water pollution noted immediately following power cutoffs, which occur on a daily basis, thus allowing for backflow, such as intrusion from the environment or back-siphonage from cross-connections into pipe networks (Karim *et al.* 2003). This also occurs during low-pressure events when the supply is on, which is exacerbated by the presence of the individual water pumps in building basements discussed earlier. Pollution in the incoming water to the building masked the potential improvement in water quality due to the implemented intervention.

The same trends apply for the FC levels, although the difference is negligible, decreasing from 93 percent in the network and tank, to 91 percent in the tap. The high level of improvement in FC levels supports the initial hypothesis that relocating attic tanks to roof top tanks reduces the risk of wastewater contamination from leaking wastewater pipes inside the building. However, the elevated and fluctuating TC levels all throughout the piping system still needs to be further investigated and rectified. One potential source is the soft deposits and biofilms accumulating throughout the years on the old pipelines. Soft pipeline deposits were found to be the key site for microbial growth in the distribution networks, containing high numbers of heterotrophic bacteria, actinomycetes, fungi and coliform bacteria (Zacheus *et al.* 2001). Another potential cause is the time spent in storage where it has been shown that storage for more than a day was associated with coliform growth (Kumpel and Nelson 2013)

One main limitation to this analysis in assessing the true impact of the interventions is the potentially confounding role of the incoming network water quality, which reaches the consumer in 43% of the sampling episodes with non-zero TC concentrations. Consequently, for a better understanding of the intervention's effect on water quality, a refined analysis was performed by eliminating all incidents where the network water quality was unacceptable through eliminating all the episodes where TC and FC levels in the network water were higher than 0 CFU/ 100 mL. The percentages of incidents where TC and FC concentrations were 0 CFU/100 ml were then computed and presented in Table 4.22. Note that here it is assumed that when network water from the tap is polluted, it implies that it is reaching the building with this pollution level. Yet, it could be that the network water is reaching the building with an acceptable quality and becoming polluted upon pumping from the basement to the network tap.

Table 4.22. Percent of incidences with improved microbiological water quality when network water is not polluted

Household ID		*TC*				*FC*			
		Tank		*Tank Tap*		*Tank*		*Tank Tap*	
		N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
1.	TJ1154-1	4	67	2	29	9	90	12	100
2.	TJ1154-2	1	33	3	60	5	100	8	100
3.	TB0110	4	100	4	44	4	100	9	100
4.	TJ1128	2	67	7	7	6	86	11	85
5.	TJ1158	2	50	7	88	6	100	12	100
6.	TB0070	2	67	3	43	9	100	14	100
7.	TB0113-1	2	40	0	0	11	100	12	92
8.	TB0113-2	0	0	1	14	5	83	7	78
9.	TB0113-3	2	33	1	11	10	100	11	85
10.	TB0029	0	-	1	33	2	100	9	100
11.	TB0118	0	-	4	67	0	-	7	100
12.	TB0115	1	25	5	63	4	100	8	89
13.	TB0119	1	50	2	29	3	100	9	100
14.	TB0034	1	100	2	17	1	100	11	85
15.	TA0089	4	57	4	57	9	100	9	69
16.	TK0437	6	86	7	70	9	100	14	100
17.	TK0408-2	2	33	3	50	8	100	12	92
18.	TK0408-3	2	50	2	50	8	100	11	92
19.	TJ0002-1	3	60	4	57	7	88	12	92
20.	TJ0002-2	4	80	3	50	7	100	11	92
21.	TJ0002-3	3	50	3	33	6	86	12	92
22.	TJ0002'	2	67	1	25	4	80	9	90
23.	TJ0104-1A	4	80	3	43	8	100	12	100
24.	TJ0104-1B	3	50	2	40	8	100	11	92
25.	TJ0104-2A	4	80	3	50	7	88	12	86
26.	TJ0104-2B	3	60	2	29	6	100	12	92
27.	TJ0103	3	75	4	44	6	100	11	92
28.	TJ1107	6	75	4	50	4	80	9	90
29.	TJ1236	5	71	7	54	5	83	13	93
Average			**59**		**44**		**95**		**92**

Fig. 4.15 illustrates the percent of episodes where sampled water showed compliance of measured TC and FC levels with drinking water quality standards, when considering all episodes, versus when episodes where incoming network water was polluted were omitted.

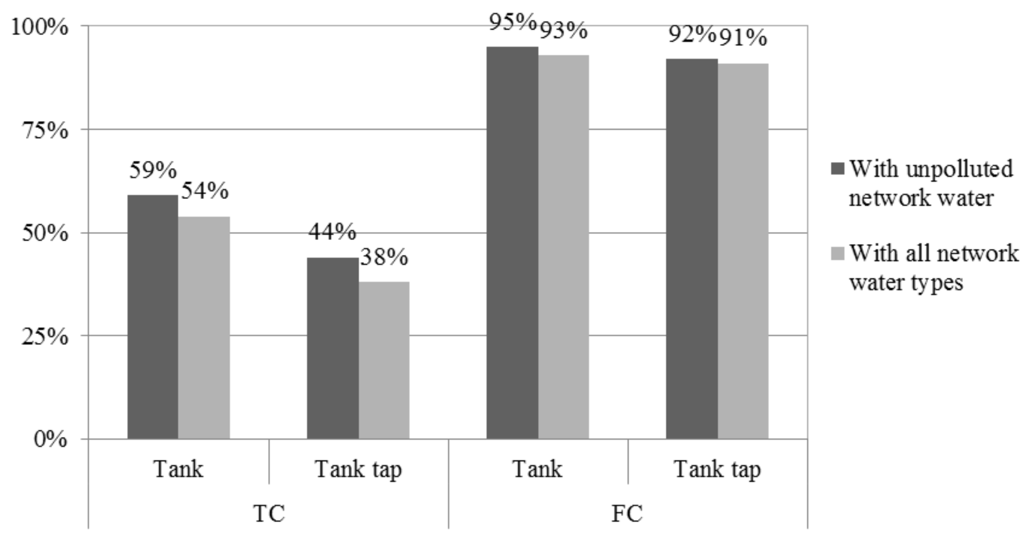
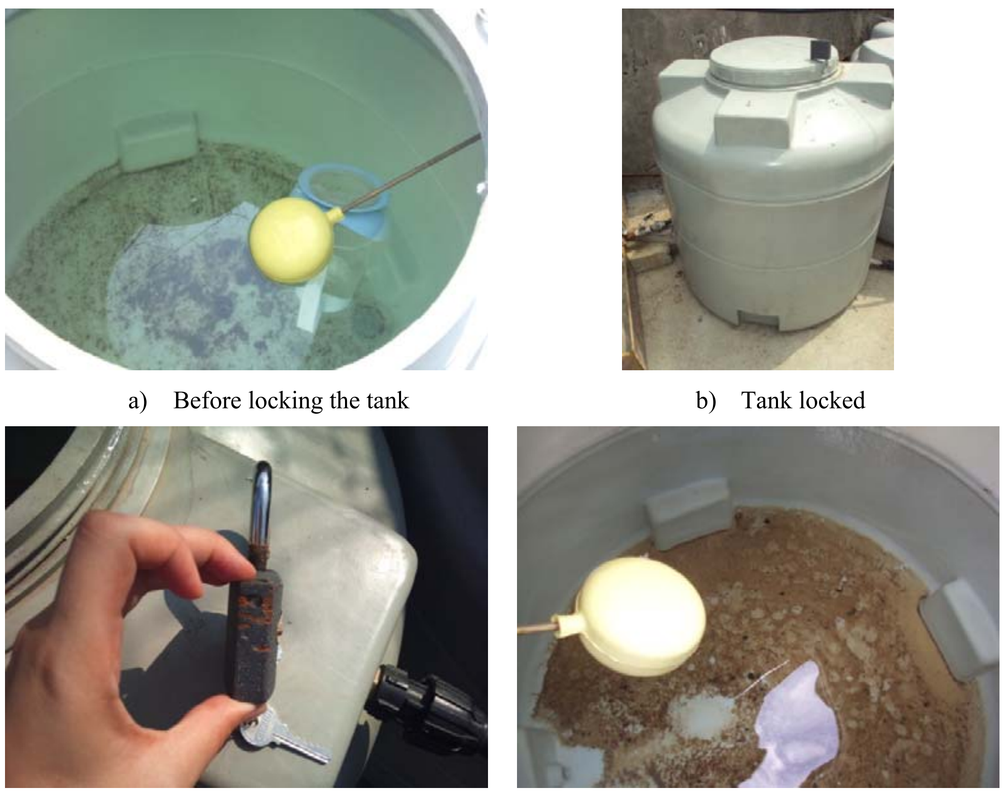


Fig. 4.15. Comparison of percent episodes where TC and FC levels complied with drinking water quality in the tank and tap connected to the tank with and without the effect of network water quality

The results showed that removing the confounding effect of polluted incoming network water led to a slight increase in the percent improvement of the implemented intervention. For TC, the percentage of times the sampled water complied with drinking water quality standards increased from 54 to 59 percent for tank water and from 38 to 44 percent for tank tap water. Similarly for FC, the percentage of times the sampled water complied with drinking water quality standards increased from 93 to 95 percent for tank water and from 91 to 92 percent for tank tap water. Yet, the persistent pollution in the tank and tank tap, despite the clean incoming water, indicate pollution sources within the buildings/households.

Looking in-depth into the impact of intervention implementation on individual households, a striking finding was the zero percent compliance of TC concentrations in the tank water of one of the households (TB0113-2) and in the tap water connected to the tank in another household (TB-0113-1). Upon investigating these issues, it was noted that residents spend the evenings on building roof tops, uncapping the newly installed storage tanks and discarding waste items inside. As such, to eliminate waste discarding into water tanks, locks were installed on most of them. Still, some of those locks were vandalized as shown in Fig. 4.16.



a) Before locking the tank

b) Tank locked

c) Lock broken

d) Tank water abused

Fig. 4.16 Installing locks and problems encountered

As for the absence of improvement in the tank tap water, it can be attributed to the old worn out pipes that convey water from the pump to the tap or tank or that connect the taps in the corresponding household to the rooftop tank. Pollution at the level of the building/household pipes maybe introduced from external sources by back-siphoning or from internal deposits or biofilms, similar to network pipes (Kumpel and Nelson 2013; Lehtola *et al.* 2004). Thus, in an attempt to eliminate pollution from corroded building pipes, an additional intervention was implemented, which included the installation of new water pipes in 4 households where attic tanks were replaced with roof top tanks (limited by the budget and dwellers' acceptance) (Fig. 4.17). This complementary intervention was in line with the CBA results and it consisted of replacing the old corroded water pipes with new ones in households that exhibited high levels of coliform bacteria. The households were selected based on the results of the water quality monitoring, whereby the water sample collected from the drinking tap was consistently found to be of better quality than the water sample taken from the tap connected to the tank. This was further confirmed by field inspection. Appendix 8 lists the locations of this intervention, along with illustrating photos.

Before

After intervention

Fig. 4.17.Replacement of old water pipes inside the household

Water quality was then monitored and the results were analyzed and presented in Table 4.23, with unacceptable incoming network water (i.e. where the TC concentration was greater than 0 CFU/mL) being eliminated.

Table 4.23. Percent episodes with improved TC and FC concentrations in 4 households after changing pipes with acceptable network water quality

Building ID	*Improvement in TC levels (%)*								*Improvement in FC levels (%)*							
	Tank				*Tank-Tap*				*Tank*				*Tank-Tap*			
	Before		*After*		*Before*		*After*		*Before*		*After*		*Before*		*After*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
TB0070	*1*	50	*1*	100	*2*	33	*1*	100	2	100	5	100	6	100	5	100
TJ0002-2	*3*	75	*1*	100	*3*	50	*1*	100	3	100	3	100	4	80	3	100
TJ0002-3	*1*	50	*2*	67	*1*	20	*2*	67	3	100	4	100	6	100	4	100
TJ0103	*1*	100	*2*	67	*2*	33	*2*	67	2	100	3	100	7	100	3	100
Average		69		84		34		84		100		100		97		100

According to Table 4.23, after changing water pipes inside the households, and in cases where incoming network water quality registered 0 CFU/mL for TC and 0 CFU/mL for FC, the percent episodes with acceptable water quality inside the tank and at the tap connected to the tank increased to reach 84% for TC at both sampling points, and 100% for FC at both sampling points. This highlights the contribution of renewed water pipes in eliminating the possibility of water recontamination.

More specifically, in two of the households, namely, TB0070 and TJ0002-2, the installation of new pipes following the replacement of attic tanks with roof top tanks, resulted in a 100 percent improvement in water quality at the point of use, when the incoming network water was clean. As for the results in the 2 households: TJ0002-3 and TJ0103 where slight improvement was noticed, further investigation is required in order to determine the persistent pollution source.

In summary, while improvement in water quality was noticeable at many locations where the initial intervention of replacing attic tanks with roof top tanks was implemented, the random variations in water quality monitoring results highlighted several other potential sources of pollution: within the drinking water network, within the building pipes, and leakages into the pipes within the building after the water leaves the storage tank and on its way to the tap outlet as illustrated below (Fig. 4.18). These sources added individually or jointly to water recontamination which made tracking pollution and identifying one corresponding solution a tedious task.

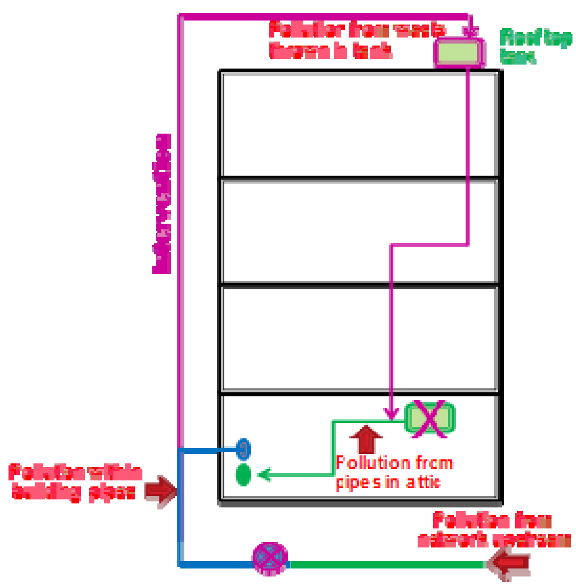


Fig. 4.18. Potential sources of pollution at the building level

The replacement of attic water tanks with rooftop plastic tanks did contribute to the water quality improvement but did not solve the problem completely. Replacing old and worn out water pipes along with the installation of roof top tanks were able to secure better results, when the incoming network water was also of acceptable quality. There still remain other sources of pollution, possibly related to hygiene practices and behavior that are worth investigating. These results emphasize the need for a holistic and comprehensive approach to water pollution in the Tebbaneh slum that brings together all stakeholders from the North Lebanon Water Authority, to the Tripoli Municipality, to the building owners and household tenants to define and implement an integrated intervention strategy, that targets the water sources, the supply network, the in-building water and wastewater plumbing, as well as consumer behaviors and hygiene practices, as described above.

4.6.2 Post Intervention Survey

The examination of water quality monitoring data after installing rooftop plastic tanks is one indicator of the overall performance of the improvement intervention. Other indicators included the incidence of diarrhea post-intervention and public perception of water quality following the improvements in the household water systems.

Regarding the incidence of diarrhea, the post-intervention survey results revealed a 53.5 percent decrease in the number of households reporting diarrhea incidence in the past three months, from 38.5 percent in the 2008 survey to 17.9 percent in the 2011 survey (Table 4.24). The difference was found to be statistically significant at $\alpha = 0.05$, with a p-value of 0.03, using Pearson's Chi Square Test. This is in line with the literature where studies have reported a reduction in water-related morbidity cases by 6 to 39 percent (Clasen *et al.* 2007; Esrey *et al.* 1991; Fewtrell *et al.* 2005) and a reduction in the risk of diarrhea by 25-85 percent, following point-of-use water disinfection, safe water storage and behavior change techniques in areas with different environmental and living conditions (CDC 2000; Garrett *et al.* 2008; Luby *et al.* 2004;

Lule *et al.* 2005; Quick *et al.* 1999, 2002; Semenza *et al.* 1998; WHO UNICEF JMP 2008). While the implemented interventions might have contributed to this reduction, further investigations and statistical analyses are needed to ascertain and quantify this contribution, since the incidence of diarrhea is determined by a multitude of factors and sources.

Table 4.24. Pre- and post- intervention survey results

Variables tested	*Before intervention*	*After intervention*	*Pearson's Chi Square (X^2)*	*p-value*
Occurrence of diarrhea in the past 3 months among household members	38.5%	17.9%	4.704	0.030
Satisfaction with network water quality during summer	34.8%	68%	12.101	0.002
Satisfaction with network water quality during winter	26.2%	75%	29.318	0.000
Network water quality rating			24.681	0.000
Good (No color, taste, odor, or residue)	21%	61%		
Medium (Some color, taste, odor, or residue)	47%	36%		
Bad (With color, taste, odor, or residue)	31%	3%		

The survey also revealed a significant improvement in the residents' satisfaction with the network water quality during both wet (p-value = 0.000) and dry seasons (p-value = 0.002), as well as in their rating of network water quality (p-value = 0.000), variables that are not directly affected by the implemented intervention (Table 4.24). This difference is interesting, since in fact, there was no serious improvement in the network water quality per se during the period between 2008 and 2011, as evident from the post-intervention water quality monitoring results, as well as from consultations with the NLWE (Sayadi 2011). In addition, the interventions affected only the tank tap water quality and not the incoming network water quality. Hence, these results first raise concern regarding bias in the residents' responses, since the interviewers were from the team involved in installing these interventions. Second, they mirror the general residents' gratitude in such a poor area with changes induced by any attempt for enhancement.

In addition, the questionnaire enquired in more detail about perceived improvement in stored water quality, post-intervention, particularly in terms of major physical indicators such as color, smell, taste and residues. The results revealed that among the 57 percent of the residents who perceived improvement, the majority justified it by the absence of color (46 percent), followed by absence of smell (36 percent), absence of taste (29 percent), and no residues (4 percent) (Fig. 4.19). Color and residues were most likely introduced by the highly corroded old metallic attic tanks and the residues accumulating in them throughout the years. The survey also unveiled that those who perceived improvement in water quality changed their tank water usages, with cooking becoming the most common new tank water use (in 53% of the surveyed population).

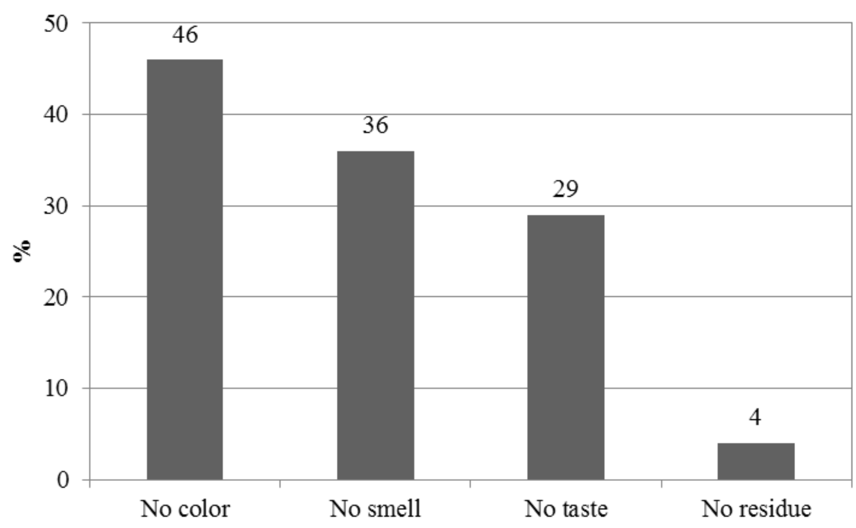


Fig. 4.19. Post-intervention survey response on reasons for perceived tank water quality improvement

In summary, while it is clear that various variables (diarrhea incidence, perception of water quality, etc.) have shown improvement in the post-intervention survey as compared to the pre-intervention survey, however, associating these changes directly to the actual interventions should be done with great caution, owing to the complexity of the interlinkages between diarrhea and its determinants.

CHAPTER 5

CLOSURE: TOWARDS SUSTAINABLE MANAGEMENT

Based on the community surveys and infrastructure mapping coupled with comparative analyses, statistical modeling and the pilot interventions monitoring and evaluation, the project's findings were summarized into a framework that will bring community contribution to urban planning, service provision and local policy making. This framework is intended as a standalone document that will serve the municipality and/or community organizations as a guide for current and future urban environmental planning specifically in the Tebbaneh region with potential extension to other similar urban areas. Accordingly, the Sustainable Urban Development Framework presented below, was developed to begin with a background section that provides a brief overview of the Tebbaneh slum and the completed study. It then highlights the main environmental problems and needs of the area, that were identified through the various surveys as well as through the close coordination with the stakeholders, followed by action plans that the municipality or other organizations can implement or seek funding for from the central government or donor agencies, to improve the existing situation and alleviate the burden on this poor urban slum. The Sustainable Urban Development Framework was translated into Arabic and presented to the Municipality of Tripoli.

5.1 Background

The Tebbaneh area, a disadvantaged urban slum located in the suburbs of the city of Tripoli, North Lebanon, is deemed amid the poorest and most deprived areas in the country. Back in the 1940's, Tebbaneh was known as the trade center between

Lebanon and Syria, whereby commercial activities, especially fruits and vegetables trade, were carried out. As a result, the Tebbaneh was referred to as “The Door of Gold”, and attracted merchants and rich families for work and residence. Buildings with ancient architectural aspects were constructed and are still testimony of a flourishing past, albeit witnessing severe degradation. Evidently, the situation in Tebbaneh has changed dramatically. The flooding of Abou Ali River in 1955 was the turning point that transformed Tebbaneh into a slum. Furthermore, the civil war (1975-1990), followed by the current unstable political situation contributed to the spread of chaos and deprivation in the area. Tebbaneh today is overcrowded, with a population density reaching 10 times that of any other urban area in the country. Its population is continuously growing within a non-organized urban fabric characterized by small narrow streets and old and deteriorating dwellings, especially in the region surrounding the vegetables market. Table 5.1 shows selected demographic and socio-economic characteristics of Tebbaneh.

Table 5.1. General Characteristics of Tebbaneh

Characteristic	*Magnitude*
Overall population (capita)	27,804
Overall area (m^2)	400,000
Population density (capita per Km^2)	69,510
Average family size (capita)	6
Average monthly income (USD)	130
Unemployment rate	12%

A research study funded by the International Development Research Center (IDRC) and implemented by the American University of Beirut (AUB) in coordination with the Municipality of Tripoli and local NGOs, defined priority water and sanitation needs in the region with corresponding social, economic, and cultural barriers contributing to environmental degradation that exacerbates poverty. Pilot interventions were developed and implemented with the participation of the community and formed the basis of a Sustainable Urban Development Framework, highlighting the needs for continuous improvement in Tebbaneh.

5.1.1 Problems and Needs

Several environmental problems were noted in the Tebbaneh region, including inadequate quality of water supply, incomplete wastewater infrastructure, excessive solid waste littering, and poor hygiene. At the urban level, a new wastewater network was recently installed in Tebbaneh with connections to most households. While the network has improved sanitation in the area, problems are still commonly encountered, mainly wastewater flooding on streets. Consultations with local NGOs indicated that the main factor hindering the adequate operation of the wastewater network was land ownership, whereby the Municipality at various locations was prevented from completing the connection to some buildings due to the presence of private lands and its inability to excavate in them. At the building level, the main problem encountered is deteriorated plumbing systems (leakages, clogging, broken pipes) and wastewater accumulation in building basements, thus creating foul odors and attracting insects and rodents that promote the spread of diseases.

Similarly, while a new water distribution network has been installed, it remains non-operational because associated appurtenances including water meters and cabinets were vandalized. Accordingly, old worn out and corroded pipes, situated below the new wastewater network continue to be used. The existing water network conveys water at relatively low pressure from three main sources, namely Hab Spring, Rasheen Spring, and Al Mallouli Well. While water from the springs is treated by filtration and chlorination before distribution, water from the Al Mallouli Well is chlorinated as it is pumped into the network, not allowing for adequate contact time for effective disinfection. Water quality monitoring in the Tebbaneh revealed that water supplied to the Tebbaneh area is of relatively acceptable quality, with few pollution incidences. However, this water gets contaminated within the deteriorated distribution network. The most evident instances of pollution are noted immediately following power cutoffs, which occur on a daily basis, when negative pressure in the network allows the seepage of wastewater into the corroded water pipes. Negative pressure is exacerbated by the presence of individual water pumps for every single household at building entrances to pump water to household storage tanks, located either in the attic (45% of tanks) or on roof tops. Most storage tanks are old, corroded, and not covered. Uncovered attic storage tanks, which are usually located below toilet plumbing systems of upper floors, and deteriorated water pipes within the building, are at an increased risk of water contamination from leaking wastewater pipes.

The quality of groundwater was generally found to be poor and unsafe for domestic usage, due to elevated levels of coliform, originating from wastewater contamination. Fortunately, reliance on groundwater is minimal. In addition, around 26 percent of Tebbaneh households supplement their network source with bottled water. Many residents mentioned buying bottled water when the network water seems turbid and when a member of the household is ill. However, water quality analysis of commonly consumed bottled water brands (unlicensed) in Tebbaneh revealed that 24 percent of the analyzed samples were polluted with Total Coliform and were not suitable for drinking.

Finally, poor hygiene at the household level and excessive solid waste littering at the building and slum level, exacerbate an already difficult situation. Lack of awareness and low education levels coupled with poverty, crowded households, and the young age of female household members, are at the core of a negligent and indifferent social behavior.

5.1.2 Sustainable Urban Management Framework

Sub-standard water quality, sanitation and hygiene in the Tebbaneh area were associated with an elevated annual incidence of diarrhea, estimated at 33.1 percent for the year 2009, amounting to a total of 9,197 cases, with around 32 percent of the cases impacting children 5 years of age or less with suspected two diarrhea-related child deaths per year. This incidence rate more than six fold the national annual incidence of diarrhea of 6 percent (IPSOS 2004), but is comparable with heavily populated poor urban areas in China and India, where waterborne diarrheal incidence rates were estimated at around 35 and 57 percent, respectively (World Bank 2007; Jadhav *et al.* 2011). Increased morbidity and mortality impose a socio-economic burden on the population in Tebbaneh, estimated to range between 2.93 and 14.79 million USD for the year 2009, thus constituting 1.3 to 6.5 percent of the GDP in the project area and emphasize the need to adopt a sustainable urban development framework with a clear action plan to improve the existing situation and alleviate the burden on an already impoverished urban slum. The framework encompasses social and physical interventions at the slum level and at the building/household level as outlined below. While the implementation of individual interventions is helpful, the realization of the framework in a holistic manner is expected to maximize its anticipated benefits.

5.1.2.1 At the Tebbaneh level

Water distribution through the old network should be discontinued as soon as possible. Missing appurtenances should be provided and reinstalled. The new water distribution network should be put into operation, whereby water would be supplied at adequate pressure, eliminating the need for individual pumps in building basements and minimizing the risk of wastewater contamination within the network. The quality of the supplied water needs to be monitored on a regular basis. These activities fall under the jurisdiction of the North Lebanon Water Establishment (NLWE) in coordination with the municipality.

In the case where the new water network cannot be discontinued, it is suggested to eliminate the individual household pumps and install a common compartmentalized water reservoir at the building basement to serve all households within the building. As such, the incoming water for the entire building will be collected in a common reservoir at ground level. Water can then be pumped to the roof-top into individual storage tanks. The installation of such a reservoir requires space at building basement, the consent of the building owner, and approval and proper management by the NLWE and the municipality.

The Al Mallouli Well that is used as a complementary water source for Tebbaneh must be appropriately managed. Well water must be properly treated before supply. This requires the installation of a disinfection tank where water is chlorinated before supply, to ensure adequate chlorine contact time. This activity falls under the jurisdiction of the NLWE.

The private wells scattered around Tebbaneh with no water quality monitoring must be closed, as they are contaminated and represent a serious threat to public health.

The NLWE must be able to provide network water to these households as an alternative. This activity should be undertaken in close coordination between the Municipality and the NLWE.

The vending of bottled water in the Tebbaneh area should be controlled by the Municipality of Tripoli and the Consumer Protection Directorate at the Ministry of Economy and Trade (MoET). The quality of bottled water brands that are not licensed by the Ministry of Public Health should be continuously monitored by the Municipality of Tripoli and the Consumer Protection Directorate and contaminated brands should be banned. A more radical alternative would be the banning of all unlicensed brands as long as an alternative clean source is made available at a reasonable cost.

5.1.2.2 At the building/household level

Besides the necessity for interventions at the slum level, which can reduce the risks of pollution at source and during distribution, other interventions are needed in order to minimize risks of water recontamination at the point of use, namely at the building and household levels. These interventions are outlined below by order of priority.

All water storage tanks located in attics should be disconnected and replaced by more hygienic plastic tanks installed on building roof tops. These roof top tanks need to be regularly cleaned and maintained, as well as tightly locked to ensure that the stored water remains protected from irresponsible users who frequent rooftops particularly during the summer. This intervention requires the consent of the household tenant only and may be easily implemented with minimal funding. Special attention should be given to the structural integrity of the buildings and whether the roof tops can accommodate the intended number and volume of water tanks.

A new water piping system needs to be installed in many households within Tebbaneh to eliminate the risk of wastewater infiltration into the water pipes and to protect the supplied water from recontamination. This intervention requires the consent of the household tenant only and may be easily implemented at a reasonable cost.

A new wastewater plumbing system also needs to be installed in many households within Tebbaneh to eliminate the problems of leakages, clogging, and broken pipes and the associated risk of wastewater infiltration into the water piping system or accumulation in basements. This intervention may require the consent of the household tenant and owner and may be implemented, with some short-term inconvenience to tenants, if funding is available.

The implementation of similar interventions at the various schools in the Tebbaneh slum also needs to be explored.

5.1.2.3 Awareness and education

Intensive and continuous awareness campaigns should be conducted year round to target primarily women and housewives in Tebbaneh, by teaching them basic principles of safe food handling practices, hygiene rituals at households, and sound water usage. Campaigns should focus on simple, practical, and inexpensive techniques that could be easily and sustainably applied by housewives. For instance, women can be shown the basic techniques of food storage, fruits and vegetables washing, domestic cleaning activities using detergents and disinfectants, as well as proper disposal of solid waste. Exclusive breastfeeding of babies to at least one year of age should also be promoted, to minimize the risk of diarrhea among young children. In addition, awareness campaigns should be conducted to sensitize Tebbaneh residents towards civic responsibilities and environmental liabilities such as respecting public property, keeping houses and neighborhoods clean, and informing responsible authorities whenever water or wastewater problems occur. There are several active NGOs in Tebbaneh, with many focusing on women issues that could undertake these campaigns in coordination with the Municipality.

For longer term impact interventions, the younger generation must be targeted through school education starting at the primary level. Topics related to personal hygiene, littering, and environmental protection should be at the core of the educational program. Such involvement at the school level constitutes the main hope for a future conscious generation with a sense of responsibility towards their community.

5.1.2.4 Management and policy approaches

The authority for managing water supply in Tebbaneh is the NLWE. It is responsible for water treatment and distribution in addition to planning and quality control. The municipality is responsible for managing and maintaining the wastewater network. Therefore, coordination between the two authorities is essential for proper planning and design of water and sanitation activities. A clear division of tasks and distribution of responsibilities are needed to ensure practicality of intervention and sustainability of works.

Many buildings in Tebbaneh are experiencing serious aging and deterioration and are mostly occupied by tenants. The problem of property ownership as well as illegal settlements need to be addressed through fair tenure regulations that keep rights reserved and allow more flexibility in the implementation of proposed interventions, while ensuring that the poor and disadvantaged are protected.

Table 5.2 presents a summary matrix of the Sustainable Urban Development Framework. This framework favors a hybrid approach that merges “bottom-up” and “top-down” styles for managing environmental problems in Tebbaneh. It sheds the light on the necessity to involve the public in decision-making and action through active community participation targeting the elaboration of a general platform for needed environmental improvements. Accordingly, local residents are to be engaged along with formal authorities in special committees in order to address and discuss current environmental problems and possible solutions, and to incorporate public needs and values into the planning process. When the dialogue between all stakeholders is adequately pursued, the proposed plan will be capable of integrating community, policy, and management, aiming at promoting the prosperity of people and their environment. It will defeat all bureaucratic and political boundaries by calling for management agreements and public engagement.

The priority level defined in Table 5.2 for the activities proposed within this framework was determined based on the need to minimize negative health impacts incurred within the community. Accordingly, four indicators were used to prioritize each activity, namely:

1. Urgency of the intervention

2. Extent (in terms of population) of positive impacts expected from the intervention

3. Timeliness of the positive impacts expected from the intervention

4. Magnitude of constraints associated with implementation (the lower the magnitude of constraints, the higher the score), such as consent of building owners,

space availability, inconvenience to tenants, governmental bureaucracy, political will, etc.

These indicators were considered to be of equal importance and each activity was allocated a score ranging between 1 and 3 for each indicator, as illustrated in Table 5.3. The priority of each activity was then assigned based on the total score, whereby:

- an activity scoring between 9 and 12 was deemed of high priority
- an activity scoring between 5 and 8 was deemed of medium priority
- an activity scoring between 1 and 4 was deemed of low priority

Table 5.2. Sustainable Urban Development Framework Implementation Matrix

	Activity	*Priority*	*Responsibility*	*Target*	*Timeline*	*Budget/ Funding*	*Constraints*
At Tebbaneh level	Launching of the new water distribution network	High	▪ NLWE ▪ Municipality	▪ Elimination of pollution risk during distribution ▪ Water supply at adequate pressure ▪ Elimination of the need for individual water pumps	Urgent	2,000 USD / building	▪ Bureaucratic requirements ▪ Protection of public appurtenance
	Installation of compartmentalized water reservoirs	Low	▪ NLWE ▪ Municipality	▪ Elimination of individual water pumps ▪ Decrease of risk of negative pressure in the water network	6 months	3,000 USD / building	▪ Space needed at building basement ▪ Consent of building owner ▪ Approval of NLWE
	Appropriate management of Al Mallouli well	High	▪ NLWE	▪ Provision of quality water with adequate residual chlorine ▪ Elimination of risk of pollution at source	Continuous	5,000 USD for installation	▪ Space availability
	Closure of private wells particularly the mosque well	High	▪ NLWE ▪ Municipality	▪ Control and provision of quality water to few affected households	Urgent	10,000 USD	▪ Connection of few households to the public water network
	Control of bottled water vending	High	▪ MOET ▪ Municipality	▪ Assurance of safe drinking water	Continuous	NA[1]	▪ Regular market control

[1] Not Applicable

Activity		Priority	Responsibility	Target	Timeline	Budget/ Funding	Constraints
At household /building level	Replacement of water storage tanks on attics by plastic tanks on roof tops	High	▪ Residents	▪ Elimination of pollution risk at point of use	6 months to 1 year	500USD - 1,000USD / household	▪ Consent of household tenant ▪ Regular cleaning and maintenance
	Installment of new water piping systems	Medium	▪ Tenants	▪ Elimination of pollution risk at point of use	1.5 years to 2 years	500USD – 1,000USD / household	▪ Consent of household tenant
	Installment of new wastewater plumbing systems	Medium	▪ Tenants ▪ Building owner	▪ Elimination of risk of wastewater infiltration and accumulation in basements	2 years	2,000USD-4,000USD / household	▪ Consent of household tenant and owner ▪ Short-term inconvenience to tenant
Awareness and Education	Provision of continuous and intensive awareness campaigns	High	▪ Local NGOs ▪ Municipality	▪ Sensitization of residents towards hygiene principles, environmental liabilities and civic responsibilities	Continuous	500,000 USD	▪ Provision of incentives for regular attendance
	Introduction of hygiene and environment related topics into educational programs	High	▪ Local schools	▪ Creation of conscious generation responsible towards the community	Continuous	NA	▪ Availability of knowledgeable educational staff
Management and Policy	Coordination between concerned authorities in water and wastewater	Medium	▪ NLWE ▪ Municipality	▪ Proper planning and design of water and sanitation activities	Continuous	NA	▪ Coping with administrative routine
	Implementation of fair tenure regulations	Medium	▪ Parliament	▪ Flexible implementation of proposed interventions	Varying[2]	NA	▪ Political coordination, harmonization and acceptability

[2] Depending on the political atmosphere in the country

Table 5.3. Matrix of priorities

Activity	*Indicators*				*Score*	*Priority*
	Urgency of intervention	*Extent of impacts*	*Timeliness of impacts*	*Constraints*		
Launching of the new water distribution network	3	3	3	2	11	High
Installation of compartmentalized water reservoirs	1	1	1	1	4	Low
Appropriate management of Al Mallouli well	3	2	3	2	10	High
Closure of private wells particularly the mosque well	3	2	3	2	10	High
Control of bottled water vending	2	3	2	2	9	High
Replacement of water storage tanks on attics by plastic tanks on roof tops	3	2	2	3	10	High
Installation of new water piping systems	2	2	2	2	8	Medium
Installment of new wastewater plumbing systems	2	2	2	2	8	Medium
Provision of continuous and intensive awareness campaigns	3	2	2	2	9	High
Introduction of hygiene and environment related topics into educational programs	3	2	2	2	9	High
Coordination between concerned authorities in water and wastewater	2	1	1	2	6	Medium
Implementation of fair tenure regulations	2	3	1	1	7	Medium

Ultimately, such a mechanism will enhance a two-way engagement towards sustainable environmental management under a policy frame that fits all parties. It will involve stakeholders starting from the household resident, local community, Non-Governmental Organizations (NGOs), the Municipality of Tripoli under the Ministry of Interior and Municipalities (MoIM), the North Lebanon Water Establishment (NLWE) under the Ministry of Energy and Water (MoEW), as well as other concerned ministries such as the Ministry of Public Health (MoPH), the Ministry of Economy and Trade

(MoET)/ Consumer Protection Directorate, and the Ministry of Education and Higher Education (MoEHE). At the higher level, the Council for Development and Reconstruction will be involved in master planning, funding management, and implementation, while the Lebanese Parliament and the Council of Ministers will be involved in legislation. Fig. 5.1 depicts the roles of and linkages between all involved stakeholders in the implementation of the proposed Sustainable Urban Development Framework.

The emerging trend of corporate social responsibility (CSR) in Lebanon (Jamali and Mirshak 2007) may lend itself useful in Tebbaneh, whereby private businesses assist in improving living conditions in the study area. In the absence of large establishments, small local businesses that work directly in the water/ wastewater business such as plumbers, for instance, may contribute in promoting improved infrastructure at the household levels. Large retail corporations that are active in Tripoli may also be involved more in promoting awareness and hygiene practices, by joining forces with the Municipality of Tripoli and local NGOs. In fact, the successful involvement of the private sector will require cross-sectoral collaboration between the private sector, public sector and active NGOs in the area. Although it is expected that the efforts of the private sector will be constrained by the local conditions of extreme poverty and resident reticence to change, CSR is still worth considering and promoting.

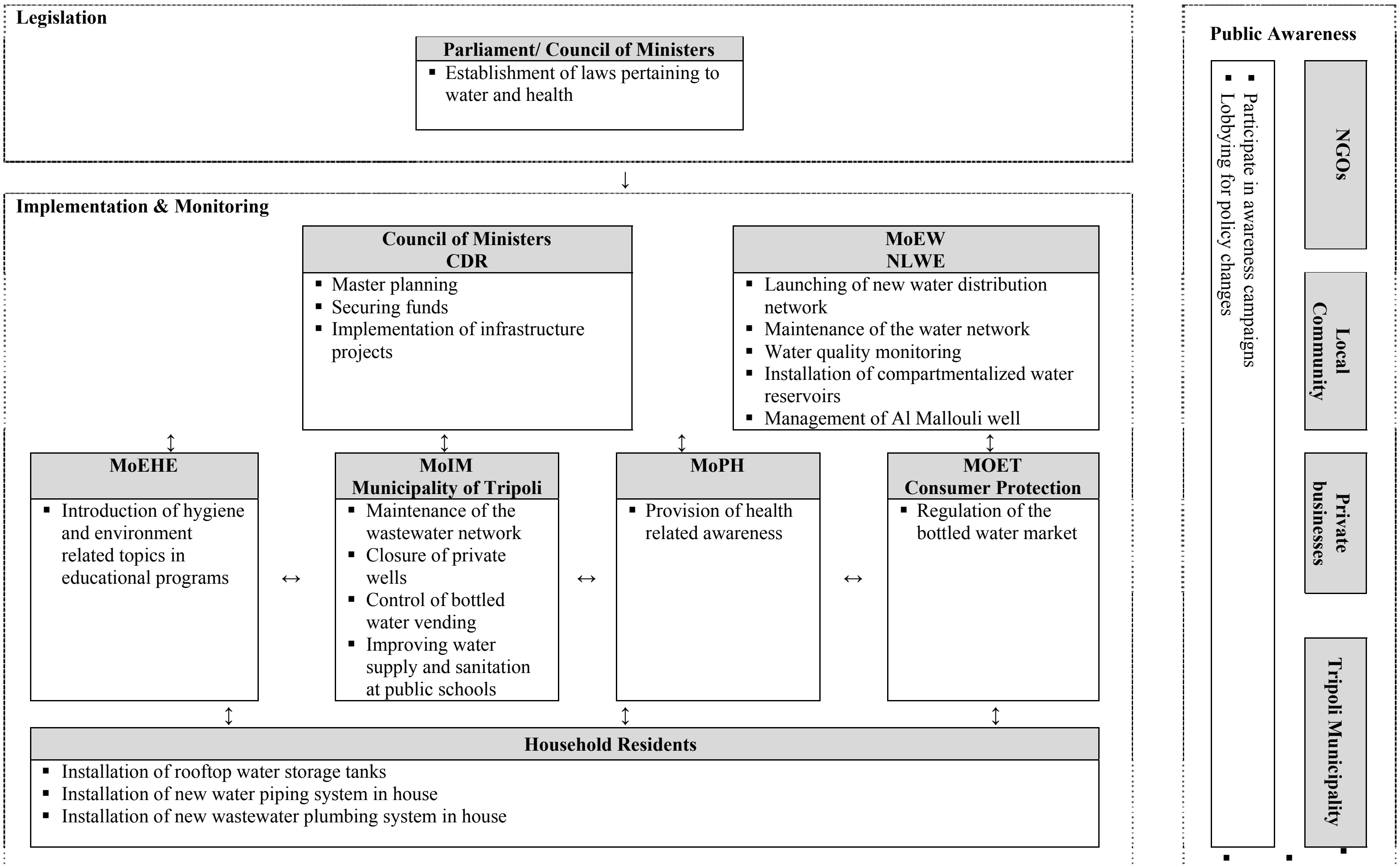


Fig. 5.1. Institutional set-up for the implementation of the proposed framework

CHAPTER 6

RESEARCH LIMITATIONS AND OUTCOMES

6.1 Limitations

Limitations are not unknown to community research projects which are often constrained by various factors. However, the beauty of such projects is the continuous interaction and feedback from the community which tends to massage these constraints and reduce their impacts on the overall project outputs.

Overall, and throughout the project duration, activities were delayed due to continuous social unrest in Tebbaneh area, where the situation is fragile, and where incidences fueled by political tensions occur continuously. This restricted field visits, particularly during the post-intervention period when the conflict escalated.

The social survey and associated statistical analysis and modeling faced various limitations:

- Prevalence of diarrhea was measured by a cross-sectional survey, which is not an optimal assessment, due to conceptual and technical issues associated with information on the prevalence of diarrhea obtained retrospectively (Morris *et al.* 1996). The first issue is the seasonal variations in the occurrence of diarrhea that are only captured in longitudinal studies. The second issue is that diarrheal morbidity was measured by asking mothers about their childrens' health in the past three months preceding the survey. This question measures mother's perception of her child's health instead of morbidity according to a clinical examination. Since perception of illness is not similar among different social groups, this may create variations across different socio-economic groups. However, given the overall homogeneity in the Tebbaneh slum, this issue should not present a significant limitation. Thirdly, loss of memory of events and misinterpretation of the reference period can also contribute to problems associated with the prevalence of diarrhea (Woldemicael 2001). Accordingly, longitudinal studies are usually preferred for the assessment of health outcomes and health interventions. However, in the absence of longitudinal and clinical data, and under time and resource constraints, cross-sectional surveys assist in assessing the determinants and patterns of childhood diarrhea in a reference time preceding the survey. This has been the case for most studies in the literature that aim to understand the determinants of diarrhea in a community (Mihrete *et al.* 2014; Arif 2012; El-Azar 2009; Boadi and Kuitunen 2005; Woldemicael 2001; Teklemariam 2000).

- Although some factors other than the ones we considered in this study affect diarrheal morbidity, we were not able to account for them. The most important one is breastfeeding practice because the focus of the study was more on the household in general, rather than individual susceptibilities. Other factors include childhood and maternal undernutrition, or other diet-related risk factors, which may have influenced the incidence of diarrhea in children (Guerrant *et al.* 2008). Furthermore, foodborne diarrhea, which is not uncommon in a poor urban slum may have accounted to the elevated incidences in the Tebbaneh slum. This was accounted for by considering that 88 % of reported diarrheal cases are attributed to unsafe water supply, inadequate sanitation and hygiene (Wilkinson 2009). Finally, although the survey tried to capture hand-washing behavior through direct questions and through observations, there was a feeling that this was tainted by over performance of respondents (Freeman *et al.* 2014) which did not reflect the true practices in the household.

- The assumption that the incidence of waterborne diarrhea in a household is limited to exposure within this same household. Some cases may be associated with exposure outside the household, including schools, workplaces, etc. An intervention at the level of the whole slum area is expected to reduce the effect of this limitation.

- The data from Irbid could not be used for more extensive statistical modeling since the AUB Team did not receive the original filled questionnaires from Jordan and was therefore unable to quality control the data and handle the data gaps.

The initial water sampling campaign was faced with a number of challenges, including:

- Water sampling was conducted during the wet season which prevented the detection of seasonal variations in water quality throughout the year as suggested by the literature (Clasen *et al.* 2006; Yassin *et al.* 2006; Gasana *et al.* 2002; Jensen *et al.* 2004).

- Water sampling was performed at the household level, which reflects the quality of water at the point of collection/use only. Understanding quality variations starting from the source of supply would have allowed the identification of critical points within the system and appropriate interventions. Unfortunately, access to public facilities seemed difficult at the time of the field work.

- Due to resource constraints, the water quality assessment campaign was restricted to households reporting diarrhea. This prevented the statistical assessment of any direct correlation between water quality and diarrhea.

The SCBA was constrained by the very limited evidence from well-conducted intervention studies assessing exclusive use of adequate access and supply of safe water or universal use of effective sanitation. This restricted the ability to differentiate health effects between different intervention improvements and imposed the use of a uniform estimate for all interventions.

6.2 Research outcomes

The research study was able to meet its objectives albeit recognizing the above limitations. The project, through lessons learned from An Nasr in Irbid, Jordan, that has similar societal and demographic characteristics coupled with the field surveys, statistical modeling, and participation of the local community and NGOs in conjunction with the local public sector represented by the municipality in conjunction with consultation with the North Lebanon Water Establishment, was able to identify the major environmental burdens in the Tebbaneh region in Tripoli, Lebanon, to implement relatively effective pilot interventions, and develop a framework for sustainable environmental development.

A first contribution for scientific research is that the availability of piped water and sanitation services in a poor slum may still be associated with diarrheal diseases from fecal contamination, and thus should not be considered as 'improved water and sanitation'. Another major lesson that can be derived for improving future projects is that when environmental services are provided in a poor urban slum, even if these services are not proper, the project should look into housing conditions and sources of pollution within poor buildings/households. These can often be rectified with minimum institutional and financial constraints and can have good positive impacts. Another lesson is related to water quality monitoring in a poor urban slum whereby a program is designed to capture peculiarities of the water supply system at both the network and the building-household levels to better understand the non-conventional sources of water pollution. A final lesson is the complex interactions between diarrhea determinants in a community and the need for an in-depth understanding of these interactions to effectively reduce this burden in a poor urban slum.

As for the main local outcomes of the research project, they include:

1. A better understanding and documentation of inter-linkages between water, sanitation, and housing problems, and poverty exacerbation in the Tebbaneh region:

- Definition of causes-impacts of service provision and housing problems on environmental degradation and correlation to poverty aggravation, whereby the significance of poor water quality was investigated, the various sources of pollution within the network and within the housing units were identified and their health-based socio-economic impact through water-related morbidity and mortality was assessed.

- Quantification of the probability of contracting diarrhea in the households of the Tebbaneh slum, whereby the statistically significant predictors of diarrhea were identified to include, the number of household members, maternal age, ability to secure 100 USD, wastewater accumulation in the basement, using network water for cooking, and living in Zone 2.

- Determination of the individual housing units that require rehabilitation of environmental infrastructure, such as houses with tanks in attics and with deteriorating water piping and wastewater plumbing systems,

- Identification of zones where environmental burdens are weighing most heavily, namely the vegetable market zone (Zone 1), where housing conditions are the worst and where problems in environmental quality occur most frequently.

- Identification of stakeholders and creation of a platform for dialogue to ensure efficient problem diagnosis and participatory intervention practices, whereby the municipality and local NGOs as well as the North Lebanon Water Establishment were periodically consulted since the initiation of the project and were directly involved in the project activities.

2. Implementation of pilot interventions to solve water, sanitation, and housing problems:

- Alleviation of environmental degradation towards improved public health through better provision of environmental services and infrastructure, including the installation of new roof top tanks and new water piping systems within buildings.

- Increased awareness among local stakeholders, including marginalized groups, of the nature of environmental degradation and existing means for their prevention and/or remediation.

- Evaluation of the usefulness of the involvement of the local community in implementation of service rehabilitation interventions, whereby NGO representatives who accompanied the AUB team increased acceptance of the residents to the project team and enhanced their collaboration in identifying and implementing the interventions.

- Diagnosis of policy gaps and institutional weaknesses potentially hindering on-the ground progress in environmental management and urban development projects, and threatening the sustainability of solutions. Identified gaps were related mainly to land tenure, tenancy, bottled water vending, etc. and institutional weaknesses were mainly evident in drinking water quality and sanitation monitoring and management.

3. Definition of a sustainable environmental development framework to be integrated in strategic planning, policies and practices entrenched in scientific findings:

- Increased integration of local perspectives (poor housing conditions) in planning and policy formulation
- Increased influence of voices of marginalized social/gender groups
- Increased capacity of local government to plan efficient intervention
- Scaling-up of lessons learned from successful interventions through integration in local urban planning and practices

Finally, what is at stake now is project continuity and the ability of the Municipality and/or community organizations to secure a funding mechanism to implement interventions at a larger scale, and in line with the Sustainable Urban Management Framework, to achieve long term water quality sustainability. This was initially hindered by the politically fragile situation in the project area which allowed for limited dissemination of project findings to raise awareness with respect to sources of pollution and hygiene practices at the building/household levels. It was further deterred by (1) the escalating unrest in the area that mirrored the military uprising in neighboring Syria, which led to damage in the already deteriorated infrastructure, and (2) the significant influx of Syrian refugees to the study area, and associated out flux of local residents, which created an imbalance in the demographic and social fabric of the Tebbaneh slum and further aggravated poverty conditions.

To conclude, the results of the presented research projects have been published in peer-reviewed journals and presented in international conferences as listed in Appendix 10. Two more publications are envisaged and are currently under preparation.

APPENDIX 1.
AN-NASR FIELD QUESTIONNAIRE

Participatory Improvement of Water and Sanitation Services in Tripoli through a Comparative Analysis in Irbid, Jordan

Questionnaire Identification					
AI1	**Country**		AI5	**Housing unit number**	|___|___|___|___|
AI2	**Neighbourhood**	|___|___|			
AI3	**Building**	|___|___|___|			|___|___|___|___|
AI4	**Floor**	|___|___|			
Schedule					
AV1	First Visit	DD-MM |___|___|-|___|___|	AT1	Start of interview (time)	hh-mm |___|___|-|___|___|
			AT2	End of Interview (time)	hh-mm |___|___|-|___|___|
AV2	Second Visit	DD-MM |___|___|-|___|___|	AT3	Start of interview	hh-mm |___|___|-|___|___|
			AT4	End of Interview	hh-mm |___|___|-|___|___|
AV3	Third Visit	DD-MM |___|___|-|___|___|	AT5	Start of interview	hh-mm |___|___|-|___|___|
			AT6	End of Interview	hh-mm |___|___|-|___|___|
AV4	Fourth Visit	DD-MM |___|___|-|___|___|	AT7	Start of interview	hh-mm |___|___|-|___|___|
			AT8	End of Interview	hh-mm |___|___|-|___|___|
AV5	Fifth Visit	DD-MM |___|___|-|___|___|	AT9	Start of interview	hh-mm |___|___|-|___|___|
			AT10	End of Interview	hh-mm |___|___|-|___|___|
AV6	**Total visits carried out**				|___|
AV7	**Editing Date**			DD-MM	|___|___|-|___|___|
AV8	**Coding Date**			DD-MM	|___|___|-|___|___|
AV9	**Data entry Date**			DD-MM	|___|___|-|___|___|
Staff					
AS1	**Interviewer**	|___|___|	AS4	**Coder**	|___|___|
AS2	**Supervisor**	|___|___|	AS5	**Data entry operator**	|___|___|
AS3	**Editor**	|___|___|			
Respondent					
Name of household head					
Name of main Respondent					
AR1	**Interview status**				
	1	Interview completed	**COMMENTS:**		
	2	Refusal converted			
	3	Partly completed			
	4	No usable information			
	7	Refusal			

سوف أبدأ بطرح بعض الاسئلة عن العائلة:

معلومات اجتماعية وديموغرافية (socio-demographic)			
SD1	عدد الغرف في المنزل **(دون المطبخ، الحمام، الشرفة والمخزن / موقف السيارة)**		|___|___|
SD2	عدد الافراد الذين يسكنون في المنزل **(الذين يتشاركون الطعام ومدخل البيت)**		|___|___|
SD3	عدد الافراد الذين يسكنون في المنزل بحسب الفئة العمرية		
SD3A1		دون سنة ذكر	|___|___|
SD3A2		أنثى	|___|___|
SD3B1		من سنة الى 10 سنوات ذكر	|___|___|
SD3B2		أنثى	|___|___|
SD3C1		من 11 سنة الى 18 سنة ذكر	|___|___|
SD3C2		أنثى	|___|___|
SD3D1		من 19 سنة الى 30 سنة ذكر	|___|___|
SD3D2		أنثى	|___|___|
SD3E1		من 31 سنة الى 65 سنة ذكر	|___|___|
SD3E2		أنثى	|___|___|
SD3F1		أكبر من 65 سنة ذكر	|___|___|
SD3F2		أنثى	|___|___|
SD4	كم عائلة تسكن في هذا المنزل؟	1 عائلة واحدة 2 عائلتان تربطهما قربة 3 عائلتان لا تربطهما قربة 4 زوج واحد وعدة عوائل 5 أكثر من عائلتان 6 غير ذلك، حدد:___________ 98 لا جواب 99 لا أعلم	
SD5	تاريخ ميلاد رب المنزل	اليوم الشهر السنة |___|___| - |___|___| - |___|___|___|___| 98 لا جواب 99 لا أعلم	
SD6	عمر رب المنزل	|___|___| 98 لا جواب 99 لا أعلم	
SD7	تاريخ ميلاد ربة المنزل	اليوم الشهر السنة |___|___| - |___|___| - |___|___|___|___| 98 لا جواب 99 لا أعلم	
SD8	عمر ربة المنزل	|___|___| 98 لا جواب 99 لا أعلم	

SD9	أعلى مستوى علمي حصّله رب المنزل	1	لا يجيد القراءة والكتابة
		2	يجيد القراءة والكتابة دون تحصيل أي مستوى
		3	ابتدائي
		4	متوسط
		5	ثانوي
		6	تقني
		7	جامعي
		98	لا جواب
		99	لا أعلم
SD10	أعلى مستوى علمي حصّلته ربة المنزل	1	لا تجيد القراءة والكتابة
		2	تجيد القراءة والكتابة دون تحصيل أي مستوى
		3	ابتدائي
		4	متوسط
		5	ثانوي
		6	تقني
		7	جامعي
		98	لا جواب
		99	لا أعلم
SD11	ما هو عدد الذكور في المنزل الذين يتعلّمون في المدرسة؟		|___|___|
		98	لا جواب
		99	لا أعلم
SD12	أين يتعلّم معظم الاولاد الذكور؟	1	مدرسة خاصة في باب التبانة / إربد؟
		2	مدرسة خاصة خارج باب التبانة / إربد؟
		3	مدرسة حكومية في باب التبانة / إربد؟
		4	مدرسة حكومية خارج باب التبانة / إربد؟
		5	غير ذلك، حدد:____________________
		98	لا جواب
		99	لا أعلم
SD13	أعلى مستوى علمي حصّله الابن الأكبر (حتى إذا لم يعد يسكن معك)	1	لا أبناء ذكور
		2	لا يجيد القراءة والكتابة
		3	يجيد القراءة والكتابة دون تحصيل أي مستوى
		4	ابتدائي
		5	متوسط
		6	ثانوي
		7	تقني
		8	جامعي
		98	لا جواب
		99	لا أعلم
SD14	ما هو عدد الإناث في المنزل الذين يتعلّمون في المدرسة؟		|___|___|
		98	لا جواب
		99	لا أعلم

SD15	أين يتعلّم معظم الاولاد الإناث؟	1	مدرسة خاصة في باب التبانة / إربد؟
		2	مدرسة خاصة خارج باب التبانة / إربد؟
		3	مدرسة حكومية في باب التبانة / إربد؟
		4	مدرسة حكومية خارج باب التبانة / إربد؟
		5	غير ذلك، حدد:________________________
		98	لا جواب
		99	لا أعلم
SD16	أعلى مستوى علمي حصّلته البنت الكبرى (حتى إذا لم تعد تسكن معك)	1	لا بنات
		2	لا تجيد القراءة والكتابة
		3	تجيد القراءة والكتابة دون تحصيل أي مستوى
		4	ابتدائي
		5	متوسط
		6	ثانوي
		7	تقني
		8	جامعي
		98	لا جواب
		99	لا أعلم
SD17	هل أحد أفراد المنزل هو عضو أو متطوّع أو على علاقة بأية جمعية إجتماعية، تنموية أو ثقافية في باب التبانة / إربد أو خارجها؟	1	نعم
		2	كلا
		98	لا جواب
		99	لا أعلم

سوف أطرح عليك بعض الأسئلة حول وضع العمل في منزلك:

العمل (Working Force)			
WF1	ما هو العمل الأساسي لرب المنزل؟		______________
		98	لا جواب
		99	لا أعلم
WF2	أين هو موقع عمله؟		______________
		98	لا جواب
		99	لا أعلم
WF3	ما هو مركزه في العمل؟	1	يعمل لحسابه الخاص
		2	موظف
		3	رب عمل
		4	غير ذلك، حدد ______________
		98	لا جواب
		99	لا أعلم
WF4	ما نوع العمل الآخر لرب المنزل؟		______________
		1	لا عمل آخر
		98	لا جواب
		99	لا أعلم
WF5	ما هو عدد أفراد منزلك الذين يعملون حالياً؟		|___|___|
		98	لا جواب
		99	لا أعلم
WF5A1	يعملون مقابل أجر خارج المنزل:	ذكور	18 ≥ |___|___|
WF5A2			18 ≤ |___|___|
WF5A3		إناث	18 ≥ |___|___|
WF5A4			18 ≤ |___|___|

WF5B1	يعملون مقابل أجر من المنزل:	ذكور	18 ≥	|___|___|
WF5B2			18 ≤	|___|___|
WF5B3		إناث	18 ≥	|___|___|
WF5B4			18 ≤	|___|___|
WF5C1	يعملون مع العائلة دون أجر:	ذكور	18 ≥	|___|___|
WF5C2			18 ≤	|___|___|
WF5C3		إناث	18 ≥	|___|___|
WF5C4			18 ≤	|___|___|
WF6	قل لي النسبة المئوية لمساهمة كل مصدر من مصادر الدخل لدخل منزلك الاجمالي:			
WF6A		عمل رب المنزل الأساسي		|___|___|___|
WF6B		عمل رب المنزل الآخر		|___|___|___|
WF6C		عمل أفراد العائلة الآخرين		|___|___|___|
WF6D		إعانات		|___|___|___|
WF6E		غير ذلك، حدد__________		|___|___|___|

سوف أطرح عليك بعض الأسئلة حول الوضع المالي لمنزلك. (لن أسأل عن أرقام محدّدة)

الوضع المالي (Financial status)			
FS1	هل تملك المنزل الذي تسكن فيه؟	1	نعم
		2	كلا
		98	لا جواب
		99	لا أعلم
FS2	هل لديك في المنزل:		
FS2A	غسالة ملابس	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
FS2B	جلاية أواني	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
FS2C	ثلاجة	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
FS2D	سخان ماء	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
FS2E	خط هاتف أرضي ثابت	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
FS2F	خط هاتف خلوي	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
FS2G	تلفاز	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
FS2H	كمبيوتر	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
FS2I	صحن لاقط	1	أمتلك صحن لاقط
		2	لدي اشتراك
		3	لا
		98	لا جواب
		99	لا أعلم

FS3	كيف تقيّم مستوى الدخل في منزلك بالمقارنة مع المنازل الأخرى في اربد (باب التبّانة)	1	أفضل بكثير	
		2	أفضل	
		3	ذات المستوى	
		4	أسوأ	
		5	أسوأ بكثير	
		98	لا جواب	
		99	لا أعلم	
FS4	في حال احتاج منزلك فجأةً لمبلغ 150,000 ليرة لبنانيّة (70 دينار)، هل تستطيع تأمينه خلال أسبوع؟	1	نعم	
		2	ربما، لكن ليس بالتأكيد	
		3	لا	Go to HS1
		98	لا جواب	Go to HS1
		99	لا أعلم	Go to HS1
FS5	إذا كان الجواب نعم، كيف تؤمّن المبلغ؟	1	استخدم مدّخراتي	
		2	بمساعدة منظمات	
		3	بمساعدة الأصدقاء	
		4	عن طريق بيع بعض الممتلكات	
		98	لا جواب	
		99	لا أعلم	

سوف أطرح عليك بعض الأسئلة حول الوضع الصحي العام لمنزلك

الوضع الصحّي (Health Status)				
HS1	هل يعاني أحد أفراد المنزل من مرض أو إعاقة مزمنة؟	1	نعم	
		2	لا	
		98	لا جواب	
		99	لا أعلم	
HS2	إذا كان الجواب نعم، ما هو المرض، الجنس، والعمر؟			
HS2A1	الفرد الأول	العمر	|___|___|	
HS2A2		الجنس	1 ذكر 2 أنثى	
HS2A3		المرض	____________	
HS2A4		الإعاقة	____________	
HS2B1	الفرد الثاني	العمر	|___|___|	
HS2B2		الجنس	1 ذكر 2 أنثى	
HS2B3		المرض	____________	
HS2B4		الإعاقة	____________	
HS2C1	الفرد الثالث	العمر	|___|___|	
HS2C2		الجنس	1 ذكر 2 أنثى	
HS2C3		المرض	____________	
HS2C4		الإعاقة	____________	
HS2D1	الفرد الرابع	العمر	|___|___|	
HS2D2		الجنس	1 ذكر 2 أنثى	
HS2D3		المرض	____________	
HS2D4		الإعاقة	____________	

HS2E1	الفرد الخامس	العمر		|___|___|
HS2E2		الجنس	1	ذكر
			2	أنثى
HS2E3		المرض		____________________
HS2E4		الإعاقة		____________________
HS3	هل عانى أحد أفراد المنزل من الإسهال في الثلاثة أشهر الماضية؟		1	نعم
			2	لا
			98	لا جواب
			99	لا أعلم
HS3A	إذا كان الجواب نعم، ما هو المرض، الجنس، والعمر؟			
HS3A1	الفرد الأول	العمر		|___|___|
HS3A2		الجنس	1	ذكر
			2	أنثى
HS3A3		المرض	1	إسهال
			2	تيفوئيد
			3	التهاب الكبد (Hepatitis A)
			4	غير ذلك، حدد ________________________
HS3A4		الأعراض	1	إسهال
			2	استفراغ
			3	حرارة مرتفعة
			4	أوجاع في المعدة
			5	غير ذلك، حدد ________________________
HS3A5		كم يوم اضطر المريض البقاء في المنزل بسبب المرض؟		|___|___|
HS3A6		للعلاج هل تم اللجوء الى	1	المستشفى
			2	المستوصف
			3	عيادة خاصة
			4	الطبيب يزورني في المنزل
			5	لا أحد
			6	غير ذلك، حدد ________________________
			98	لا جواب
			99	لا أعلم
HS3A7a		ما كانت تكلفة العلاج بالليرة اللبنانيّة (الدينارالأردني)؟	التكلفة الإجماليّة	|___|___|___|___|___|___|
HS3A7b			ثمن الدواء	|___|___|___|___|___|___|
HS3A7c			أجرة الطبيب في المستوصف	|___|___|___|___|___|___|
HS3A7d			أجرة الطبيب في المنزل	|___|___|___|___|___|___|
HS3A7e			أجرة المستشفى	|___|___|___|___|___|___|
HS3A7f			98	لا جواب
			99	لا أعلم
HS3B1	الفرد الثاني	العمر		|___|___|
HS3B2		الجنس	1	ذكر
			2	أنثى
HS3B3		المرض	1	إسهال
			2	تيفوئيد
			3	التهاب الكبد (Hepatitis A)
			4	غير ذلك، حدد ________________________

HS3B4		الأعراض	1	إسهال
			2	استفراغ
			3	حرارة مرتفعة
			4	أوجاع في المعدة
			5	غير ذلك، حدد ___________________________
HS3B5		كم يوم اضطر المريض البقاء في المنزل بسبب المرض؟		|___|___|
HS3B6		للعلاج تم اللجوء الى	1	المستشفى
			2	المستوصف
			3	عيادة خاصة
			4	الطبيب يزورني في المنزل
			5	لا أحد
			6	غير ذلك، حدد ___________
			98	لا جواب
			99	لا أعلم
HS3B7a		ما كانت تكلفة العلاج بالليرة اللبنانيّة (الدينار الأردني)؟	التكلفة الإجماليّة	|___|___|___|___|___|___|
HS3B7b			ثمن الدواء	|___|___|___|___|___|___|
HS3B7c			أجرة الطبيب في المستوصف	|___|___|___|___|___|___|
HS3B7d			أجرة الطبيب في المنزل	|___|___|___|___|___|___|
HS3B7e			أجرة المستشفى	|___|___|___|___|___|___|
HS3B7f			98	لا جواب
			99	لا أعلم
HS3C1	الفرد الثالث	العمر		|___|___|
HS3C2		الجنس	1	ذكر
			2	أنثى
HS3C3		المرض	1	إسهال
			2	تيفوئيد
			3	التهاب الكبد (Hepatitis A)
			4	غير ذلك، حدد ___________________________
HS3C4		الأعراض	1	إسهال
			2	استفراغ
			3	حرارة مرتفعة
			4	أوجاع في المعدة
			5	غير ذلك، حدد ___________________________
HS3C5		كم يوم اضطر المريض البقاء في المنزل بسبب المرض؟		|___|___|

HS3C6		للعلاج هل تم اللجوء الى	1	المستشفى
			2	المستوصف
			3	عيادة خاصة
			4	الطبيب يزورني في المنزل
			5	لا أحد
			6	غير ذلك، حدد ___________
			98	لا جواب
			99	لا أعلم
HS3C7a		ما كانت تكلفة العلاج بالليرة اللبنانيّة (الدينار الأردني)؟	التكلفة الإجماليّة	|___|___|___|___|___|___|
HS3C7b			ثمن الدواء	|___|___|___|___|___|___|
HS3C7d			أجرة الطبيب في المستوصف	|___|___|___|___|___|___|
HS3C7e			أجرة الطبيب في المنزل	|___|___|___|___|___|___|
HS3C7f			أجرة المستشفى	|___|___|___|___|___|___|
HS3C7g			98	لا جواب
			99	لا أعلم
HS3D1	الفرد الرابع	العمر		|___|___|
HS3D2		الجنس	1	ذكر
			2	أنثى
HS3D3		المرض	1	إسهال
			2	تيفوئيد
			3	التهاب الكبد (Hepatitis A)
			4	غير ذلك، حدد ___________________________
HS3D4		الأعراض	1	إسهال
			2	استفراغ
			3	حرارة مرتفعة
			4	أوجاع في المعدة
			5	غير ذلك، حدد ____________________________
HS3D5		كم يوم اضطر المريض البقاء في المنزل بسبب المرض؟		|___|___|
HS3D6		للعلاج هل تم اللجوء الى	1	المستشفى
			2	المستوصف
			3	عيادة خاصة
			4	الطبيب يزورني في المنزل
			5	لا أحد
			6	غير ذلك، حدد ___________
			98	لا جواب
			99	لا أعلم

HS3D7a HS3D7b HS3D7c HS3D7e HS3D7f HS3D7g	ما كانت تكلفة العلاج بالليرة اللبنانيّة (الدينارالأردني)؟		التكلفة الإجماليّة ثمن الدواء أجرة الطبيب في المستوصف أجرة الطبيب في المنزل أجرة المستشفى 98 99	|___|___|___|___|___|___| |___|___|___|___|___|___| |___|___|___|___|___|___| |___|___|___|___|___|___| |___|___|___|___|___|___| لا جواب لا أعلم
HS4	في العموم، اذا احتاج أحد أفراد منزلك للطبابة، الى أين تلجأ؟	1 2 3 4 5 6 7 98 99	مستوصف عام في باب التبّانة/ اربد مستوصف عام خارج باب التبّانة/ اربد عيادة خاصة في باب التبّانة/ اربد عيادة خاصة خارج باب التبّانة/ اربد مستشفى خارج باب التبّانة/ اربد زيارة منزليّة غير ذلك، حدد___________________ لا جواب لا أعلم	
HS5	لما فضلت هذا الخيار؟	1 2 3 4 5 6 7 98 99	لأنه الخيار الأوفر لأنه الخيار الأفضل لأنه اكثر راحة من غيره لأني أثق به أكثر لأنه لدينا تأمين عام (ضمان) لأنه لدينا تأمين خاص غير ذلك، حدد لا جواب لا أعلم	

الآن سوف أسأل عن المياه في المنزل

مصادر المياه (water sources)				
WS1	ما هي مصادر المياه التي تصل الى المنزل؟			
WS1A		شبكة المياه العامة	1 2 99	نعم كلا لا أعلم
WS1B		بئر	1 2 99	نعم كلا لا أعلم
WS1C		صهريج مياه	1 2 99	نعم كلا لا أعلم
WS1D		مياه منقولة باليد	1 2 99	نعم كلا لا أعلم
WS1E		مياه معبأة	1 2 99	نعم كلا لا أعلم
WS1F		غير ذلك، حدد: __________		
WS2A WS2B WS2C WS2D WS2E WS2F	حدد النسبة المئوية لكل مصدر بحسب الكمية التي تحصل عليها في الشتاء (المجموع يجب أن يكون 100%)	شبكة المياه العامة بئر صهريج مياه مياه منقولة باليد مياه معبأة غير ذلك		|___|___|% |___|___|% |___|___|% |___|___|% |___|___|% |___|___|%
WS3A WS3B WS3C WS3D WS3E WS3F	حدد النسبة المئوية لكل مصدر بحسب الكمية التي تحصل عليها في الصيف (المجموع يجب أن يكون 100%)	شبكة المياه العامة بئر صهريج مياه مياه منقولة باليد مياه معبأة غير ذلك		|___|___|% |___|___|% |___|___|% |___|___|% |___|___|% |___|___|%
WS4	كم برميل مياه يستهلك منزلك يومياً في فصل الصيف		 99	|___|___| برميل/يوم لا أعلم
WS5	كم برميل مياه يستهلك منزلك يومياً في فصل الشتاء		 99	|___|___| برميل/يوم لا أعلم
WS6	هل تكفيك كميّة مياه الإستعمال التي تصل الى منزلك في فصل الصيف ؟		1 2 3 4 98 99	أكثر من كافية كافية بالكاد تكفي لا تكفي لا جواب لا أعلم

WS7	هل تكفيك كميّة مياه الإستعمال التي تصل الى منزلك في فصل الشتاء؟	1 2 3 4 98 99	أكثر من كافية كافية بالكاد تكفي لا تكفي لا جواب لا أعلم
WS8	هل أنت راضٍ عن نوعيّة مياه الاستعمال التي تصل الى منزلك فيً فصل الصيف؟	1 2 98 99	نعم لا لا جواب لا أعلم
WS9	لماذا أنت غير راضٍ؟	1 2 3 4 98 99	المياه ليست صافية هناك رائحة كلور في المياه المياه ملوّثة غير ذلك، حدد ____________ لا جواب لا أعلم
WS10	هل أنت راضٍ عن نوعيّة مياه الاستعمال التي تصل الى منزلك فيً فصل الشتاء؟	1 2 98 99	نعم لا لا جواب لا أعلم
WS11	لماذا أنت غير راضٍ؟	1 2 3 4 98 99	المياه ليست صافية هناك رائحة كلور في المياه المياه ملوّثة غير ذلك، حدد ____________ لا جواب لا أعلم

إذا كنت تحصل على المياه من الشبكة العامّة

مياه الشبكة العامة (network water)				
NW1	هل لديك عداد أم عيار بالمتر المكعب؟		1 2 3 99	عداد عيار بالمتر المكعب غير ذلك، حدد ____________ لا أعلم
NW2A	إذا كان لديك عدّاد	رقم العداد	____________________	
NW2B		فاتورة كلّ	|___|___|	شهر
NW2C		الكمية المستهلكة فى آخر فاتورة عداد	|___|___|___|___|	متر مكعب
NW2D		القيمة المدفوعة فى آخر فاتورة	|___|___|___|___|	ليرة / دينار
NW3A	إذا كان لديك عيار بالمتر المكعب	ما قيمة فاتورتك السنويّة؟	|___|___|___|___|	ليرة / دينار
NW3B		ما قياس العيار؟	|___|___|	مم
NW4A	ما هي استخدامات المياه التي تحصل عليها من شبكة المياه العامة	للشرب	1 2 99	نعم كلا لا أعلم

NW4B	لغسل الأيدي		1 2 99	نعم كلا لا أعلم
NW4C	للاستحمام		1 2 99	نعم كلا لا أعلم
NW4D	لغسل الطعام		1 2 99	نعم كلا لا أعلم
NW4E	للطبخ		1 2 99	نعم كلا لا أعلم
NW4F	لغسل الصحون		1 2 99	نعم كلا لا أعلم
NW4G	لتنظيف البيت		1 2 99	نعم كلا لا أعلم
NW4H	في غرفة الغسيل		1 2 99	نعم كلا لا أعلم
NW4I	للري		1 2 99	نعم كلا لا أعلم
NW4J	غير ذلك، حدد:______________			
NW5	ما وتيرة تزويد المياه عبر الشبكة العامّة؟		 1 98 99	|___| مرة في الأسبوع بشكل مستمر لا جواب لا أعلم
NW6	كم تبقى المياه مزوّدة حين تأتي؟		 1 98 99	|___|___| ساعة بشكل مستمر لا جواب لا أعلم
NW7	كيف تجد نوعية هذه المياه؟	1 2 3 98 99		جيدة (دون لون، طعم، رائحة، ورواسب) متوسطة (بعض اللون، طعم، رائحة، ورواسب) سيئة (ذات لون، طعم، رائحة، ورواسب) لا جواب لا أعلم

إذا كنت تحصل على المياه من الآبار

مياه الآبار (Well water)					
WW1	عدد الآبار التي تصل منها مياه الى المنزل |___|				
WW2		A	B	C	D
		البئر 1	**البئر 2**	**البئر 3**	**البئر 4**
1	إسم البئر	____________ 99 لا أعلم	____________ 99 لا أعلم	____________ 99 لا أعلم	____________ 99 لا أعلم

2	نوع البئر	1 خاص للمنزل 2 مشترك بين عدة منازل 3 مشترك للحي 99 لا أعلم	1 خاص للمنزل 2 مشترك بين عدة منازل 3 مشترك للحي 99 لا أعلم	1 خاص للمنزل 2 مشترك بين عدة منازل 3 مشترك للحي 99 لا أعلم	1 خاص للمنزل 2 مشترك بين عدة منازل 3 مشترك للحي 99 لا أعلم
3	حالة البئر	1 مغطّى 2 مفتوح 99 لا أعلم	1 مغطّى 2 مفتوح 99 لا أعلم	1 مغطّى 2 مفتوح 99 لا أعلم	1 مغطّى 2 مفتوح 99 لا أعلم
4	طريقة السحب	1 مضخّة 2 نقل باليد 3 غير ذلك، حدد: ____________ 99 لا أعلم	1 مضخّة 2 نقل باليد 3 غير ذلك، حدد: ____________ 99 لا أعلم	1 مضخّة 2 نقل باليد 3 غير ذلك، حدد: ____________ 99 لا أعلم	1 مضخّة 2 نقل باليد 3 غير ذلك، حدد: ____________ 99 لا أعلم

WW3A	ما هي استخدامات المياه التي تحصل عليها من البئر	للشرب	1 نعم 2 كلا 99 لا أعلم
WW3B		لغسل الأيدي	1 نعم 2 كلا 99 لا أعلم
WW3C		للاستحمام	1 نعم 2 كلا 99 لا أعلم
WW3D		لغسل الطعام	1 نعم 2 كلا 99 لا أعلم
WW3E		للطبخ	1 نعم 2 كلا 99 لا أعلم
WW3F		لغسل الصحون	1 نعم 2 كلا 99 لا أعلم
WW3G		لتنظيف البيت	1 نعم 2 كلا 99 لا أعلم
WW3H		في غرفة الغسيل	1 نعم 2 كلا 99 لا أعلم
WW3I		للري	1 نعم 2 كلا 99 لا أعلم
WW3J		غير ذلك، حدد: ______________	

WW4	ما وتيرة تزويد المياه عبر الآبار؟	|___| مرة في الأسبوع 98 لا جواب 99 لا أعلم
WW5	كم تبقى المياه مزوّدة حين تأتي؟	ساعة|___|___| 98 لا جواب 99 لا أعلم
WW6	ماذا تدفع مقابل مياه الآبار	1 لا شيء |___|___| ليرة/ دينار شهرياً 98 لا جواب 99 لا أعلم
WW7	كيف تجد نوعية هذه المياه؟	1 جيدة (دون لون، طعم، رائحة، ورواسب) 2 متوسطة (بعض اللون، طعم، رائحة، ورواسب) 3 سيئة (ذات لون، طعم، رائحة، ورواسب) 98 لا جواب 99 لا أعلم

إذا كنت تحصل على المياه من الصهاريج:

صهاريج المياه (Water tankers)			
WT1A	ما هي استخدامات المياه التي تحصل عليها من صهاريج المياه	للشرب	1 نعم 2 كلا 99 لا أعلم
WT1B		لغسل الأيدي	1 نعم 2 كلا 99 لا أعلم
WT1C		للاستحمام	1 نعم 2 كلا 99 لا أعلم
WT1D		لغسل الطعام	1 نعم 2 كلا 99 لا أعلم
WT1E		للطبخ	1 نعم 2 كلا 99 لا أعلم
WT1F		لغسل الصحون	1 نعم 2 كلا 99 لا أعلم
WT1G		لتنظيف البيت	1 نعم 2 كلا 99 لا أعلم
WT1H		في غرفة الغسيل	1 نعم 2 كلا 99 لا أعلم
WT1I		للري	1 نعم 2 كلا 99 لا أعلم
WT1J		غير ذلك، حدد:__________	1 نعم
WT2	كم مرّة في الاسبوع يحصل المنزل على صهريج؟		|___|___|

WT3	ما هي سعة الصهريج؟	|___|___|	متر مكعب
WT4	كم تدفع عن كل صهريج؟	|___|___|___|___|	ليرة / دينار
WT5	كيف تجد نوعية هذه المياه؟	1 جيدة (دون لون، طعم، رائحة، ورواسب) 2 متوسطة (بعض اللون، طعم، رائحة، ورواسب) 3 سيئة (ذات لون، طعم، رائحة، ورواسب) 98 لا جواب 99 لا أعلم	

إذا كنت تنقل المياه شخصياً باليد:

المياه المنقولة باليد (Hand-carried)				
HC1	كم مرة تحضر الماء إلى المنزل يومياً؟	 99	|___|___| لا أعلم	مرة
HC2	ما كمية الماء في كل مرة؟	 99	|___|___| لا أعلم	ليتر
HC3	هل تدفع مقابل هذه المياه؟	1 2 98	نعم كلا لا جواب	
HC4	إذا كان الجواب نعم، كم تدفع؟	 99	|___|___|___|___| لا أعلم	ليرة / دينار
HC5	كم دقيقة تستغرق من الوقت لإحضار المياه الى المنزل؟	 99	|___|___|___| لا أعلم	دقيقة
HC6A	ما هي استخدامات المياه المنقولة باليد؟ للشرب	1 2 99	نعم كلا لا أعلم	
HC6B	لغسل الأيدي	1 2 99	نعم كلا لا أعلم	
HC6C	للاستحمام	1 2 99	نعم كلا لا أعلم	
HC6D	لغسل الطعام	1 2 99	نعم كلا لا أعلم	
HC6E	للطبخ	1 2 99	نعم كلا لا أعلم	
HC6F	لغسل الصحون	1 2 99	نعم كلا لا أعلم	
HC6G	لتنظيف البيت	1 2 99	نعم كلا لا أعلم	
HC6H	في غرفة الغسيل	1 2 99	نعم كلا لا أعلم	

HC6I	للري	1 نعم 2 كلا 99 لا أعلم
HC6J	غير ذلك، حدد:__________	
HC7	كيف تجد نوعية هذه المياه؟	1 جيدة (دون لون، طعم، رائحة، ورواسب) 2 متوسطة (بعض اللون، طعم، رائحة، ورواسب) 3 سيئة (ذات لون، طعم، رائحة، ورواسب) 98 لا جواب 99 لا أعلم

إذا كنت تشتري المياه المعبأة:

المياه المعبأة (bottled water)		
BW1	كم عبوة يستهلك المنزل في الاسبوع؟	|___|___| 99 لا أعلم
BW2	ما هي سعة العبوة؟	|___|___| ليتر 99 لا أعلم
BW3	إسم العبوة (إذا أمكن)	____________________
BW4	كم تدفع عن كل عبوة؟	|___|___|___|___| ليرة / دينار 99 لا أعلم
BW5A	ما هي استخدامات المياه المعبأة؟ للشرب	1 نعم 2 كلا 99 لا أعلم
BW5B	لغسل الأيدي	1 نعم 2 كلا 99 لا أعلم
BW5C	للاستحمام	1 نعم 2 كلا 99 لا أعلم
BW5D	لغسل الطعام	1 نعم 2 كلا 99 لا أعلم
BW5E	للطبخ	1 نعم 2 كلا 99 لا أعلم
BW5F	لغسل الصحون	1 نعم 2 كلا 99 لا أعلم
BW5G	لتنظيف البيت	1 نعم 2 كلا 99 لا أعلم
BW5H	في غرفة الغسيل	1 نعم 2 كلا 99 لا أعلم

BW5I	للري	1 2 99	نعم كلا لا أعلم	
BW5J	غير ذلك، حدد:__________	1	نعم	
BW6	كيف تجد نوعية هذه المياه؟	1 2 3 98 99	جيدة (دون لون لون، طعم، رائحة، ورواسب) متوسطة (بعض اللون، طعم، رائحة، ورواسب) سيئة (ذات لون، طعم، رائحة، ورواسب) لا جواب لا أعلم	

الآن سوف أسأل عن المياه التي تستخدمها للشرب:

مياه الشرب (drinking water)			
DW1	ما هي كميّة مياه الشرب التي يستهلكها منزلك يومياً في فصل الصيف	 99	|___|___| ليتر لا أعلم
DW2	ما هي كميّة مياه الشرب التي يستهلكها منزلك يومياً في فصل الشتاء	 99	|___|___| ليتر لا أعلم
DW3	هل أنت راضٍ على نوعيّة مياه الشرب التي تستهلك؟	1 2 98 99	نعم لا لا جواب لا أعلم
DW4	لماذا أنت غير راضٍ؟	1 2 3 4 98 99	المياه ليست صافية هناك رائحة كلور في المياه المياه ملوّثة غير ذلك، حدد __________ لا جواب لا أعلم
DW5	إذا أصبحت غير راضٍ عن نوعية مياه الشرب التي تستهلك حالياً، ما المصدر البديل الذي قد تلجأ إليه؟	1 2 3 4 5 98 99	لا مصدر بديل مياه نبع مياه بئر أشتري مياه معبأة غير ذلك، حدد __________ لا جواب لا أعلم
DW6	هل تتخذ أي إجراء لتحسين نوعية المياه قبل شربها؟	1 2 3 4 5 98 99	لا غليها تركها بضع ساعات تحت أشعة الشمس ترشيح (فلتر) غير ذلك، حدد __________ لا جواب لا أعلم

الآن سوف أسأل عن تخزين المياه في منزلك:

تخزين المياه (water tanks)			
WT1	هل للمنزل خزان مياه؟	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
WT2	ما نوع هذا الخزان؟	1	خزان معدني فوق المنزل
		2	خزان بلاستيكي فوق المنزل
		3	خزان فايبر جلاس فوق المنزل
		4	خزان إسمنتي فوق المنزل
		5	خزان ارضي معدني
		6	خزان ارضي بلاستيكي
		7	خزان ارضي فايبر جلاس
		8	خزان ارضي إسمنتي
		10	برميل
		98	لا جواب
		99	لا أعلم
WT3	ما سعة هذا الخزان؟		|___|___| برميل
		98	لا جواب
		99	لا أعلم
WT4	هل تمزج المياه الآتية من كافة المصادر في الخزان؟	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
WT5	كم مرة تنظّف خزان المياه؟	1	ولا مرة
		2	مرة كل سنتين
		3	مرة كل ثلاث سنوات
		4	سنوياً
		5	كل ستة اشهر
		6	غير ذلك، حدد________
		98	لا جواب
		99	لا أعلم
WT6	هل تستخدم أي مادّة لمعالجة المياه في الخزان؟	1	لا
		2	نعم، منتجات الكلور
		3	نعم، منتجات بتروليّة
		4	غير ذلك، حدد______________
		98	لا جواب
		99	لا أعلم
WT7	كيف يتم سحب المياه من الخزان؟	1	دلو
		2	أوعية خاصة
		3	مضخة موصولة بصنابير المنزل
		4	صنبور
		5	غير ذلك، حدد ______________
		98	لا جواب
		99	لا أعلم

WT8	هل تستخدم مياه الخزان للشرب؟	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم

سوف أطرح عليك بعض الأسئلة حول التجهيزات والممارسات الصحيّة

التجهيزات والممارسات الصحيّة (personal hygiene and fixtures)			
PH1	هل يوجد دوش\ حوض استحمام في المنزل؟	1	نعم, خاص بالعائلة
		2	نعم, مشترك مع عوائل أخرى
		3	لا يوجد
		98	لا جواب
		99	لا اعلم
PH2	أين يتم غسل اليدين عادة؟	1	مغسلة داخل الحمام أو قريبة منه
		2	مغسلة ليست داخل الحمام أو قريبة منه
		3	مغسلة في المطبخ
		4	مغسلة في الحديقة
		5	صنبور في فناء المنزل
		6	مكان أخر, حدد ________
		7	نادراً ما تغسل الأيدي
		98	لا جواب
		99	لا اعلم
PH3	ماذا تستخدم عند غسل اليدين؟	1	مياه صنبور مع صابون
		2	مياه صنبور دون صابون
		3	مياه حوض مع صابون
		4	مياه حوض دون صابون
		5	مياه دلو مع صابون
		6	مياه حوض دون صابون
		98	لا جواب
		99	لا اعلم
PH4	هل يوجد ماء ساخن باستمرار؟	1	نعم
		2	لا
		98	لا جواب
		99	لا اعلم
PH5	أين يتم غسل الصحون؟	1	في المطبخ
		2	في الحديقة
		3	مجرى الماء
		98	لا جواب
		99	لا اعلم

سوف أطرح عليك بعض الأسئلة حول التخلص من المياه المبتذلة

التخلص من المياه المبتذلة (wastewater disposal)			
WWD1	هل تشارك احد في الحمام؟	1	لا - مرحاض خاص داخل المنزل
		2	نعم ـ مع عوائل أخرى
		3	نعم ـ مرحاض عام
		98	لا جواب
		99	لا أعلم
WWD2	أين يوجد الحمام؟	1	داخل المنزل
		2	داخل البناية ـ خارج المنزل
		3	خارج البناية
		98	لا جواب
		99	لا أعلم
WWD3	هل يوجد مغسلة بالقرب من أو داخل الحمام؟	1	نعم ـ داخل الحمام
		2	نعم ـ بالقرب من الحمام
		3	لا ـ بعيدة عن الحمام
		98	لا جواب
		99	لا أعلم
WWD4	كيف يتخلص منزلك من المياه المبتذلة؟	1	جورة صحية
		2	شبكة المجاري
		3	في قناة مغطاة
		4	في قناة مفتوحة
		5	غير ذلك، حدد ______________
		98	لا جواب
		99	لا أعلم
WWD5	إذا كان لديك جورة صحيّة، ما وتيرة تفريغها؟		|___|___|
		98	لا جواب
		99	لا أعلم
WWD6	كيف تقوم بتفريغها؟	1	صهريج يضخ المياه المبتذلة للخارج
		2	مواد كيميائية تنظف الجورة
		3	غير ذلك، حدد ______________
		98	لا جواب
		99	لا أعلم

سوف أطرح عليك بعض الأسئلة حول التخلص من النفايات الصلبة

التخلص من النفايات الصلبة (solid waste disposal)				
SWD1	كيف يتم تخزين النفايات في منزلك؟	1	وعاء - مفتوح	
		2	وعاء - مغلق	
		3	أكياس بلاستيكية	
		4	غير ذلك، حدد	____________
		98	لا جواب	
		99	لا اعلم	
SWD2	كم مرة يتم إخراج النفايات من المنزل؟	1	يومياً	
		2	كل يومين	
		3	مرتين أسبوعيا	
		4	مرة في الأسبوع	
		5	مرات متباعدة	
		6	لا يوجد إمكانية جمع النفايات	
		7	غير ذلك، حدد	____________
		98	لا جواب	
		99	لا اعلم	
SWD3	كيف يتم التخلّص من النفايات؟	1	تجمعها السلطات	
		2	تجمعها المؤسسات المحلية	
		3	تجمعها مؤسسات خاصة	
		4	ترمى داخل حدود البناية	
		5	ترمى على الشارع \ قطعة ارض خالية	
		6	تحرق	
		7	تدفن	
		8	تدوّر	
		9	تطعم للحيوانات	
		10	غير ذلك، حدد	____________
		98	لا جواب	
		99	لا اعلم	
SWD4	كم تبعد حاويات البلدية عن المنزل؟	1	لا يوجد حاويات للبلديّة	
		2	أقل من 50 م	
		3	من 50 - 100 م	
		4	أكثر من 100 م	
		98	لا جواب	
		99	لا اعلم	
SWD5	هل المنزل أو المجمع السكني خالي من النفايات؟	1	نعم	
		2	لا	
		98	لا جواب	
		99	لا اعلم	

تحديد الأولويات (prioritization)		
PR1	ما هما برأيك أهم مشكلتان بيئيتان أساسيتان تعاني منهما اربد/ باب التبانة	______________________ ______________________ ______________________
PR2	ما هما برأيك أهم مشكلتان صحيتان أساسيتان تعاني منهما اربد/ باب التبانة	______________________ ______________________

APPENDIX 2.
LIST OF PARTICIPANTS AT THE INCEPTION MEETING IN TRIPOLI (OCTOBER 25, 2008)

Name	*Organization*	*Contact information*
1- Engineer Rachid Jamali	Tripoli Municipality	
2- Dr. Bechara Eid	جمعية تعاون وتنمية	03/235621
3- Zeina Karameh	اللقاء النسائي الخيري	03/229973 zeinaka@idm.net.lb
4- Nazha Salloum	الإتحاد النسائي ألتقدمي	03/134334
5- Michline Koborsy	Rene Mouawad Foundation	06/382824, 03/839523 michline@hotmail.com
6- Fadwa Mustapha	جمعية الفدى الجتماعية الخيرية	03/130443
7- Khaled Menkara	جمعية الفدى الجتماعية الخيرية	03/141658
8- Sabah Mawloud	جمعية العمل النسوي	06/381112, 03/980547 kmawloud@hotmail.com
9- Dima El Aatal	جمعية العمل النسوي	06/381112
10- Rabih Omar	Tripoli Municipality	70/843826 rabih_omar@hotmail.com
11- Dr. Thamar Al Hamwi	Lebanese University	03/246315 simcima@ul.edu.lb
12- Amira Charamand	Ministry of Social Affairs	06/390567
13- Wafaa Ismail	جمعية العطاء المحب	03/475320
14- Ahmad Aabous	جمعية أل عبوس	03/173097
15- Mohammad Kabara	Safadi Foundation	03/931033
16- Aabdallah Baroudy	Tripoli Municipality	03/279781
17- Abdel Salam Turkomani	Al Balad Newspaper	03/189086
18- Rayyan Sbayti	Rafic Hariri Foundation	70/907817
19- Nadine Munla	Rafic Hariri Foundation	70/113131 socialnadine@hotmail.com
20- Dr. Mutassem El Fadel	American University of Beirut	01/350000
21- Raja Bou Fakher Aldeen	American University of Beirut	01/350000



Selected photos from the inception meeting in Tripoli – October 25, 2008

APPENDIX 3.
REVISED QUESTIONNAIRE FOR TEBBANEH, TRIPOLI

Participatory Improvement of Water and Sanitation Services in Tripoli through a Comparative Analysis in Irbid, Jordan

Questionnaire Identification					
AI1	**Country**	**Lebanon**	AI4	**Building**	|___|___|___|___|___|___|___|
AI2	**Zone**	|___|	AI5	**Floor**	|___|___|
AI3	**Neighbourhood**	____________________	AI6	**Housing unit number**	(Start from right side) |___|___|
Schedule					
AV1	First Visit	DD-MM |___|___|-|___|___|	AT1	Start of interview (time)	hh-mm |___|___|-|___|___|
			AT2	End of Interview (time)	hh-mm |___|___|-|___|___|
AV2	Second Visit	DD-MM |___|___|-|___|___|	AT3	Start of interview	hh-mm |___|___|-|___|___|
			AT4	End of Interview	hh-mm |___|___|-|___|___|
AV3	Third Visit	DD-MM |___|___|-|___|___|	AT5	Start of interview	hh-mm |___|___|-|___|___|
			AT6	End of Interview	hh-mm |___|___|-|___|___|
AV4	Fourth Visit	DD-MM |___|___|-|___|___|	AT7	Start of interview	hh-mm |___|___|-|___|___|
			AT8	End of Interview	hh-mm |___|___|-|___|___|
AV6	**Total visits carried out**				|___|
AV7	**Editing Date**		DD-MM		|___|___|-|___|___|
AV8	**Coding Date**		DD-MM		|___|___|-|___|___|
AV9	**Data entry Date**		DD-MM		|___|___|-|___|___|
Staff					
AS1	**Interviewer**	|___|___|	AS4	**Coder**	|___|___|
AS2	**Supervisor**	|___|___|	AS5	**Data entry operator**	|___|___|
AS3	**Editor**	|___|___|			
Respondent					
Name of household head					
Name of main Respondent					
AR1	**Interview status**				
	1	Interview completed	**COMMENTS:**		
	4	No usable information			
	7	Refusal			

سوف أبدأ بطرح بعض الاسئلة عن العائلة:

	معلومات اجتماعية وديموغرافية (socio-demographic)	
SD1	عدد الغرف في المنزل **(دون المطبخ، الحمام، الشرفة والمخزن/موقف السيارة)**	|___|___|
SD2	عدد الافراد الذين يسكنون في المنزل **(الذين يتشاركون الطعام ومدخل البيت)**	|___|___|
SD3	عدد الافراد الذين يسكنون في المنزل بحسب الفئة العمرية	
SD3A1	دون سنة - ذكر	|___|___|
SD3A2	أنثى	|___|___|
SD3B1	من سنة الى 3 سنوات - ذكر	|___|___|
SD3B2	أنثى	|___|___|
SD3C1	من 3 سنوات الى 10 سنوات - ذكر	|___|___|
SD3C2	أنثى	|___|___|
SD3D1	من 11 سنة الى 18 سنة - ذكر	|___|___|
SD3D2	أنثى	|___|___|
SD3E1	من 19 سنة الى 30 سنة - ذكر	|___|___|
SD3E2	أنثى	|___|___|
SD3F1	من 31 سنة الى 65 سنة - ذكر	|___|___|
SD3F2	أنثى	|___|___|
SD3G1	أكبر من 65 سنة - ذكر	|___|___|
SD3G2	أنثى	|___|___|
SD4	كم عائلة تسكن في هذا المنزل؟	1 عائلة واحدة 2 عائلتان تربطهما قربة 3 عائلتان لا تربطهما قربة 4 زوج واحد وعدة عوائل 5 أكثر من عائلتان 6 غير ذلك، حدد:______________________ 98 لا جواب 99 لا أعلم
SD5	تاريخ ميلاد رب المنزل	اليوم الشهر السنة |___|___| - |___|___| - |___|___|___|___| 98 لا جواب 99 لا أعلم
SD6	عمر رب المنزل	|___|___| 98 لا جواب 99 لا أعلم
SD7	تاريخ ميلاد ربة المنزل	اليوم الشهر السنة |___|___| - |___|___| - |___|___|___|___| 98 لا جواب 99 لا أعلم
SD8	عمر ربة المنزل	|___|___| 98 لا جواب 99 لا أعلم
SD9	أعلى مستوى علمي حصّله رب المنزل	1 لا يجيد القراءة والكتابة 2 يجيد القراءة والكتابة دون تحصيل أي مستوى 3 ابتدائي 4 متوسط

		5	ثانوي
		6	تقني
		7	جامعي
		98	لا جواب
		99	لا أعلم
SD10	أعلى مستوى علمي حصّلته ربة المنزل	1	لا تجيد القراءة والكتابة
		2	تجيد القراءة والكتابة دون تحصيل أي مستوى
		3	ابتدائي
		4	متوسط
		5	ثانوي
		6	تقني
		7	جامعي
		98	لا جواب
		99	لا أعلم
SD11	ما هو عدد الذكور في المنزل الذين يتعلّمون في المدرسة؟		|___|___|
		98	لا جواب
		99	لا أعلم
SD12	أين يتعلّم معظم الاولاد الذكور؟	1	مدرسة خاصة في باب التبانة؟
		2	مدرسة خاصة خارج باب التبانة؟
		3	مدرسة حكومية في باب التبانة؟
		4	مدرسة حكومية خارج باب التبانة؟
		5	غير ذلك، حدد:__________________________
		98	لا جواب
		99	لا أعلم
SD13	أعلى مستوى علمي حصّله الابن الأكبر (حتى إذا لم يعد يسكن معك)	1	لا أبناء ذكور
		2	لا يجيد القراءة والكتابة
		3	يجيد القراءة والكتابة دون تحصيل أي مستوى
		4	ابتدائي
		5	متوسط
		6	ثانوي
		7	تقني
		8	جامعي
		98	لا جواب
		99	لا أعلم
SD14	ما هو عدد الإناث في المنزل الذين يتعلّمون في المدرسة؟		|___|___|
		98	لا جواب
		99	لا أعلم
SD15	أين يتعلّم معظم الاولاد الإناث؟	1	مدرسة خاصة في باب التبانة؟
		2	مدرسة خاصة خارج باب التبانة؟
		3	مدرسة حكومية في باب التبانة؟
		4	مدرسة حكومية خارج باب التبانة؟
		5	غير ذلك، حدد:__________________________
		98	لا جواب
		99	لا أعلم
SD16	أعلى مستوى علمي حصّلته البنت الكبرى	1	لا بنات
		2	لا تجيد القراءة والكتابة

	(حتى إذا لم تعد تسكن معك)	3	تجيد القراءة والكتابة دون تحصيل أي مستوى
		4	ابتدائي
		5	متوسط
		6	ثانوي
		7	تقني
		8	جامعي
		98	لا جواب
		99	لا أعلم
SD17	هل أحد أفراد المنزل هو عضو أو متطوّع أو على علاقة بأية جمعية إجتماعية، تنموية أو ثقافية في باب التبانة أو خارجها؟	1	نعم
		2	كلا
		98	لا جواب
		99	لا أعلم

سوف أطرح عليك بعض الأسئلة حول وضع العمل في منزلك:

العمل (Working Force)				
WF1	ما هو العمل الأساسي لرب المنزل؟		___________	
		98	لا جواب	
		99	لا أعلم	
WF2	أين هو موقع عمله؟		___________	
		98	لا جواب	
		99	لا أعلم	
WF3	ما هو مركزه في العمل؟	1	يعمل لحسابه الخاص	
		2	موظف	
		3	رب عمل	
		4	غير ذلك، حدد	___________
		98	لا جواب	
		99	لا أعلم	
WF4	ما نوع العمل الآخر لرب المنزل؟		___________	
		1	لا عمل آخر	
		98	لا جواب	
		99	لا أعلم	
WF5	ما هو عدد أفراد منزلك الآخرين الذين يعملون حاليّاً؟		|___|___|	
		98	لا جواب	
		99	لا أعلم	
WF5A1	يعملون مقابل أجر خارج المنزل:	ذكور	18 ≥	|___|___|
WF5A2			≤18	|___|___|
WF5A3		إناث	18 ≥	|___|___|
WF5A4			18 ≤	|___|___|
WF5B1	يعملون مقابل أجر من المنزل:	ذكور	18 ≥	|___|___|
WF5B2			18 ≤	|___|___|
WF5B3		إناث	18 ≥	|___|___|
WF5B4			18 ≤	|___|___|
WF5C1	يعملون مع العائلة دون أجر:	ذكور	18 ≥	|___|___|
WF5C2			18 ≤	|___|___|
WF5C3		إناث	18 ≥	|___|___|
WF5C4			18 ≤	|___|___|

WF6	قل لي النسبة المئوية لمساهمة كل مصدر من مصادر الدخل لدخل منزلك الاجمالي:	
WF6A	عمل رب المنزل الأساسي	|___|___|___|
WF6B	عمل رب المنزل الآخر	|___|___|___|
WF6C	عمل أفراد العائلة الآخرين	|___|___|___|
WF6D	إعانات	|___|___|___|
WF6E	غير ذلك، حدد ___________	|___|___|___|

سوف أطرح عليك بعض الأسئلة حول الوضع المالي لمنزلك. (لن أسأل عن أرقام محدّدة)

الوضع المالي (Financial status)			
FS1	هل تملك المنزل الذي تسكن فيه؟	1	نعم
		2	كلا
		98	لا جواب
		99	لا أعلم
FS2	هل لديك في المنزل:		
FS2A	غسالة ملابس	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
FS2B	جلاية أواني	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
FS2C	ثلاجة	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
FS2D	سخان ماء	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
FS2E	خط هاتف أرضي ثابت	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
FS2F	خط هاتف خلوي	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
FS2G	تلفاز	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم

FS2H	كمبيوتر	1 2 98 99	نعم لا لا جواب لا أعلم
FS2I	صحن لاقط	1 2 3 98 99	أمتلك صحن لاقط لدي اشتراك لا لا جواب لا أعلم
FS3	كيف تقيّم مستوى الدخل في منزلك بالمقارنة مع المنازل الأخرى في باب التبّانة	1 2 3 4 5 98 99	أفضل بكثير أفضل ذات المستوى أسوأ أسوأ بكثير لا جواب لا أعلم
FS4	في حال احتاج منزلك فجأةً لمبلغ 150,000 ليرة لبنانيّة، هل تستطيع تأمينه خلال أسبوع؟	1 2 3 98 99	نعم ربما، لكن ليس بالتأكيد لا لا جواب لا أعلم
FS5	إذا كان الجواب نعم، كيف تؤمّن المبلغ؟	1 2 3 4 98 99	استخدم مدّخراتي بمساعدة منظمات بمساعدة الأصدقاء عن طريق بيع بعض الممتلكات لا جواب لا أعلم

سوف أطرح عليك بعض الأسئلة حول الوضع الصحي العام لمنزلك

الوضع الصحّي (Health Status)				
HS1	هل يعاني أحد أفراد المنزل من مرض أو إعاقة مزمنة؟		1 2 98 99	نعم لا لا جواب لا أعلم
HS2	إذا كان الجواب نعم، ما هو المرض، الجنس، والعمر؟			
HS2A1	الفرد الأول	العمر		|___|___|
HS2A2		الجنس	1 2	ذكر أنثى
HS2A3		المرض		____________
HS2A4		الإعاقة		____________
HS2B1	الفرد الثاني	العمر		|___|___|
HS2B2		الجنس	1 2	ذكر أنثى
HS2B3		المرض		____________
HS2B4		الإعاقة		____________

HS2C1	الفرد الثالث	العمر	___ ___
HS2C2		الجنس	1 ذكر 2 أنثى
HS2C3		المرض	______________
HS2C4		الإعاقة	______________
HS2D1	الفرد الرابع	العمر	___ ___
HS2D2		الجنس	1 ذكر 2 أنثى
HS2D3		المرض	______________
HS2D4		الإعاقة	______________
HS2E1	الفرد الخامس	العمر	___ ___
HS2E2		الجنس	1 ذكر 2 أنثى
HS2E3		المرض	______________
HS2E4		الإعاقة	______________
HS3	هل عانى أحد أفراد المنزل من الإسهال في الثلاثة أشهر الماضية؟		1 نعم 2 لا 98 لا جواب 99 لا أعلم
HS3A	إذا كان الجواب نعم، ما هو المرض، الجنس، والعمر؟		
HS3A1	الفرد الأول	العمر	___ ___
HS3A2		الجنس	1 ذكر 2 أنثى
HS3A3		المرض	1 إسهال 2 تيفوئيد 3 التهاب الكبد (Hepatitis A) 4 غير ذلك، حدد ______________
HS3A4a		الأعراض	1 إسهال
HS3A4b			2 استفراغ
HS3A4c			3 حرارة مرتفعة
HS3A4d			4 أوجاع في المعدة
HS3A4e			5 غير ذلك، حدد ______________
HS3A5		كم يوم اضطر المريض البقاء في المنزل بسبب المرض؟	___ ___
HS3A8		من اهتمّ بالمريض خلال فترة مرضه؟	______________
HS3A6		للعلاج هل تم اللجوء الى	1 المستشفى 2 المستوصف 3 عيادة خاصة 4 الطبيب يزورني في المنزل 5 لا أحد 6 غير ذلك، حدد ______________ 98 لا جواب 99 لا أعلم
HS3A7a		ما كانت تكلفة العلاج بالليرة اللبنانيّة؟	التكلفة الإجماليّة ___ ___ ___ ___ ___ ___
HS3A7b			ثمن الدواء ___ ___ ___ ___ ___ ___

HS3A7c			أجرة الطبيب في المستوصف	___ ___ ___ ___ ___ ___
HS3A7d			أجرة الطبيب في المنزل	___ ___ ___ ___ ___ ___
HS3A7e			أجرة المستشفى	___ ___ ___ ___ ___ ___
HS3A7f			98	لا جواب
			99	لا أعلم
HS3B1	الفرد الثاني	العمر	___ ___	
HS3B2		الجنس	1	ذكر
			2	أنثى
HS3B3		المرض	1	إسهال
			2	تيفوئيد
			3	التهاب الكبد (Hepatitis A)
			4	غير ذلك، حدد ____________________
HS3B4a		الأعراض	1	إسهال
HS3B4b			2	استفراغ
HS3B4c			3	حرارة مرتفعة
HS3B4d			4	أوجاع في المعدة
HS3B4f			5	غير ذلك، حدد ____________________
HS3B5		كم يوم اضطر المريض البقاء في المنزل بسبب المرض؟		___ ___
HS3B8		من اهتمّ بالمريض خلال فترة مرضه؟		____________________
HS3B6		للعلاج هل تم اللجوء الى	1	المستشفى
			2	المستوصف
			3	عيادة خاصة
			4	الطبيب يزورني في المنزل
			5	لا أحد
			6	غير ذلك، حدد __________
			98	لا جواب
			99	لا أعلم
HS3B7a		ما كانت تكلفة العلاج بالليرة اللبنانيّة؟	التكلفة الإجماليّة	___ ___ ___ ___ ___ ___
HS3B7b			ثمن الدواء	___ ___ ___ ___ ___ ___
HS3B7c			أجرة الطبيب في المستوصف	___ ___ ___ ___ ___ ___
HS3B7d			أجرة الطبيب في المنزل	___ ___ ___ ___ ___ ___
HS3B7e			أجرة المستشفى	___ ___ ___ ___ ___ ___
HS3B7f			98	لا جواب
			99	لا أعلم
HS3C1	الفرد الثالث	العمر	___ ___	
HS3C2		الجنس	1	ذكر
			2	أنثى

HS3C3		المرض	1	إسهال
			2	تيفؤيد
			3	التهاب الكبد (Hepatitis A)
			4	غير ذلك، حدد ________________________
HS3C4a		الأعراض	1	إسهال
HS3C4b			2	استفراغ
HS3C4c			3	حرارة مرتفعة
HS3C4d			4	أوجاع في المعدة
HS3C4e			5	غير ذلك، حدد _________________________
HS3C5		كم يوم اضطر المريض البقاء في المنزل بسبب المرض؟	|___|___|	
HS3C8		من اهتمّ بالمريض خلال فترة مرضه؟ _____________________		
HS3C6		للعلاج هل تم اللجوء الى	1	المستشفى
			2	المستوصف
			3	عيادة خاصة
			4	الطبيب يزورني في المنزل
			5	لا أحد
			6	غير ذلك، حدد ___________
			98	لا جواب
			99	لا أعلم
HS3C7a		ما كانت تكلفة العلاج بالليرة اللبنانيّة؟	التكلفة الإجماليّة	|___|___|___|___|___|___|
HS3C7b			ثمن الدواء	|___|___|___|___|___|___|
HS3C7d			أجرة الطبيب في المستوصف	|___|___|___|___|___|___|
HS3C7e			أجرة الطبيب في المنزل	|___|___|___|___|___|___|
HS3C7f			أجرة المستشفى	|___|___|___|___|___|___|
HS3C7g			98	لا جواب
			99	لا أعلم
HS3D1	الفرد الرابع	العمر	|___|___|	
HS3D2		الجنس	1	ذكر
			2	أنثى
HS3D3		المرض	1	إسهال
			2	تيفؤيد
			3	التهاب الكبد (Hepatitis A)
			4	غير ذلك، حدد ________________________
HS3D4a		الأعراض	1	إسهال
HS3D4b			2	استفراغ
HS3D4c			3	حرارة مرتفعة
HS3D4e			4	أوجاع في المعدة
HS3D4f			5	غير ذلك، حدد _________________________
HS3D5		كم يوم اضطر المريض البقاء في المنزل بسبب	|___|___|	

	المرض؟			
HS3D8	من اهتمّ بالمريض خلال فترة مرضه؟			____________________
HS3D6	للعلاج هل تم اللجوء الى	1	المستشفى	
		2	المستوصف	
		3	عيادة خاصة	
		4	الطبيب يزورني في المنزل	
		5	لا أحد	
		6	غير ذلك، حدد ___________	
		98	لا جواب	
		99	لا أعلم	
HS3D7a	ما كانت تكلفة العلاج بالليرة اللبنانيّة؟		التكلفة الإجماليّة	|___|___|___|___|___|___|
HS3D7b			ثمن الدواء	|___|___|___|___|___|___|
HS3D7c			أجرة الطبيب في المستوصف	|___|___|___|___|___|___|
HS3D7e			أجرة الطبيب في المنزل	|___|___|___|___|___|___|
HS3D7f			أجرة المستشفى	|___|___|___|___|___|___|
HS3D7g		98		لا جواب
		99		لا أعلم
HS4	في العموم، اذا احتاج أحد أفراد منزلك للطبابة، الى أين تلجأ؟	1	مستوصف عام في باب التبّانة	
		2	مستوصف عام خارج باب التبّانة	
		3	عيادة خاصة في باب التبّانة	
		4	عيادة خاصة خارج باب التبّانة	
		5	مستشفى خارج باب التبّانة	
		6	زيارة منزليّة	
		7	غير ذلك، حدد ________________	
		98	لا جواب	
		99	لا أعلم	
HS5	لما فضلت هذا الخيار؟	1	لأنه الخيار الأوفر	
		2	لأنه الخيار الأفضل	
		3	لأنه اكثر راحة من غيره	
		4	لأني أثق به أكثر	
		5	لأنه لدينا تأمين عام (ضمان)	
		6	لأنه لدينا تأمين خاص	
		7	غير ذلك، حدد ________________	
		98	لا جواب	
		99	لا أعلم	
HS6	هل حصل في منزلك حالة وفاة أطفال بسبب الإسهال	1	نعم	
		2	كلا	
		98	لا جواب	
		99	لا أعلم	
HS6A1	إذا الجواب نعم، متى حصلت		________ الشهر	

	الوفاة؟	|___|___|___|___| السنة
HS6A2	ما كان عمر الطفل عند وفاته؟	|___|___| شهر

الآن سوف أسأل عن المياه في المنزل

مصادر المياه (water sources)				
WS1	ما هي مصادر المياه التي تصل الى المنزل؟			
WS1A		شبكة المياه العامة	1 2 99	نعم كلا لا أعلم
WS1B		بئر	1 2 99	نعم كلا لا أعلم
WS1C		صهريج مياه	1 2 99	نعم كلا لا أعلم
WS1D		مياه منقولة باليد	1 2 99	نعم كلا لا أعلم
WS1E		مياه معبأة	1 2 99	نعم كلا لا أعلم
WS1F		غير ذلك، حدد: ______		
WS2A WS2B WS2C WS2D WS2E WS2F	حدد النسبة المئوية لكل مصدر بحسب الكمية التي تحصل عليها في الشتاء (المجموع يجب أن يكون 100%)	شبكة المياه العامة بئر صهريج مياه مياه منقولة باليد مياه معبأة غير ذلك		|___|___|% |___|___|% |___|___|% |___|___|% |___|___|% |___|___|%
WS3A WS3B WS3C WS3D WS3E WS3F	حدد النسبة المئوية لكل مصدر بحسب الكمية التي تحصل عليها في الصيف (المجموع يجب أن يكون 100%)	شبكة المياه العامة بئر صهريج مياه مياه منقولة باليد مياه معبأة غير ذلك		|___|___|% |___|___|% |___|___|% |___|___|% |___|___|% |___|___|%
WS4	كم برميل مياه يستهلك منزلك يومياً في فصل الصيف		 99	|___|___| برميل/يوم لا أعلم
WS5	كم برميل مياه يستهلك منزلك يومياً في فصل الشتاء		 99	|___|___| برميل/يوم لا أعلم
WS6	هل تكفيك كميّة مياه الإستعمال التي تصل الى منزلك في فصل الصيف ؟		1 2 3 4 98 99	أكثر من كافية كافية بالكاد تكفي لا تكفي لا جواب لا أعلم
WS7	هل تكفيك كميّة مياه الإستعمال التي تصل الى منزلك في فصل الشتاء؟		1 2	أكثر من كافية كافية

		3	بالكاد تكفي
		4	لا تكفي
		98	لا جواب
		99	لا أعلم
WS8	هل أنت راضٍ عن نوعيّة مياه الاستعمال التي تصل الى منزلك فيً فصل الصيف؟	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
WS9	لماذا أنت غير راضٍ؟	1	المياه ليست صافية
		2	هناك رائحة كلور في المياه
		3	المياه ملوّثة
		4	غير ذلك، حدد ______________
		98	لا جواب
		99	لا أعلم
WS10	هل أنت راضٍ عن نوعيّة مياه الاستعمال التي تصل الى منزلك فيً فصل الشتاء؟	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم
WS11	لماذا أنت غير راضٍ؟	1	المياه ليست صافية
		2	هناك رائحة كلور في المياه
		3	المياه ملوّثة
		4	غير ذلك، حدد ______________
		98	لا جواب
		99	لا أعلم

إذا كنت تحصل على المياه من الشبكة العامّة

مياه الشبكة العامة (network water)					
NW1	هل لديك عداد أم عيار بالمتر المكعب؟		1 2 3 4 99	عداد عيار بالمتر المكعب لا عداد ولا عيار غير ذلك، حدد ______________ لا أعلم	
NW2A	إذا كان لديك عدّاد	رقم العداد	____________________		
NW2B		فاتورة كلّ	|___|___|		شهر
NW2C		الكمية المستهلكة في آخر فاتورة عداد	|___|___|___|___|		متر مكعب
NW2D		القيمة المدفوعة في آخر فاتورة	|___|___|___|___|		ليرة
NW3A	إذا كان لديك عيار بالمتر المكعب	ما قيمة فاتورتك السنويّة؟	|___|___|___|___|		ليرة
NW3B		ما قياس العيار؟	|___|___|		مم
NW4A	ما هي استخدامات المياه التي تحصل عليها من شبكة المياه العامة	للشرب	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4B		لغسل الأيدي	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4C		للاستحمام	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4D		لغسل الطعام	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4E		للطبخ	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4F		لغسل الصحون	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4G		لتنظيف البيت	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4H		في غرفة الغسيل	1 2 3 99	نعم كلا أحياناً لا أعلم	

NW4I	للري	1 2 3 99	نعم كلا أحياناً لا أعلم
NW4J	غير ذلك، حدد:_____________		
NW5	ما وتيرة تزويد المياه عبر الشبكة العامّة؟	 2 1 98 99	|___| مرة في الأسبوع متقطَع لكن لا يمكن تحديد الوتيرة بشكل مستمر لا جواب لا أعلم
NW6	كم تبقى المياه مزوّدة حين تأتي؟	 2 1 98 99	|___|___| ساعة متقطَع لكن لا يمكن التحديد بشكل مستمر لا جواب لا أعلم
NW7	كيف تجد نوعية هذه المياه؟	1 2 3 98 99	جيدة (دون لون، طعم، رائحة، ورواسب) متوسطة (بعض اللون، طعم، رائحة، ورواسب) سيئة (ذات لون، طعم، رائحة، ورواسب) لا جواب لا أعلم

إذا كنت تحصل على المياه من الآبار

مياه الآبار (Well water)					
WW1	عدد الآبار التي تصل منها مياه الى المنزل |___|				
WW2		A	B	C	D
		البئر 1	**البئر 2**	**البئر 3**	**البئر 4**
1	إسم البئر (إذا أمكن)	______ 99 لا أعلم	______ 99 لا أعلم	______ 99 لا أعلم	______ 99 لا أعلم
2	نوع البئر	1 خاص للمنزل 2 مشترك بين عدة منازل 3 مشترك للحي 99 لا أعلم	1 خاص للمنزل 2 مشترك بين عدة منازل 3 مشترك للحي 99 لا أعلم	1 خاص للمنزل 2 مشترك بين عدة منازل 3 مشترك للحي 99 لا أعلم	1 خاص للمنزل 2 مشترك بين عدة منازل 3 مشترك للحي 99 لا أعلم
3	حالة البئر	1 مغطّى 2 مفتوح 99 لا أعلم	1 مغطّى 2 مفتوح 99 لا أعلم	1 مغطّى 2 مفتوح 99 لا أعلم	1 مغطّى 2 مفتوح 99 لا أعلم
4	طريقة السحب	1 مضخّة 2 نقل باليد 3 غير ذلك، حدد: ______ 99 لا أعلم	1 مضخّة 2 نقل باليد 3 غير ذلك، حدد: ______ 99 لا أعلم	1 مضخّة 2 نقل باليد 3 غير ذلك، حدد: ______ 99 لا أعلم	1 مضخّة 2 نقل باليد 3 غير ذلك، حدد: ______ 99 لا أعلم
WW3A	ما هي استخدامات المياه التي تحصل عليها من البئر للشرب	1 نعم 2 كلا 3 أحياناً 99 لا أعلم			

WW3B	لغسل الأيدي	1 2 3 99	نعم كلا أحياناً لا أعلم
WW3C	للاستحمام	1 2 3 99	نعم كلا أحياناً لا أعلم
WW3D	لغسل الطعام	1 2 3 99	نعم كلا أحياناً لا أعلم
WW3E	للطبخ	1 2 3 99	نعم كلا أحياناً لا أعلم
WW3F	لغسل الصحون	1 2 3 99	نعم كلا أحياناً لا أعلم
WW3G	لتنظيف البيت	1 2 3 99	نعم كلا أحياناً لا أعلم
WW3H	في غرفة الغسيل	1 2 3 99	نعم كلا أحياناً لا أعلم
WW3I	للري	1 2 3 99	نعم كلا أحياناً لا أعلم
WW3J	غير ذلك، حدد:_______________		
WW4	ما وتيرة تزويد المياه عبر الآبار؟	 98 99	|___| مرة في الأسبوع لا جواب لا أعلم
WW5	كم تبقى المياه مزوّدة حين تأتي؟	 98 99	|___|___| ساعة لا جواب لا أعلم
WW6	ماذا تدفع مقابل مياه الآبار	1 98 99	لا شيء |___|___| ليرة شهرياً لا جواب لا أعلم

WW7	كيف تجد نوعية هذه المياه؟	1 جيدة (دون لون، طعم، رائحة، ورواسب) 2 متوسطة (بعض اللون، طعم، رائحة، ورواسب) 3 سيئة (ذات لون، طعم، رائحة، ورواسب) 98 لا جواب 99 لا أعلم

إذا كنت تحصل على المياه من الصهاريج:

صهاريج المياه (Water tankers)			
WT1A	ما هي استخدامات المياه التي تحصل عليها من صهاريج المياه	للشرب	1 نعم 2 كلا 3 أحياناً 99 لا أعلم
WT1B		لغسل الأيدي	1 نعم 2 كلا 3 أحياناً 99 لا أعلم
WT1C		للاستحمام	1 نعم 2 كلا 3 أحياناً 99 لا أعلم
WT1D		لغسل الطعام	1 نعم 2 كلا 3 أحياناً 99 لا أعلم
WT1E		للطبخ	1 نعم 2 كلا 3 أحياناً 99 لا أعلم
WT1F		لغسل الصحون	1 نعم 2 كلا 3 أحياناً 99 لا أعلم
WT1G		لتنظيف البيت	1 نعم 2 كلا 3 أحياناً 99 لا أعلم
WT1H		في غرفة الغسيل	1 نعم 2 كلا 3 أحياناً 99 لا أعلم
WT1I		للري	1 نعم 2 كلا 3 أحياناً 99 لا أعلم
WT1J		غير ذلك، حدد: ____________	

WT2	كم مرّة في الاسبوع يحصل المنزل على صهريج؟	|___|___|	
WT3	ما هي سعة الصهريج؟	|___|___|	متر مكعب
WT4	كم تدفع عن كل صهريج؟	|___|___|___|___|___|	ليرة
WT5	كيف تجد نوعية هذه المياه؟	1 جيدة (دون لون، طعم، رائحة، ورواسب) 2 متوسطة (بعض اللون، طعم، رائحة، ورواسب) 3 سيئة (ذات لون، طعم، رائحة، ورواسب) 98 لا جواب 99 لا أعلم	

إذا كنت تنقل المياه شخصياً باليد:

المياه المنقولة باليد (Hand-carried)				
HC1	كم مرة تحضر الماء إلى المنزل يومياً؟		|___|___| 99 لا أعلم	مرة
HC2	ما كمية الماء في كل مرة؟		|___|___| 99 لا أعلم	ليتر
HC3	هل تدفع مقابل هذه المياه؟		1 نعم 2 كلا 98 لا جواب	
HC4	إذا كان الجواب نعم، كم تدفع؟		|___|___|___|___| 99 لا أعلم	ليرة
HC5	كم دقيقة تستغرق من الوقت لإحضار المياه الى المنزل؟		|___|___|___| 99 لا أعلم	دقيقة
HC6A	ما هي استخدامات المياه المنقولة باليد؟	للشرب	1 نعم 2 كلا 3 أحياناً 99 لا أعلم	
HC6B		لغسل الأيدي	1 نعم 2 كلا 3 أحياناً 99 لا أعلم	
HC6C		للاستحمام	1 نعم 2 كلا 3 أحياناً 99 لا أعلم	
HC6D		لغسل الطعام	1 نعم 2 كلا 3 أحياناً 99 لا أعلم	
HC6E		للطبخ	1 نعم 2 كلا 3 أحياناً 99 لا أعلم	
HC6F		لغسل الصحون	1 نعم 2 كلا 3 أحياناً 99 لا أعلم	

HC6G	لتنظيف البيت	1 2 3 99	نعم كلا أحياناً لا أعلم
HC6H	في غرفة الغسيل	1 2 3 99	نعم كلا أحياناً لا أعلم
HC6I	للري	1 2 3 99	نعم كلا أحياناً لا أعلم
HC6J	غير ذلك، حدد:_______________		
HC7	كيف تجد نوعية هذه المياه؟	1 2 3 98 99	جيدة (دون لون، طعم، رائحة، ورواسب) متوسطة (بعض اللون، طعم، رائحة، ورواسب) سيئة (ذات لون، طعم، رائحة، ورواسب) لا جواب لا أعلم

إذا كنت تشتري المياه المعبأة:

المياه المعبأة (bottled water)			
BW1	كم عبوة يستهلك المنزل في الاسبوع؟	 99	|___|___| لا أعلم
BW2	ما هي سعة العبوة؟	 99	|___|___| ليتر لا أعلم
BW3	إسم العبوة (إذا أمكن)		______________________________
BW4	كم تدفع عن كل عبوة؟	 99	|___|___|___|___|___| ليرة لا أعلم
BW5A	ما هي استخدامات المياه المعبأة؟ للشرب	1 2 3 99	نعم كلا أحياناً لا أعلم
BW5B	لغسل الأيدي	1 2 3 99	نعم كلا أحياناً لا أعلم
BW5C	للاستحمام	1 2 3 99	نعم كلا أحياناً لا أعلم
BW5D	لغسل الطعام	1 2 3 99	نعم كلا أحياناً لا أعلم

BW5E	للطبخ	1 2 3 99	نعم كلا أحياناً لا أعلم
BW5F	لغسل الصحون	1 2 3 99	نعم كلا أحياناً لا أعلم
BW5G	لتنظيف البيت	1 2 3 99	نعم كلا أحياناً لا أعلم
BW5H	في غرفة الغسيل	1 2 3 99	نعم كلا أحياناً لا أعلم
BW5I	للري	1 2 3 99	نعم كلا أحياناً لا أعلم
BW5J	غير ذلك، حدد:__________		
BW6	كيف تجد نوعية هذه المياه؟	1 2 3 98 99	جيدة (دون لون، طعم، رائحة، ورواسب) متوسطة (بعض اللون، طعم، رائحة، ورواسب) سيئة (ذات لون، طعم، رائحة، ورواسب) لا جواب لا أعلم

الآن سوف أسأل عن المياه التي تستخدمها للشرب:

مياه الشرب (drinking water)			
DW1	ما هي كميّة مياه الشرب التي يستهلكها منزلك يومياً في فصل الصيف	 99	|___|___| ليتر لا أعلم
DW2	ما هي كميّة مياه الشرب التي يستهلكها منزلك يومياً في فصل الشتاء	 99	|___|___| ليتر لا أعلم
DW3	هل أنت راضٍ على نوعيّة مياه الشرب التي تستهلك؟	1 2 98 99	نعم لا لا جواب لا أعلم
DW4	لماذا أنت غير راضٍ؟	1 2 3 4 98 99	المياه ليست صافية هناك رائحة كلور في المياه المياه ملوّثة غير ذلك، حدد _____________ لا جواب لا أعلم

DW5	إذا أصبحت غير راض عن نوعية مياه الشرب التي تستهلك حالياً، ما المصدر البديل الذي قد تلجأ إليه؟	1 2 3 4 5 98 99	لا مصدر بديل مياه نبع مياه بئر أشتري مياه معبأة غير ذلك، حدد __________ لا جواب لا أعلم
DW6	هل تتخذ أي إجراء لتحسين نوعية المياه قبل شربها؟	1 2 3 4 5 98 99	لا غليها تركها بضع ساعات تحت أشعة الشمس ترشيح (فلتر) غير ذلك، حدد __________ لا جواب لا أعلم

الآن سوف أسأل عن تخزين المياه في منزلك:

تخزين المياه (water tanks)			
WT1	هل للمنزل خزان مياه؟	1 2 98 99	نعم لا لا جواب لا أعلم
WT2A WT2B WT2C WT2D WT2E WT2F WT2G WT2H WT2I WT2J WT2K	ما نوع هذه الخزانات؟	1 2 3 4 5 6 7 8 10 98 99	خزان معدني فوق المنزل خزان بلاستيكي فوق المنزل خزان فايبر جلاس فوق المنزل خزان إسمنتي فوق المنزل خزان ارضي معدني خزان ارضي بلاستيكي خزان ارضي فايبر جلاس خزان ارضي إسمنتي برميل لا جواب لا أعلم
WT3	ما سعة هذا الخزان؟	 98 99	|___|___| برميل لا جواب لا أعلم
WT4	هل تمزج المياه الآتية من كافة المصادر في الخزان؟	1 2 98 99	نعم لا لا جواب لا أعلم

WT5	كم مرة تنظّف خزان المياه؟	1	ولا مرة
		2	مرة كل سنتين
		3	مرة كل ثلاث سنوات
		4	سنوياً
		5	كل ستة اشهر
		6	غير ذلك، حدد_________
		98	لا جواب
		99	لا أعلم
WT6	هل تستخدم أي مادّة لمعالجة المياه في الخزان؟	1	لا
		2	نعم، منتجات الكلور
		3	نعم، منتجات بتروليّة
		4	غير ذلك، حدد____________
		98	لا جواب
		99	لا أعلم
WT7	كيف يتم سحب المياه من الخزان؟	1	دلو
		2	أوعية خاصة
		3	مضخة موصولة بصنابير المنزل
		4	صنبور
		5	غير ذلك، حدد____________
		98	لا جواب
		99	لا أعلم
WT8	هل تستخدم مياه الخزان للشرب؟	1	نعم
		2	لا
		98	لا جواب
		99	لا أعلم

سوف أطرح عليك بعض الأسئلة حول التجهيزات والممارسات الصحيّة

التجهيزات والممارسات الصحيّة (personal hygiene and fixtures)			
PH1	هل يوجد دوش\ حوض استحمام في المنزل؟	1	نعم, خاص بالعائلة
		2	نعم, مشترك مع عوائل أخرى
		3	لا يوجد
		98	لا جواب
		99	لا اعلم
PH2	أين يتم غسل اليدين عادة؟	1	مغسلة داخل الحمام أو قريبة منه
		2	مغسلة ليست داخل الحمام أو قريبة منه
		3	مغسلة في المطبخ
		4	مغسلة في الحديقة
		5	صنبور في فناء المنزل
		6	مكان أخر, حدد ____________
		7	نادراً ما تغسل الأيدي
		98	لا جواب
		99	لا اعلم
PH4	هل يوجد ماء ساخن باستمرار؟	1	نعم
		2	لا
		98	لا جواب
		99	لا اعلم
PH5	أين يتم غسل الصحون؟	1	في المطبخ

		2	في الحديقة
		3	مجرى الماء
		98	لا جواب
		99	لا اعلم
وجّهي هذه الأسئلة الى الشخص الذي يحضّر الطعام ويعتني يالأطفال:			
PH6A	متى تغسل يديك؟ عّددِ	1	بعد الدخول الى الحمام
PH6B		2	بعد تغيير حفاضات الأطفال
PH6C		3	قبل تحضير الطعام
PH6D		4	قبل الأكل
PH6E		5	قبل إطعام الأطفال
PH6F		98	لا جواب
PH6G		99	لا اعلم
PH7A	هل يمكنكِ ان تريني كيف تغسل يديك عادةً؟	1	تستعمل المياه فقط
PH7B	**(راقب طريقة غسل اليدين ودوّر الطرق المعتمدة)**	2	تستعمل الياه والصابون
PH7C		3	تغسل اليدين الاثنين
PH7D		4	تفرك اليدين معا أقّله ثلاث مرات
PH7E		5	تجفّفين يديك بإستعمال فوطة نظيفة
PH7F		98	لا جواب
PH7G		99	لا اعلم

سوف أطرح عليك بعض الأسئلة حول التخلص من المياه المبتذلة

التخلص من المياه المبتذلة (wastewater disposal)			
WWD1	هل تشارك احد في الحمام؟	1	لا ـ مرحاض خاص داخل المنزل
		2	نعم ـ مع عوائل أخرى
		3	نعم ـ مرحاض عام
		98	لا جواب
		99	لا أعلم
WWD2	أين يوجد الحمام؟	1	داخل المنزل
		2	داخل البناية ـ خارج المنزل
		3	خارج البناية
		98	لا جواب
		99	لا أعلم
WWD3	هل يوجد مغسلة بالقرب من أو داخل الحمام؟	1	نعم ـ داخل الحمام
		2	نعم ـ بالقرب من الحمام
		3	لا ـ بعيدة عن الحمام
		98	لا جواب
		99	لا أعلم
WWD4	كيف يتخلص منزلك من المياه المبتذلة؟	1	جورة صحية
		2	شبكة المجاري
		3	في قناة مغطاة
		4	في قناة مفتوحة
		5	غير ذلك، حدد ____________
		98	لا جواب
		99	لا أعلم

WWD5	إذا كان لديك جورة صحيّة، ما وتيرة تفريغها؟		|___|___|
		98	لا جواب
		99	لا أعلم
WWD6	كيف تقوم بتفريغها؟	1	صهريج يضخ المياه المبتذلة للخارج
		2	مواد كيميائية تنظف الجورة
		3	غير ذلك، حدد ____________________
		98	لا جواب
		99	لا أعلم
WWD7	هل يعاني المبنى/المسكن الذي تقطنه من أي مشكلة في نظام صرف المياه المبتذلة؟	1	غير موصول بشبكة التصريف العامة
		2	تجمّع المياه المبتذلة في الطابق السفلي/الملجأ
		3	إنسدادات
		4	روائح
		5	تشققات وتسرب
		6	غير ذلك، حدد ____________________
		98	لا جواب
		99	لا أعلم

سوف أطرح عليك بعض الأسئلة حول التخلص من النفايات الصلبة

التخلص من النفايات الصلبة (solid waste disposal)				
SWD1	كيف يتم تخزين النفايات في منزلك؟	1	وعاء - مفتوح	
		2	وعاء - مغلق	
		3	أكياس بلاستيكية	
		4	غير ذلك، حدد	________
		98	لا جواب	
		99	لا اعلم	
SWD2	كم مرة يتم إخراج النفايات من المنزل؟	1	يومياً	
		2	كل يومين	
		3	مرتين أسبوعيا	
		4	مرة في الأسبوع	
		5	مرات متباعدة	
		6	لا يوجد إمكانية جمع النفايات	
		7	غير ذلك، حدد	________
		98	لا جواب	
		99	لا اعلم	
SWD3	كيف يتم التخلّص من النفايات؟	1	تجمعها السلطات	
		2	تجمعها المؤسسات المحلية	
		3	تجمعها مؤسسات خاصة	
		4	ترمى داخل حدود البناية	
		5	ترمى على الشارع \ قطعة ارض خالية	
		6	تحرق	
		7	تدفن	
		8	تدوّر	
		9	تطعم للحيوانات	
		10	غير ذلك، حدد	________
		98	لا جواب	
		99	لا اعلم	
SWD4	كم تبعد حاويات البلدية عن المنزل؟	1	لا يوجد حاويات للبلديّة	
		2	أقل من 50 م	
		3	من 50 - 100 م	
		4	أكثر من 100 م	
		98	لا جواب	
		99	لا اعلم	
SWD5	هل المنزل أو المجمع السكني خالي من النفايات؟	1	نعم	
		2	لا	
		98	لا جواب	
		99	لا اعلم	

تحديد الأولويات (prioritization)		
PR1	ما هما برأيك أهم مشكلتان بيئيتان أساسيتان تعاني منهما باب التبانة	________ ________

PR2	ما هما برأيك أهم مشكلتان صحيتان أساسيتان تعاني منهما باب التبانة	______________________ ______________________

الإستعداد للدفع (willingness to pay)		
WTP1	في حال تأمّنت لك المياه بنوعية وكمّية أفضل ما هو المبلغ الشهري الذي تستطيع تأمينه للإشتراك في هذه الخدمة (الليرة اللبنانيّة)	|___|___|___|___|___|___|___|___|___|
WTP2	في حال تأمّن لك تحسين إمدادات الصرف الصحّي ما هو المبلغ الشهري الذي تستطيع تأمينه للإستفادة من هذه الخدمة (الليرة اللبنانيّة)	||___|___|___|___|___|___|___|___|___|

ملاحظات:

____

____

____

____

____

____

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____

____

APPENDIX 4.
QUESTIONNAIRE USED FOR THE SURVEY OF DISPENSARIES

المسح الصحّي للمستوصفات في التبّانة

1. **إسم الباحث:** ______________________
2. **تاريخ البحث:** ______________________

---

3. **إسم وموقع المستوصف:** ______________________
   - 3.1 إسم الطبيب: ______________________
   - 3.2 رقم الهاتف: ______________________

4. **عدد إصابات الإسهال التي سجّلت في المستوصف خلال الفترة الممتدّة ما بين أيلول 2008 وأيلول 2009:** ______________________

4.1 ما هي كلفة معالجة إصابة الإسهال الواحدة (الليرة اللبنانيّة):

	الحد الأدنى:	الحد الأقصى:
اجرة المستوصف:	________	________
ثمن الدواء:	________	________
تكاليف أخرى:	________	________
التكلفة الإجماليّة:	________	________

4.2 ما هي الأدوية الأكثر شيوعاً لمعالجة حالات الإسهال:

إسم الدواء:	عدد الوحدات:
________	________
________	________
________	________

5. **عدد إصابات التيفوئيد التي سجّلت في المستوصف خلال الفترة الممتدّة ما بين <u>أيلول 2008</u> و<u>أيلول 2009</u>:**

5.1 ما هي كلفة علاج حالة التيفوئيد الواحدة (الليرة اللبنانيّة):

	الحد الأدنى:	الحد الأقصى:
اجرة المستوصف:	________	________
ثمن الدواء:	________	________
تكاليف أخرى:	________	________
التكلفة الإجماليّة:	________	________

5.2 ما هي الأدوية الأكثر شيوعاً لمعالجة حالات التيفوئيد:

إسم الدواء:	عدد الوحدات:
________	________
________	________

6. **يعتبر عدد إصابات الإسهال والتيفوئيد الذي سجّل في المستوصف المعني خلال الفترة الواقعة ما بين أيلول 2008 وأيلول 2009:**
   - ❑ دون المعدّل السنوي للحالات المسجلة خلال الثلاث إلى خمس سنوات السابقة
   - ❑ فوق المعدّل السنوي للحالات المسجلة خلال الثلاث إلى خمس سنوات السابقة
   - ❑ ضمن المعدّل السنوي للحالات المسجلة خلال الثلاث إلى خمس سنوات السابقة

إن كان الجواب <u>دون</u> أو <u>فوق</u> المعدّل السنوي، ما هي الأسباب المحتملة لذلك؟

____

____

ملاحظات عامة:

هل مجمل الإصابات من الأطفال أو البالغين؟ ______________________

هل حصل أي إنتشار وبائي في الفترة الأخيرة؟ ______________________

APPENDIX 5.
POST-INTERVENTION SURVEY QUESTIONNAIRE IN TEBBANEH

Participatory Improvement of Water Services in Tripoli

<table>
<tr><th colspan="6">Questionnaire Identification</th></tr>
<tr><td>AI1</td><td>Country</td><td>Lebanon</td><td>AI4</td><td>Building</td><td>|___|___|___|___|___|___|</td></tr>
<tr><td>AI2</td><td>Zone</td><td>|___|</td><td>AI5</td><td>Floor</td><td>|___|___|</td></tr>
<tr><td>AI3</td><td>Neighbourhood</td><td>________________________</td><td>AI6</td><td>Housing unit number</td><td>(Start from right side) |___|</td></tr>
<tr><th colspan="6">Schedule</th></tr>
<tr><td>AV1</td><td>First Visit</td><td>DD.MM.YY
|___|___|.|___|___|.|___|___|</td><td>AT1</td><td>Start of interview (time)</td><td>hh:mm
|___|___|:|___|___|</td></tr>
<tr><td></td><td></td><td></td><td>AT2</td><td>End of Interview (time)</td><td>hh:mm
|___|___|:|___|___|</td></tr>
<tr><td>AV2</td><td>Second Visit</td><td>DD.MM.YY
|___|___|.|___|___|.|___|___|</td><td>AT3</td><td>Start of interview</td><td>hh:mm
|___|___|:|___|___|</td></tr>
<tr><td></td><td></td><td></td><td>AT4</td><td>End of Interview</td><td>hh:mm
|___|___|:|___|___|</td></tr>
<tr><td></td><td></td><td></td><td>AT10</td><td>End of Interview</td><td>hh:mm
|___|___|:|___|___|</td></tr>
<tr><td>AV6</td><td colspan="5">Total visits carried out |___|</td></tr>
<tr><td>AV7</td><td colspan="2">Editing Date</td><td colspan="2">DD.MM.YY</td><td>|___|___|.|___|___|.|___|___|</td></tr>
<tr><td>AV8</td><td colspan="2">Coding Date</td><td colspan="2">DD.MM.YY</td><td>|___|___|.|___|___|.|___|___|</td></tr>
<tr><td>AV9</td><td colspan="2">Data entry Date</td><td colspan="2">DD.MM.YY</td><td>|___|___|.|___|___|.|___|___|</td></tr>
<tr><th colspan="6">Staff</th></tr>
<tr><td>AS1</td><td>Interviewer</td><td>|___|___|</td><td>AS4</td><td>Coder</td><td>|___|___|</td></tr>
<tr><td>AS2</td><td>Supervisor</td><td>|___|___|</td><td>AS5</td><td>Data entry operator</td><td>|___|___|</td></tr>
<tr><td>AS3</td><td>Editor</td><td>|___|___|</td><td></td><td></td><td></td></tr>
<tr><th colspan="6">Respondent</th></tr>
<tr><td>AH1</td><td colspan="5">Name of household head (optional) ____</td></tr>
<tr><td>AH2</td><td colspan="5">Name of main Respondent (optional) ____</td></tr>
<tr><td>AR1</td><td colspan="5">Interview status</td></tr>
<tr><td></td><td>1
2
3
4
5
6
7</td><td colspan="2">Interview completed
Refusal converted
Partly completed
No usable information
Household unit is vacant
No contact
Refusal</td><td colspan="2">COMMENTS:</td></tr>
</table>

سوف أطرح عليك بعض الأسئلة حول الوضع الصحي العام لمنزلك

الوضع الصحّي (Health Status)				
HS1	هل يعاني أحد أفراد المنزل من مرض أو إعاقة مزمنة؟	1	نعم	
		2	لا	Go to HS3
		98	لا جواب	
		99	لا أعلم	
HS3	هل عانى أحد أفراد المنزل من الإسهال في الثلاثة أشهر الماضية؟	1	نعم	
		2	لا	
		98	لا جواب	
		99	لا أعلم	
HS3A	إذا كان الجواب نعم، ما هو الجنس والعمر؟			
HS3A1	الفرد الأول العمر		|___|___|	
HS3A2	الجنس	1	ذكر	
		2	أنثى	
HS3A4a	الأعراض (ممكن أكثر من جواب)	1	إسهال	
HS3A4b		2	استفراغ	
HS3A4c		3	حرارة مرتفعة	
HS3A4d		4	أوجاع في المعدة	
HS3A4e		5	غير ذلك، حدد ________	
HS3A5	كم يوم اضطر المريض البقاء في المنزل بسبب المرض؟		|___|___|	
HS3A6	للعلاج هل تم اللجوء الى	1	المستشفى	
		2	المستوصف	
		3	عيادة خاصة	
		4	الطبيب يزورني في المنزل	
		5	لا أحد	
		6	غير ذلك، حدد ________	
		98	لا جواب	
		99	لا أعلم	
HS3B1	الفرد الثاني العمر		|___|___|	
HS3B2	الجنس	1	ذكر	
		2	أنثى	
HS3B3	المرض	1	إسهال	
		2	تيفوئيد	
		3	التهاب الكبد (Hepatitis A)	
		4	غير ذلك، حدد ________	
HS3B4a	الأعراض (ممكن أكثر من جواب)	1	إسهال	
HS3B4b		2	استفراغ	
HS3B4c		3	حرارة مرتفعة	
HS3B4d		4	أوجاع في المعدة	
HS3B4f		5	غير ذلك، حدد ________	

HS3B5	كم يوم اضطر المريض البقاء في المنزل بسبب المرض؟		|___|___|
HS3B6	للعلاج هل تم اللجوء الى	1	المستشفى
		2	المستوصف
		3	عيادة خاصة
		4	الطبيب يزورني في المنزل
		5	لا أحد
		6	غير ذلك، حدد ___________
		98	لا جواب
		99	لا أعلم
HS3C1	الفرد الثالث العمر		|___|___|
HS3C2	الجنس	1	ذكر
		2	أنثى
HS3C3	المرض	1	إسهال
		2	تيفوئيد
		3	التهاب الكبد (Hepatitis A)
		4	غير ذلك، حدد ___________
HS3C4a	الأعراض (ممكن أكثر من جواب)	1	إسهال
HS3C4b		2	استفراغ
HS3C4c		3	حرارة مرتفعة
HS3C4d		4	أوجاع في المعدة
HS3C4e		5	غير ذلك، حدد ___________
HS3C5	كم يوم اضطر المريض البقاء في المنزل بسبب المرض؟		|___|___|
HS3C6	للعلاج هل تم اللجوء الى	1	المستشفى
		2	المستوصف
		3	عيادة خاصة
		4	الطبيب يزورني في المنزل
		5	لا أحد
		6	غير ذلك، حدد ___________
		98	لا جواب
		99	لا أعلم

الآن سوف أسأل عن المياه في المنزل

مصادر المياه (water sources)			
WS1	ما هي مصادر المياه التي تصل الى المنزل؟		
WS1A	شبكة المياه العامة	1 2 99	نعم كلا لا أعلم
WS1B	بئر	1 2 99	نعم كلا لا أعلم
WS1D	مياه منقولة باليد	1 2 99	نعم كلا لا أعلم
WS1E	مياه معبأة	1 2 3 99	نعم، دائماً نعم، أحياناً في حالة المرض كلا لا أعلم
WS6	هل تكفيك كميّة مياه الإستعمال التي تصل الى منزلك في فصل الصيف ؟	1 2 3 4 98 99	أكثر من كافية كافية بالكاد تكفي لا تكفي لا جواب لا أعلم
WS7	هل تكفيك كميّة مياه الإستعمال التي تصل الى منزلك في فصل الشتاء؟	1 2 3 4 98 99	أكثر من كافية كافية بالكاد تكفي لا تكفي لا جواب لا أعلم

إذا كنت تحصل على المياه من الشبكة العامّة

مياه الشبكة العامة (network water)				
NW4A	ما هي استخدامات المياه التي تحصل عليها من شبكة المياه العامة للشرب	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4B	لغسل الأيدي	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4C	للاستحمام	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4D	لغسل الطعام	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4E	للطبخ	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4F	لغسل الصحون	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4G	لتنظيف البيت	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4H	في غرفة الغسيل	1 2 3 99	نعم كلا أحياناً لا أعلم	
NW4J	غير ذلك، حدد:______________			
NW7	هل أنت راض عن نوعيّة المياه التي تصل الى منزلك في فصلِ الصيف؟	1 2 98 99	نعم لا لا جواب لا أعلم	Go to NW9

NW8	لماذا أنت غير راضٍ؟ (ممكن أكثر من جواب)	1 2 3 4 5 98 99	المياه ليست صافية هناك رائحة كلور في المياه هناك طعم للمياه المياه ملوّثة غير ذلك، حدد ______________ لا جواب لا أعلم
NW9	هل أنت راضٍ عن نوعيّة مياه الاستعمال التي تصل الى منزلكَ في فصل الشتاء؟	1 2 98 99	نعم Go To NW11 لا لا جواب لا أعلم
NW10	لماذا أنت غير راضٍ؟ (ممكن أكثر من جواب)	1 2 3 4 5 98 99	المياه ليست صافية هناك رائحة كلور في المياه هناك طعم للمياه المياه ملوّثة غير ذلك، حدد ______________ لا جواب لا أعلم
NW11	كيف تصنف نوعية المياه التي تصلك من الشبكة؟	1 2 3 98 99	جيدة (دون لون، طعم، رائحة، ورواسب) متوسطة (بعض اللون، طعم، رائحة، ورواسب) سيئة (ذات لون، طعم، رائحة، ورواسب) لا جواب لا أعلم

إذا كنت تشتري المياه المعبأة:

المياه المعبأة (bottled water)			
BW1A	ما هي استخدامات المياه المعبأة؟ للشرب	1 2 3 99	نعم كلا أحياناً لا أعلم
BW1B	لغسل الأيدي	1 2 3 99	نعم كلا أحياناً لا أعلم
BW1C	للاستحمام	1 2 3 99	نعم كلا أحياناً لا أعلم
BW1D	لغسل الطعام	1 2 3 99	نعم كلا أحياناً لا أعلم
BW1E	للطبخ	1 2 3 99	نعم كلا أحياناً لا أعلم
BW1F	لغسل الصحون	1 2 3 99	نعم كلا أحياناً لا أعلم
BW1G	لتنظيف البيت	1 2 3 99	نعم كلا أحياناً لا أعلم
BW1H	في غرفة الغسيل	1 2 3 99	نعم كلا أحياناً لا أعلم
BW1J	غير ذلك، حدد: ______________		

BW6	كيف تجد نوعية هذه المياه؟	1 2 3 98 99	جيدة (دون لون، طعم، رائحة، ورواسب) متوسطة (بعض اللون، طعم، رائحة، ورواسب) سيئة (ذات لون، طعم، رائحة، ورواسب) لا جواب لا أعلم

هل شعرت بتحسّن في نوعيّة مياه الاستعمال بعد تغيير الخزان؟ كيف؟

هل تغيّرت وجهة استخدامك للمياه المخزّنة؟ كيف؟

ملاحظات:

APPENDIX 5.
DETAILED RESULTS OF PRE-INTERVENTION ANALYSIS OF WATER SAMPLES

Results of microbiological and physicochemical analysis of water samples collected from the drinking water network

Sample ID	Fecal coliform (CFU/ 100 ml after 24 hrs)	Fecal coliform (CFU/ 100 ml after 48 hrs)	Total coliform (CFU/ 100 ml)	Nitrate (mg/L NO_3^-)	Residual Chlorine (mg/L Cl_2)	pH	TDS (mg/L)	Color (PtCo APHA)	Turbidity (NTU)
1. TA0034-1	0	0	0	15.6	0.04	7.11	365	12	2.36
2. TA0045-1	0	0	0	21.6	0.15	6.96	831	4	1.9
3. TA0046-1	0	0	0	25.8	0.23	6.92	839	6	1.6
4. TA0058-1	0	0	0	16.2	0.06	7.15	368	5	4.1
5. TA0074-1	0	0	0	19.6	0.21	7.12	364	7	2.4
6. TA0085-1	0	0	0	25	0.22	6.82	812	5	1.24
7. TA0090-1	0	0	0	22.9	0.25	6.83	784	5	0.25
8. TA0097-1	0	0	0	23.9	0.13	7.1	514	4	1.27
9. TA0102-1	0	0	0	16.1	0.08	7.24	328	9	1.34
10. TA0106-1	0	0	0	22.4	0.05	7.21	520	6	1.44
11. TA0113-1	0	0	0	16.1	0.06	7.26	393	58	1.95
12. TA0127-1	0	0	0	19.3	0.23	7.84	804	10	3
13. TA0143-1	0	0	0	22	0.2	6.78	855	8	1.14
14. TB0039-1	0	0	10	16.1	0.06	7.12	314	11	NA
15. TB0072-1	0	0	0	18	0.05	6.8	310	6	NA
16. TB0102-1	0	0	0	20.6	0.06	6.92	706	0	NA
17. TB0110-1	1	0	2	19.1	0.07	6.99	567	6	NA[2]
18. TB0122-1	0	0	0	16.7	0.04	6.97	396	21	NA
19. TB0129-1	0	0	1	16	0.12	6.98	299	20	NA
20. TB0132-1	0	0	5	19.2	0.03	7.03	298	22	NA
21. TB0161-1	0	0	0	17.8	0.06	7.05	278	10	NA
22. TB0178-1	0	0	0	14.7	0.01	7.22	315	4	NA
23. TB0183-1	0	0	0	15.1	0.05	6.77	316	6	NA
24. TB0536-1	0	0	1 (154 non TC)	20.9	0.06	7.31	311	11	NA
25. TB0539-1	0	0	0 (120 non TC)	19.1	0.05	6.93	361	UR	NA
26. TB0615-1	0	0	(TNTC non TC)	17	0.06	6.88	818	UR	NA
27. TB0623-1	0	0	(68 non TC)	15.9	0.03	7.03	647	UR	NA
28. TB0631-1	0	0	(2 non TC)	20	0.13	6.74	294	UR	NA

Sample ID	Fecal coliform (CFU/ 100 ml after 24 hrs)	Fecal coliform (CFU/ 100 ml after 48 hrs)	Total coliform (CFU/ 100 ml)	Nitrate (mg/L NO_3^-)	Residual Chlorine (mg/L Cl_2)	pH	TDS (mg/L)	Color (PtCo APHA)	Turbidity (NTU)
29. TB0642-1	0	0	1 (TNTC non TC)	17.2	0.17	7.07	832	UR	NA
30. TB0645-1	0	0	0	21.7	0.24	7.05	744	UR	NA
31. TB0646-1	0	0	0	18.6	0.08	7.01	846	UR	NA
32. TB0649-1	0	0	0	17.7	0.23	7.26	465	UR	NA
33. TB0664-1	0	0	0	13.4	0.15	7.15	455	UR	NA
34. TJ0002-1	0	0	0	23.9	0.06	6.83	291	1	NA
35. TJ0008-1	0	0	0 (3 non TC)	19.2	0.05	6.82	290	2	NA
36. TJ0018-1	0	0	500 (TNTC non TC)	19.1	0.18	7.11	860	19	NA
37. TJ0021-1	0	0	0	18.3	0.09	7.1	390	11	NA
38. TJ0023-1	0	0	(7 non TC)	16.5	0.03	6.94	306	5	NA
39. TJ0045-1	0	0	0	9.2	0.07	6.8	295	6	NA
40. TJ0052-1	0	0	0	19.1	0.07	6.69	308	10	NA
41. TJ0062-1	0	0	(15 non TC)	19.6	0.04	7.01	304	7	NA
42. TJ0066-1	0	0	0 (2 non TC)	19.2	0.1	6.81	283	1	NA
43. TJ0072-1	0	0	1 (20 non TC)	17	0.09	7.07	301	25	NA
44. TJ0080-1	0	0	0	17.4	0.11	6.66	279	3	NA
45. TJ0091-1	0	0	1 (20 non TC)	20.1	0.13	6.94	859	12	NA
46. TJ0102-1	0	0	0 (2 non TC)	13.1	0.16	6.85	297	51	NA
47. TJ0103-1	0	0	0 (6 non TC)	18.2	0.12	6.86	287	18	NA
48. TJ0104-1	0	0	0	18.9	0.12	6.69	319	4	NA
49. TJ0252-1	0	0	0	18.8	0.22	6.92	857	53	NA
50. TJ0286-1	0	0	0 (19 non TC)	12.6	0.15	6.85	277	8	NA
51. TJ0493-1	0	0	0	16.4	0.11	6.69	208	UR	NA
52. TJ1100-1	0	0	0	17.4	0.07	6.82	315	2	NA
53. TJ1103-1	0	0	0	16.2	0.03	7	289	UR	NA
54. TJ1106-1	0	0	0	20.2	0.18	6.84	322	UR	NA
55. TJ1111-1	0	0	1	17.1	0.1	6.45	217	UR	NA
56. TJ1127-1	0	0	4	12.4	0.05	7.38	493	15	NA

Sample ID	Fecal coliform (CFU/ 100 ml after 24 hrs)	Fecal coliform (CFU/ 100 ml after 48 hrs)	Total coliform (CFU/ 100 ml)	Nitrate (mg/L NO_3^-)	Residual Chlorine (mg/L Cl_2)	pH	TDS (mg/L)	Color (PtCo APHA)	Turbidity (NTU)
57. TJ1132-1	0	0	2	21.1	0.17	6.82	315	2	NA
58. TJ1136-1	0	0	0	16.6	0.25	6.87	855	49	NA
59. TJ1148-1	0	0	0	21.3	0.3	6.7	862	0	NA
60. TJ1151-1	0	0	0	18.5	0.01	7.17	306	2	NA
61. TJ1152-1	0	0	2	14.6	0.05	7.25	317	4	NA
62. TJ1154-1	3	0	43	14.7	0.02	7.38	493	15	NA
63. TJ1158-1	0	0	0	13.8	0.04	7.09	310	22	NA
64. TJ1166-1	0	0	0	17.1	0.1	7.16	670	8	NA
65. TJ1169-1	0	0	(10 non TC)	20.5	0.19	6.9	832	UR	NA
66. TJ1182-1	0	0	0	18.4	0.27	6.95	853	1	NA
67. TJ1187-1	0	0	0	6.1	0.12	7.12	301	46	NA
68. TJ1189-1	0	0	0	27.8	0.09	7.08	307	16	NA
69. TJ1207-1	0	0	133	18.7	0.15	6.99	310	UR	NA
70. TJ1216-1	0	0	0	15.6	0.09	6.63	209	UR	NA
71. TJ1221-1	0	0	174	16.4	0.06	6.73	217	UR	NA
72. TJ1227-1	0	0	0	15.9	0.05	6.49	215	UR	NA
73. TJ1228-1	0	0	0	16.1	0.07	6.96	656	9	NA
74. TJ1229-1	0	0	2	14.9	0.02	7.04	317	11	NA
75. TJ1231-1	2	0	210	14.8	0.13	6.04	215	7	NA
76. TK0484-1	0	0	0	17.2	0.12	7.27	370	34	8.6

Results of microbiological and physicochemical analysis of water samples collected from the storage tanks

Sample ID	Location of Tank	Fecal coliform CFU/ 100 ml after 24 hrs)	Fecal coliform (CFU/ 100 ml after 48 hrs)	Total coliform (CFU/ 100 ml)	Nitrate (mg/L NO_3^-)	pH	TDS (mg/L)	Color (PtCo APHA)	Turbidity (NTU)
1. TA0034-2	Roof Top	0	0	0	20.8	7.36	400	13	1.44
2. TA0045-2	Attic	0	0	0	24.1	7.29	841	12	1.39
3. TA0085-2	Attic	0	0	0	24.4	7.09	851	9	1.46
4. TA0090-2	Attic	0	0	0	20.4	7.01	808	5	1.6
5. TA0106-2	Roof Top	0	0	0	18.1	7.32	381	10	1.2
6. TA0113-2	Roof Top	0	0	0	18.4	7.48	392	13	NA
7. TA0143-2	Attic	0	0	0	23	7.15	838	15	0.98
8. TB0039-2	Roof Top	0	0	0	14	7.21	420	23	NA
9. TB0072-2	Attic	0	0	0	18.8	6.9	395	9	NA
10. TB0102-2	Roof Top	0	0	21	19.1	6.85	369	11	1.55
11. TB0110-2	Attic	0	0	13	18.6	7.00	495	7	NA
12. TB0122-2	Other	9	0	177	18.2	6.95	578	8	NA
13. TB0129-2	Roof Top	0	0	9	23.2	6.98	643	6	NA
14. TB0132-2	Attic	0	0	0	17.8	7.07	319	15	NA
15. TB0161-2	Attic	0	0	0	19.5	7.00	350	14	NA
16. TB0178-2	Attic	0	0	0	15	7.22	304	7	NA
17. TB0183-2	Attic	0	0	0	19	7.16	377	11	NA
18. TB0536-2	Roof Top	0	0	1 (112 non TC)	14.5	7.09	350	17	NA
19. TB0539-2	Attic	0	0	3 (TNTC non TC)	23.7	7.17	356	UR	NA
20. TB0615-2	Roof Top	0	0	8 (few non TC)	17.1	7.15	806	UR	NA
21. TB0623-2	Roof Top	0	0	(60 non TC)	16.3	7.08	712	24	NA
22. TB0631-2	Roof Top	0	0	(150 non TC)	13.3	6.36	307	UR	NA
23. TB0642-2	Roof Top	0	0	2 (120 non TC)	21.1	7.09	813	UR	NA
24. TB0645-2	Roof Top	0	0	1	21.5	7.05	769	UR	NA
25. TB0646-2	Roof Top	0	0	3 (TNTC non TC)	16.6	6.86	655	UR	NA
26. TB0649-2	Roof Top	0	0	1 (140 non TC)	18.2	7.12	355	UR	NA
27. TB0664-2	Roof Top	0	0	0	18.9	6.75	345	7	NA
28. TJ0002-2	Attic	0	0	13 (TNTC non TC)	17.1	6.85	321	4	NA

Sample ID	Location of Tank	Fecal coliform CFU/ 100 ml after 24 hrs)	Fecal coliform (CFU/ 100 ml after 48 hrs)	Total coliform (CFU/ 100 ml)	Nitrate (mg/L NO_3^-)	pH	TDS (mg/L)	Color (PtCo APHA)	Turbidity (NTU)
29. TJ0021-2	Attic	0	0	(3 non TC)	19.4	6.98	833	6	NA
30. TJ0023-2	Attic	0	0	(15 non TC)	23.1	7.02	762	6	NA
31. TJ0052-2	Attic	0	0	(10 non TC)	27.7	6.68	768	UR	NA
32. TJ0066-2	Attic	0	0	0 (13 non TC)	19.9	6.84	409	16	NA
33. TJ0072-2	Roof Top	0	0	(TNTC non TC)	18.3	7.02	758	26	NA
34. TJ0091-2		0	0	0	17.2	7.03	689	27	NA
35. TJ0103-2	Attic	0	0	3 (2 non TC)	31.1	6.87	280	4	NA
36. TJ0104-2	Attic	4 (TNTC non FC)	0	10 (TNTC non TC)	15	6.95	308	23	NA
37. TJ0252-2	Attic	0	0	(10 non TC)	20.2	6.92	810	2	NA
38. TJ0286-2	Attic	4	9	85 (TNTC non TC)	17.7	6.95	278	39	NA
39. TJ1100-2	Attic	0	0	0	17.5	7.29	314	UR	NA
40. TJ1103-2	Attic	0	0	0	15.7	7.02	320	2	NA
41. TJ1106-2	Roof Top	0	0	0	15.5	7.02	317	8	NA
42. TJ1111-2	Attic	0	0	0	13.4	6.82	322	3	NA
43. TJ1127-2	Attic	0	0	0	19.6	7.21	897	62	NA
44. TJ1132-2	Roof Top	0	0	0	18.4	7.29	314	UR	NA
45. TJ1136-2	Attic	0	0	(24 Non TC)	24.7	6.71	802	1	NA
46. TJ1148-2	Attic	0	0	(24 Non TC)	21.6	6.92	741	2	NA
47. TJ1151-2	Roof Top	0	0	3	13.7	7.21	303	8	NA
48. TJ1152-2	Roof Top	0	0	8	14.3	7.13	313	61	NA
49. TJ1154-2	Attic	0	0	3	12	7.09	587	10	NA
50. TJ1158-2	Attic	2	0	3	17.5	8	300	10	NA
51. TJ1166-2	Roof Top	0	0	0	17.1	7.11	315	9	NA
52. TJ1169-2	Attic	0	0	0	21	6.97	832	1	NA
53. TJ1182-2	Attic	0	0	0	20.2	6.96	804	UR	NA
54. TJ1187-2	Roof Top	0	0	5	13.5	7.12	302	8	NA
55. TJ1189-2	Attic	2	0	3	31.8	7.13	341	25	NA
56. TJ1207-2	Roof Top	0	0	124	17.5	6.84	214	UR	NA
57. TJ1216-2	Roof Top	0	0	6	18.9	7.18	642	3	NA
58. TJ1221-2	Roof Top	0	0	1	17.4	7.18	648	4	NA

Sample ID	Location of Tank	Fecal coliform CFU/ 100 ml after 24 hrs)	Fecal coliform (CFU/ 100 ml after 48 hrs)	Total coliform (CFU/ 100 ml)	Nitrate (mg/L NO_3^-)	pH	TDS (mg/L)	Color (PtCo APHA)	Turbidity (NTU)
59. TJ1227-2	Attic	1	0	35	15.3	7.12	313	7	NA
60. TJ1228-2	Roof Top	0	0	0	17.3	7.04	315	20	NA
61. TJ1229-2	Roof Top	0	0	2	16.5	7.14	328	5	NA
62. TJ1231-2	Roof Top	0	0	0	12.3	7.18	656	67	NA
63. TK0484-2	Attic	0	0	0	20.5	7.37	381	17	NA

Results of microbiological and physicochemical analysis of bottled water samples collected from Tebbaneh and Irbid

Brand name	FC(CFU/100mL)					TC (CFU/100mL)					Nitrate (mg/L)				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
TEBBANNEH, LEBANON															
Brand T1	0	0	0	0	0	0	0	0	0	0	13.6	14.2	12.1	11.8	10.7
Brand T2	0	0	0	0	0	0	1	0	2	147	14.3	7.6	7.9	7.9	6.3
Brand T3	0	0	0	0	0	24	30	0	0	38	10.4	10.5	12.1	12.3	10.2
Brand T4	0	0	0	0	0	0	0	2	0	0	11.3	11.7	15.5	12	14.2
Brand T5	0					1					27				
Brand T6	207	0	2	0	0	48	0	53	9	8	29.6	31.1	39.1	49.5	42.3
Brand T7	0	0	0	0	0	0	0	0	0	0	13.3	13.9	15.5	13.5	18.9
Brand T8	0	0	0	0	0	0	0	0	0	0	13.8	11.9	13.4	13	11.5
Brand T9	1	0	0			3	0	2			11.7	9.7	10.1		
Brand T10	0	0	0	0	0	2	0	0	0	0	6.8	4.6	8.5	4.6	5
Brand T11	0					0					17.9				
Brand T12	0	0	0	0	0	0	0	0	0	0	2.3	6.4	10.7	9.3	7.5
Brand T13	0	0	0	0	0	0	2	84	0	0	28	29.4	29.8	34.6	22.6
Brand T14	0	0	0	0	0	0	0	10	0	0	12.4	9.6	8.6	9.8	8.6
Brand T15	0	0	0	0	0	0	0	0	0	0	2.2	5.6	5.8	8.5	8.4
Brand T16	0	0	0	0	0	0	0	0	0	0	8.7	6.2	6.1	7.8	5.5
Brand T17	0					0					7.7				
Brand T18	0	0	0	0	0	0	0	0	0	0	6.6	6.9	6.2	4.4	3.6
AN-NASR JORDAN															
Brand A1	0	0	0	-	-	0	0	0	-	-	9.6	4.9	11.7	-	-
Brand A2	0	0	0	-	-	0	0	0	-	-	15.7	8.4	13.7	-	-
Brand A3	0	0	0	-	-	0	0	0	-	-	16.2	20.7	18.5	-	-
Brand A4	0	0	0	-	-	0	0	0	-	-	5.2	10.9	4.5	-	-
Brand A5	0	0	0	-	-	0	0	0	-	-	7	11.1	11.6	-	-
Brand A6	0	0	0	-	-	0	0	0	-	-	14.9	15.2	12.7	-	-

Results of microbiological and physico-chemical analysis of water samples collected from the drinking water network in the second sampling round

Sample ID	Fecal coliform (CFU/ 100 ml after 24 hrs)	Fecal coliform (CFU/ 100 ml after 48 hrs)	Total coliform (CFU/ 100 ml)	Free residual chlorine (mg/L Cl^-)
1. TJ0006 D	0	0	1	
2. TJ0014 D	0	0	0	0.16
3. TJ0024 D	0	0	1	0.17
4. TJ0094 D	0	0	0	0.25
5. TJ1137 D	0	0	5	0.09
6. TJ1150 D	0	0	0	0.16
7. TJ1183 D	0	0	0	0.12
8. Sabeel (TJ0033/ 34/70)	0	0	0	0.22
9. TA0054 D	0	0	6	0.18
10. TA0064 D	0	0	0	0.17
11. TA0089 D	0	0	7	0.17
12. TB0553 D	0	0	2	0.1
13. TK0408 D	0	0	2	0.16
14. TK0437 D	0	0	4	0.08
15. TK0439 D	0	0	0	0.08
16. TB0070 D	0	0	1	0.09
17. TB0080 D	0	0	0	0.13
18. TB0085 D	0	0	160	0.09
19. TB0105 D	0	0	1	0.19
20. TB0112 D	0	0	0	0.15
21. TB0126 D	0	0	1	0.22
22. TJ1128 D	0	0	0	0.22
23. TB0016 D	0	0	0	0.28
24. TB0073 D	0	0	0	0.34
25. TB0139 D	0	0	0	0.26
26. TB0174 D	0	0	0	0.17
27. TB0177 D	0	0	3	0.15
28. TB0652 D	0	0	2	0.28
29. TB0678 D	1	3	TNTC	0.18
30. TJ0280 D	0	0	0	0.13
31. TJ0495 D	0	0	0	0.33
32. TJ1107 D	0	1	1	?
33. TJ1156 D	0	0	0	0.13
34. TJ1190 D	0	0	1	0.31

Results of microbiological and physico-chemical analysis of water samples collected from the storage tanks in the second sampling round

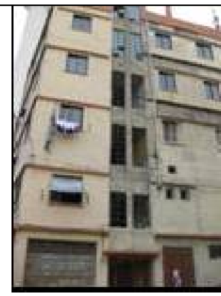
Sample ID	Location of Tank	Fecal coliform (CFU/ 100 ml after 24 hrs)	Fecal coliform (CFU/ 100 ml after 48 hrs)	Total coliform (CFU/ 100 ml)
1. TJ0006 T	attic	0	0	0
2. TJ0014 T	attic	0	0	0
3. TJ0024 T	attic	0	0	0
4. TJ0033 T	roof	0	0	0
5. TJ0034 T	roof	0	0	1
6. TJ0070 T	roof	0	0	0
7. TJ0093 T	attic	0	0	2
8. TJ0094 T	attic	0	0	0
9. TJ1137 T	attic	0	0	1
10. TJ1150 T	roof	0	0	0
11. TJ1183 T	attic	0	0	0
12. TA0048 T	roof	0	0	0
13. TA0054 T	roof	0	0	9
14. TA0064 T	roof	0	0	101 in 75 ml
15. TA0089 T	attic	0	0	32
16. TB0553 T	roof	0	0	2
17. TK0408 T	attic	0	0	5
18. TK0437 T	attic	21	28	183
19. TK0439 T	attic	0	0	3 non TC
20. TB0070 T	attic	0	0	200
21. TB0073 T	roof	0	0	0
22. TB0080 T	attic	0	0	150
23. TB0085 T	attic	0	0	18
24. TB0105 T	attic	0	0	7
25. TB0112 T	roof	0	0	3
26. TB0126 T	roof	1	2	TNTC
27. TJ1128 T	attic	0	0	140
28. TB0016 T	Roof	0	0	1
29. TB0139 T	Attic	0	39 yellow	TNTC
30. TB0174 T	Roof	0	0	0
31. TB0177 T	Roof	0	0	0
32. TB0652 T	Attic	0	0	0
33. TB0678 T	Attic	80	80	TNTC
34. TJ0280 T	attic	0	0	0
35. TJ0280 T	roof	0	0	0
36. TJ0495 T	Attic	0	0	1
37. TJ0504 T	Attic	0	0	0
38. TJ1107 T	Attic	0	13	5
39. TJ1156 T	Attic	0	0	4
40. TJ1190 T	Attic	0	0	20

APPENDIX 7.
FIELD INSPECTION OF SELECTED BUILDINGS

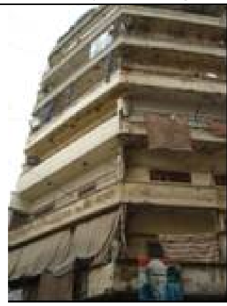
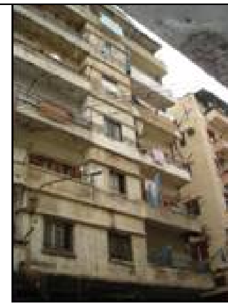
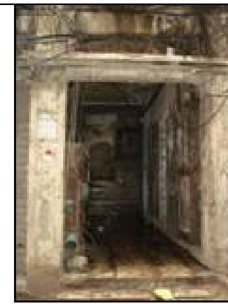
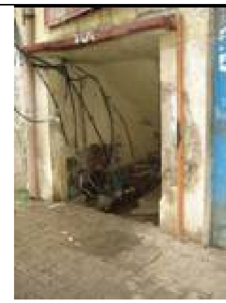
Characteristics of selected buildings

Building Number	*Zone*	*Street Name*	*Landmark*	*No. of floors*	*No. of housing units per bldg*	*Space availability around the bldg*	*Notes*
TB0110	1	Baal Al Sarakibi Street		3	3	None	Very old building, directly on the main street with shops on the ground floor
TJ1154	1		Next to Sabil and Meat Palace	6	24	Limited space on building entrance	Very old building, bad condition
TJ1158	1		In front of Masjad Al Rashwani	5	15	Space inside the building entrance	The building is in relatively good condition, located in the middle of the vegetables retail market
TJ1189	1		Al Sabil	5	35	Very limited space around or inside building.	In the middle of the vegetables retail market. Shops on ground floor
TB0539	2	Mouhajireen street	Directly next to Al Imam Ali Mosque	4	12	A lot of space outside the building.	Building in very good condition
TJ0002	4		Across the street from Jihad Mosque	3	7	There is some space (4X4m^2)	Car body repair workshop at ground level
TJ0103	4	Bazar Street		6	12	Some space available	
TJ0104	4		Next to Forn Al Hamawi	2	4	No space available	
TJ0286	4		In front of Khalil Al Rahman Mosque	6	12	Space on 1st floor (5x5m^2)	
TJ1227	5		3 buildings away from Al Jihad Mosque	6	21	No space available	

Photos of selected buildings

Building Number	*Photos of buildings*
TB0110	 
TJ1154	  
TJ1158	  

Building Number	*Photos of buildings*
TJ1189	  
TB0539	  
TJ0002	   

Building Number	*Photos of buildings*
TJ0103	   
TJ0104	  
TJ0286	 x   

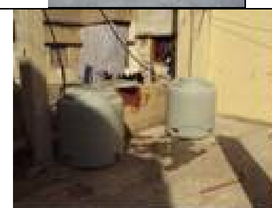
Building Number	*Photos of buildings*
TJ1227	 

APPENDIX 8.
LOCATION AND PHOTOS OF INTERVENTION IMPLEMENTATION

Date, location, and owner of households were tanks were replaced

Date	*Zone*	*Bldg Id*	*Floor*
08/02/2011	4	TJ0002	1
	4	TJ0104	2
	4	TJ0104	1
10/02/ 2011	4	TJ0103	4
	3	TA0089	1
	5	TJ1107	2
11/02/2011	3	TK0437	1
	1	TJ1154	1
	1	TB0110	1
	3	TK0408	2
15/02/2011	4	TJ0002	2
	4	TJ0002	4
	1	TJ1128	6
	1	TJ1158	1
17/02/2011	4	TJ0104	1
	4	TJ0104	2
	1	TB0070	2
	2	TB0678	1
18/02/2011	3	TK0408	3
	1	TB0113	2
	1	TB0029	1
	1	TJ1154	2
23/02/2011	4	TJ0002'	3
	5	TJ1236	5
	1	TB0113	3
	1	TB0113	1
24/02/2011	1	TB0118	1
	1	TB0115	0
	1	TB0119	1
	1	TB0034	0

Photos of new and replaced of storage tanks

Bldg Id	*Old tank*	*New tank*
TJ0002		
TJ0104		
TJ0104		
TJ0103		
TA0089		
TJ1107	-	

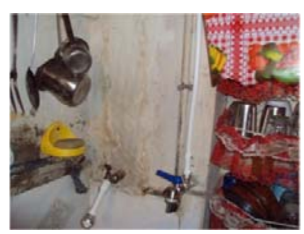
Bldg Id	*Old tank*	*New tank*
TK0437		
TJ1154		
TB0110		
TK0408		
TJ0002		

Bldg Id	*Old tank*	*New tank*
TJ0002		
TJ1128		
TJ1158		
TJ0104		
TJ0104		

Bldg Id	*Old tank*	*New tank*
TB0070		
TB0678		
TK0408		
TB0113		
TB0029		
TJ1154		

Bldg Id	*Old tank*	*New tank*
TB0118		
TB0115		
TB0119		
TB0034		

Photos of replaced pipes

Bldg Id	*New water pipes*	
TJ0002		
TJ0002		
TB0070		
TJ0103		

APPENDIX 9.

DETAILED RESULTS OF POST-INTERVENTION WATER QUALITY MONITORING PROGRAM

Results of microbiological and physicochemical analysis of water samples collected from the **drinking water tap** from March 27 till July 10

Date	*March 27, April 3*			*April 10, April 17*			*May 1, May 8*			*May 15, May 22*			*June 5, June 26*			*July 3, July 10*		
Building Id	*Free Cl[1]*	*TC[2]*	*FC[3]*	*Free Cl[1]*	*TC[2]*	*FC[3]*	*Free Cl[1]*	*TC[2]*	*FC[3]*	*Free Cl[1]*	*TC[2]*	*FC[3]*	*Free Cl[1]*	*TC[2]*	*FC[3]*	*Free Cl[1]*	*TC[2]*	*FC[3]*
TJ1154-1	0.52	0	0	0.39	27	2	0.28	0	0	0.35	1	0	-	-	-	-	-	-
TJ1154-2	0.52	0	0	0.39	27	2	0.28	0	0	0.33	0	0	0.42	11	0	-	-	-
TB0110	0.24	0	0	0.35	0	0	0.31	0	0	0.31	0	0	0.28	0	0	0.24	0	0
TJ1128	-	-	-	-	-	-	0.32	0	0	-	-	-	-	-	-	0.28	11	0
TJ1158	0.21	0	0	0.26	0	0	0.31	2	0	0.24	0	0	0.28	175	0	0.16	2	0
TB0070	0.46	0	0	0.26	0	0	0.3	1	0	0.32	0	0	0.3	0	0	0.10	3	0
TB0113-1	0.12	0	0	0.28	TNTC	38	0.3	0	0	-	-	-	0.34	TNTC	3	0.22	47	0
TB0113-2	0.12	0	0	0.28	TNTC	38	0.3	0	0	-	-	-	-	-	-	-	-	-
TB0113-3	0.12	0	0	0.28	TNTC	38	0.3	0	0	-	-	-	0.31	TNTC	2	-	-	-
TB0029	0.4	TNTC	0	0.3	0	0	0.33	2	0	0.31	0	0	0.28	TNTC	0	0.26	7	2
TB0118	0.13	0	0	0.34	0	0	0.3	0	0	-	-	-	-	-	-	-	-	-
TB0115	0.29	0	0	0.27	0	0	0.3	0	0	0.33	TNTC	0	0.33	0	0	0.10	0	0
TB0119	0.12	0	0	0.31	0	0	0.38	0	0	-	-	-	0.32	TNTC	0	-	0	0
TB0034	0.35	18	0	0.27	0	0	0.46	0	0	0.38	0	0	0.29	167	0	0.20	0	0
TB0678	0.42	77	74	-	-	-	0.25	TNTC	TNTC	0.37	TNTC	32	-	-	-	0.12	TNTC	92
TA0089	0.27	1	0	0.39	10	0	0.29	0	0	0.50	1	0	0.29	55	0	-	-	-
TK0437	0.22	1	0	0.38	0	0	-	1	0	0.28	0	0	0.27	0	0	0.11	0	0
TK0408-2	0.33	1	0	0.35	61	0	0.33	1	0	0.40	TNTC	0	0.40	0	0	-	-	-
TK0408-3	0.33	1	0	0.35	61	0	0.33	1	0	0.27	17	0	0.40	2	0	-	-	-
TJ0002-1	0.28	0	0	0.28	88	0	0.35	TNTC	0	0.28	0	1	0.25	6	0	0.24	74	0
TJ0002-2	0.28	0	0	0.28	88	0	0.35	TNTC	0	0.32	TNTC	0	-	-	-	-	-	-
TJ0002-3	0.28	0	0	0.28	88	0	0.35	TNTC	0	0.27	0	0	0.26	0	0	0.39	TNTC	0
TJ0002'	0.28	0	0	0.26	1	0	0.21	32	0	0.3	8	0	-	-	-	-	-	-
TJ0104-1A	0.33	10	0	0.35	TNTC	0	-	0	0	0.26	TNTC	0	0.34	0	0	0.38	50	0

Date	*March 27, April 3*			*April 10, April 17*			*May 1, May 8*			*May 15, May 22*			*June 5, June 26*			*July 3, July 10*		
Building Id	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]
TJ0104-1B	0.33	10	0	0.35	TNTC	0	-	0	0	0.31	TNTC	0	0.37	27	0	-	-	-
TJ0104-2A	0.33	10	0	0.35	TNTC	0	-	0	0	0.36	TNTC	0	0.36	TNTC	1	0.19	TNTC	0
TJ0104-2B	0.33	10	0	0.35	TNTC	0	-	0	0	0.29	112	0	0.39	55	0	0.29	11	0
TJ0103	0.2	44	0	0.27	4	0	-	0	0	0.27	0	0	0.33	0	0	-	-	-
TJ1107	0.35	0	0	0.35	0	0	0.27	1	0	0.30	0	0	0.22	4	0	0.29	0	0
TJ1236	0.28	0	0	0.33	0	0	0.28	0	0	0.27	0	0	-	-	-	0.19	0	0

[1] Free residual chlorine (mg/L Cl^-) [2] Total Coliform (CFU/100 ml) [3] Fecal Coliform (CFU/100 ml)

Results of microbiological and physicochemical analysis of water samples collected from the **drinking water tap** from July 17 till October 30

Date	*July 17, July 24*			*Aug 7-14, Sept 4*			*Sept 11, Sept 18*			*Sept 25, Oct 2*			*Oct 9, Oct 16*			*Oct 23, Oct 30*		
Building Id	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]
TJ1154-1	0.21	0	0	-	-	-	0.09	54	0	0.12	0	0	0.22	156	0	0.20	0	0
TJ1154-2	-	-	-	0.10	142	0	0.08	0	0	-	-	-	-	-	-	0.12	0	0
TB0110	-	-	-	-	-	-	-	-	-	0.02	0	0	-	-	-	-	-	-
TJ1128	-	-	-	-	-	-	-	-	-	0.07	TNTC	0	0.17	188	0	-	-	-
TJ1158	0.12	1	0	0.14	0	0	-	-	-	-	-	-	0.09	0	0	0.03	0	0
TB0070	0.09	8	0	-	-	-	0.42	0	0	0.03	TNTC	0	0.09	1	0	0.13	0	0
TB0113-1	0.20	34	0	-	-	-	0.22	0	0	0.19	0	0	0.25	0	0	-	-	-
TB0113-2	-	-	-	-	-	-	-	-	-	-	-	-	0.07	1	0	-	-	-
TB0113-3	-	-	-	-	-	-	0.24	0	0	-	-	-	0.11	2	0	-	-	-
TB0029	0.21	TNTC	TNTC	0.08	0	0	-	-	-	-	-	-	0.23	2	0	0.13	0	0
TB0118	-	-	-	-	-	-	0.16	0	0	-	-	-	-	-	-	-	-	-
TB0115	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TB0119	-	-	-	-	-	-	-	-	-	-	-	-	0.30	0	0	-	-	-
TB0034	0.18	0	0	-	-	-	0.10	0	0	0.31	0	0	0.18	0	0	0.21	0	0
TB0678	0.16	34	17	-	-	-	-	-	-	0.14	TNTC	123	0.13	15	10	-	-	-
TA0089	0.18	0	0	-	-	-	0.37	0	0	0.10	81	0	0.14	29	0	0.19	0	0
TK0437	0.36	0	0	0.15	0	0	0.20	0	0	0.19	0	0	0.10	0	0	0.14	0	0
TK0408-2	0.17	TNTC	0	0.19	0	0	-	-	-	0.03	0	0	0.04	20	0	-	13	0
TK0408-3	-	TNTC	0	0.14	1	0	0.16	0	0	0.04	0	0	0.08	0	0	0.04	TNTC	0
TJ0002-1	0.09	8	0	0.21	0	0	0.13	0	0	0.24	0	0	0.05	0	0	0.21	47	0
TJ0002-2	0.07	0	0	0.19	0	0	0.03	0	0	-	-	-	0.14	TNTC	0	0.21	0	0
TJ0002-3	-	-	-	-	-	-	0.37	12	-	0.13	0	0	0.17	0	0	0.19	0	0

Date	*July 17, July 24*			*Aug 7-14, Sept 4*			*Sept 11, Sept 18*			*Sept 25, Oct 2*			*Oct 9, Oct 16*			*Oct 23, Oct 30*		
Building Id	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]
TJ0002'	0.14	33	0	0.15	66	0	-	-	-	-	-	-	0.06	44	0	0.08	0	0
TJ0104-1A	0.20	0	0	0.19	0	0	0.16	0	0	0.20	106	0	0.17	0	0	0.40	0	0
TJ0104-1B	0.12	0	0	0.18	0	1	0.16	0	0	0.17	TNTC	0	-	-	-	0.22	0	0
TJ0104-2A	0.27	25	0	-	0	0	0.16	0	0	0.22	159	0	0.20	92	0	0.29	0	0
TJ0104-2B	0.27	0	0	-	0	0	-	-	-	0.19	0	0	0.12	0	0	0.39	0	0
TJ0103	0.24	0	0	0.11	0	0	-	-	-	0.19	0	0	-	-	-	0.13	0	0
TJ1107	0.17	0	0	-	-	-	-	-	-	0.28	0	0	-	-	-	-	-	-
TJ1236	0.16	0	0	-	-	-	0.12	0	0	0.17	0	0	0.10	TNTC	0	0.17	0	0

[1] Free residual chlorine (mg/L Cl^-) [2] Total Coliform (CFU/100 ml) [3] Fecal Coliform (CFU/100 ml)

Results of microbiological and physicochemical analysis of water samples collected from the **tap connected to tank** from March 27 till July 10

Date	*March 27, April 3*			*April 10, April 17*			*May 1, May 8*			*May 15, May 22*			*June 5, June 26*			*July 3, July 10*		
Building Id	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]
TJ1154-1	0.43	0	0	0.26	0	0	0.25	0	0	0.29	0	0	-	-	-	-	-	-
TJ1154-2	0.33	0	0	0.29	0	0	0.29	0	0	0.32	TNTC	0	0.32	11	0	-	-	-
TB0110	0.17	0	0	0.26	1	0	0.35	1	0	0.25	72	0	0.29	0	0	0.22	0	0
TJ1128	0.25	6	0	0.3	0	0	0.39	0	0	0.29	0	0	0.34	TNTC	0	-	-	-
TJ1158	0.33	0	0	0.26	0	0	0.26	1	0	0.24	0	0	0.30	247	0	0.15	0	0
TB0070	0.28	1	0	0.36	0	0	0.32	1	0	0.25	15	0	0.37	TNTC	0	0.18	1	0
TB0113-1	0.12	35	30	0.27	1	0	0.31	2	0	0.32	5	0	0.30	103	0	0.17	TNTC	0
TB0113-2	0.13	TNTC	0	0.33	TNTC	0	0.32	TNTC	0	0.27	70	0	0.27	0	0	-	-	-
TB0113-3	0.11	16	0	0.26	0	0	0.24	0	0	0.35	TNTC	0	0.30	33	4	0.29	13	0
TB0029	-	35	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TB0118	0.09	0	0	0.31	0	0	0.27	0	0	0.22	9	0	-	-	-	-	-	-
TB0115	0.33	0	0	0.29	0	0	0.28	60	0	0.28	26	0	0.28	TNTC	61	0.20	0	0
TB0119	0.13	18	0	0.28	0	0	0.25	32	0	0.24	1	0	0.30	TNTC	0	-	0	0
TB0034	-	-	-	0.34	28	0	0.3	102	0	0.22	18	0	0.28	225	TNTC	0.16	TNTC	0
TB0678	0.36	112	15	0.34	0	0	0.26	TNTC	88	0.33	31	17	0.29	1	0	0.07	TNTC	21
TA0089	0.38	55	37	0.24	27	16	0.29	TNTC	0	0.29	TNTC	TNTC	0.25	TNTC	68	0.36	TNTC	0
TK0437	0.14	1	0	0.32	25	0	-	14	0	0.24	6	0	0.28	0	0	0.13	0	0
TK0408-2	0.33	13	0	0.33	TNTC	0	0.28	TNTC	0	0.28	14	1	0.36	0	0	0.36	TNTC	0
TK0408-3	-	-	-	0.32	1	0	0.26	23	1	0.32	TNTC	0	0.36	TNTC	0	-	-	-
TJ0002-1	0.26	3	0	0.32	27	0	0.27	1	0	0.26	1	0	0.24	21	0	0.32	0	0
TJ0002-2	0.27	9	0	0.26	150	0	0.28	50	0	0.32	0	0	0.29	1	0	0.30	TNTC	13
TJ0002-3	0.32	0	0	0.24	0	0	0.25	0	0	0.22	TNTC	0	0.28	4	0	0.31	TNTC	0

Date	*March 27, April 3*			*April 10, April 17*			*May 1, May 8*			*May 15, May 22*			*June 5, June 26*			*July 3, July 10*		
Building Id	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]
TJ0002'	0.24	TNTC	0	0.27	1	0	0.35	27	0	0.21	110	0	0.23	0	0	-	-	-
TJ0104-1A	-	-	-	0.33	0	0	-	1	0	-	-	-	0.26	45	0	0.29	TNTC	0
TJ0104-1B	0.28	TNTC	0	0.39	2	0	-	0	0	0.28	140	0	0.40	33	0	-	-	-
TJ0104-2A	0.27	12	1	0.35	0	0	-	4	0	0.33	163	0	0.32	51	0	0.22	38	0
TJ0104-2B	0.33	0	0	0.28	2	0	-	2	0	0.31	TNTC	0	0.26	0	0	0.38	2	0
TJ0103	0.26	34	1	0.3	4	0	-	1	0	0.21	1	0	0.27	5	0	0.30	0	0
TJ1107	-	-	-	0.35	0	0	0.27	1	0	0.25	0	0	0.25	28	0	0.30	0	0
TJ1236	0.25	0	0	0.26	TNTC	0	0.29	TNTC	0	0.35	0	0	0.27	0	0	0.14	25	0

[1] Free residual chlorine (mg/L Cl^-) [2] Total Coliform (CFU/100 ml) [3] Fecal Coliform (CFU/100 ml)

Results of microbiological and physicochemical analysis of water samples collected from the **tap connected to tank** from July 17 till October 30

Date	*July 17, July 24*			*Aug 7-14, Sept 4*			*Sept 11, Sept 18*			*Sept 25, Oct 2*			*Oct 9, Oct 16*			*Oct 23, Oct 30*		
Building Id	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]
TJ1154-1	0.22	TNTC	0	0.07	1	0	0.11	0	0	0.14	35	0	0.13	TNTC	0	0.12	TNTC	0
TJ1154-2	-	-	-	0.29	2	0	0.11	0	0	-	-	-	-	-	-	0.21	1	0
TB0110	0.16	0	0	0.21	1	0	-	-	-	0.15	0	0	-	-	-	-	-	-
TJ1128	0.16	TNTC	1	0.24	0	0	0.03	0	4	0.17	0	0	0.26	1	0	0.25	0	0
TJ1158	0.10	4	0	0.02	0	0	-	-	-	-	-	-	0.09	0	0	0.11	0	0
TB0070	0.15	45	0	0.16	0	0	0.16	49	0	0.01	110	0	0.19	0	0	0.05	0	0
TB0113-1	0.21	19	0	0.20	15	0	0.20	TNTC	0	0.14	TNTC	0	0.09	2	0	-	-	-
TB0113-2	-	-	-	0.26	TNTC	1	-	-	-	-	-	-	0.07	110	14	-	-	-
TB0113-3	0.26	72	0	0.25	TNTC	15	0.15	2	0	0.15	TNTC	0	0.19	88	10	-	-	-
TB0029	0.12	0	0	0.24	TNTC	0	0.12	5	0	-	-	-	0.32	TNTC	0	0.19	0	0
TB0118	-	-	-	-	-	-	0.12	25	0	0.11	0	0	-	-	-	-	-	-
TB0115	-	-	-	0.13	0	0	-	-	-	-	-	-	-	-	-	-	-	-
TB0119	-	-	-	-	-	-	-	-	-	0.03	TNTC	0	0.14	38	0	-	-	-
TB0034	0.15	TNTC	0	0.24	24	0	0.04	TNTC	0	0.11	TNTC	70	0.17	2	0	0.06	0	0
TB0678	0.15	TNTC	3	-	-	-	-	-	-	0.18	TNTC	92	0.11	116	2	-	-	0
TA0089	0.22	130	0	0.16	0	0	0.23	0	0	0.21	28	0	0.15	68	0	0.29	0	0
TK0437	0.17	0	0	0.23	0	0	0.25	0	0	0.11	0	0	0.01	26	0	0.08	0	0
TK0408-2	0.19	TNTC	0	0.15	0	0	-	-	-	0.02	TNTC	0	0.02	TNTC	0	-	TNTC	0
TK0408-3	0.08	TNTC	0	0.18	0	0	0.13	0	0	0.08	2	0	0.03	86	0	0.02	0	0
TJ0002-1	0.28	0	0	0.21	0	0	0.06	0	0	0.15	0	0	0.13	0	0	0.13	0	0
TJ0002-2	0.17	1	0	0.19	0	0	0.10	0	0	-	-	-	0.14	72	0	0.20	0	0
TJ0002-3	0.18	12	0	0.12	12	0	0.10	0	0	0.11	0	0	0.09	8	0	0.11	0	0

Date	*July 17, July 24*			*Aug 7-14, Sept 4*			*Sept 11, Sept 18*			*Sept 25, Oct 2*			*Oct 9, Oct 16*			*Oct 23, Oct 30*		
Building Id	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]
TJ0002'	0.11	0	0	0.23	2	0	-	-	-	-	-	-	0.08	TNTC	0	0.01	6	0
TJ0104-1A	0.23	1	0	0.23	TNTC	0	0.28	51	0	0.25	TNTC	0	0.20	0	0	0.31	0	0
TJ0104-1B	0.23	1	0	0.18	7	6	0.26	0	0	0.17	15	0	-	-	-	0.35	1	0
TJ0104-2A	0.13	TNTC	0	-	9	0	0.12	0	0	0.16	1	0	0.20	1	0	0.20	0	0
TJ0104-2B	0.21	9	1	0.23	0	0	-	-	-	0.25	13	0	0.18	2	0	0.21	0	0
TJ0103	0.17	TNTC	0	0.08	0	0	-	-		0.20	0	0	-	-	-	0.08	0	0
TJ1107	0.17	0	0	-	-	-	-	-	-	0.18	TNTC	0	0.01	3	0	-	-	-
TJ1236	0.16	27	0	0.23	0	0	0.15	0	0	0.18	0	0	0.14	0	0	0.17	0	0

[1] Free residual chlorine (mg/L Cl^-) [2] Total Coliform (CFU/100 ml) [3] Fecal Coliform (CFU/100 ml)

Results of microbiological and physicochemical analysis of water samples collected from the **storage tanks** from May 1 till October 2

Date	*May1, May 8*			*July 3, July 10*			*July 17, July 24*			*Aug 7-14, Sept 4*			*Sept 11, Sept 18*			*Sept 25, Oct 2*		
Building Id	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]
TJ1154-1	0.31	0	0	-	-	-	0.14	TNTC	17	0.24	0	0	0.16	0	0	0.11	0	0
TJ1154-2	-	-	-	-	-	-	0.12	6	0	0.25	0	0	0.11	TNTC	0	-	-	-
TB0110	-	-	-	0.25	0	0	0.17	0	0	0.18	0	0	-	-	-	0.14	0	0
TJ1128	-	-	-	0.32	39	0	0.16	TNTC	1	0.34	0	0	-	-	-	0.10	0	0
TJ1158	-	-	-	0.16	0	0	0.12	1	0	-	-	-	-	-	-	-	-	-
TB0070	-	-	-	0.13	0	0	0.09	0	0	0.08	0	0	0.15	3	0	0.05	6	0
TB0113-1	0.35	2	0	0.11	0	0	0.19	30	0	0.24	TNTC	0	0.18	0	0	0.18	0	0
TB0113-2	-	-	-	0.08	83	0	-	-	-	0.30	100	140	0.12	TNTC	0	-	-	-
TB0113-3	-	-	-	0.19	0	0	0.18	131	0	0.31	TNTC	0	0.10	0		0.13	TNTC	0
TB0029	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TB0118	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TB0115	-	-	-	0.15	TNTC	0	-	-	-	0.13	0	0	-	-	-	-	-	-
TB0119	-	-	-	0.15	TNTC	0	-	-	-	-	-	-	-	-	-	-	-	-
TB0034	-	-	-	0.18	0	0	-	-	-	-	-	-	-	-	-	-	-	-
TB0678	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TA0089	0.35	5	0	0.48	TNTC	0	0.19	84	0	0.25	0	0	0.40	0	0	0.15	TNTC	0
TK0437	-	-	-	0.17	0	0	0.10	0	0	-	-	-	0.15	0	0	0.20	0	0
TK0408-2	-	-	-	0.34	TNTC	0	0.18	13	0	0.19	2	0	0.15	0	0	0.02	0	0
TK0408-3	-	-	-	-	-	-	0.22	TNTC	0	0.20	0	0	0.10	0	0	0.04	33	0
TJ0002-1	-	-	-	0.32	TNTC	0	0.15	0	0	0.15	0	0	0.08	0	0	0.15	0	0
TJ0002-2	0.28	50	0	0.34	19	0	0.15	0	0	0.12	0	0	0.05	0	0	-	-	-
TJ0002-3	-	-	-	0.35	0	0	0.12	0	0	0.16	1	0	0.14	0	0	0.18	0	0
TJ0002'	-	-	-	0.30	0	0	0.12	0	0	0.16	5	0	-	-	-	-	-	-
TJ0104-1A	-	-	-	0.31	3	0	0.16	0	0	-	0	0	0.06	0	0	0.04	24	0

Date	*May1, May 8*			*July 3, July 10*			*July 17, July 24*			*Aug 7-14, Sept 4*			*Sept 11, Sept 18*			*Sept 25, Oct 2*		
Building Id	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]	*Free Cl*[1]	*TC*[2]	*FC*[3]
TJ0104-1B	-	-	-	0.20	TNTC	0	0.17	TNTC	0	-	0	0	0.24	0	0	0.21	8	0
TJ0104-2A	-	-	-	0.29	38	0	0.15	0	0	-	0	0	0.33	0	0	0.26	0	0
TJ0104-2B	-	-	-	0.33	63	0	0.19	0	0	-	0	0	-	-	-	0.22	2	0
TJ0103	-	-	-	-	-	-	-	-	-	0.22	0	0	-	-	-	0.14	0	0
TJ1107	-	-	-	0.28	0	0	0.13	0	0	-	-	-	-	-	-	0.18	0	0
TJ1236	-	-	-	0.27	0	0	0.16	0	0	0.13	0	0	0.11	0	0	0.17	0	0

[1] Free residual chlorine (mg/L Cl^-) [2] Total Coliform (CFU/100 ml) [3] Fecal Coliform (CFU/100 ml)

Results of microbiological and physicochemical analysis of water samples collected from the **storage tanks** from October 9 till October 30

Date	*Oct 9, Oct 16*			*Oct 23, Oct 30*		
Building Id	*Free residual chlorine (mg/L Cl^-)*	*TC (CFU/ 100 ml)*	*FC (CFU/ 100 ml)*	*Free residual chlorine (mg/L Cl^-)*	*TC (CFU/ 100 ml)*	*FC (CFU/ 100 ml)*
TJ1154-1	0.10	0	0	0.19	1	0
TJ1154-2	-	-	-	0.14	0	0
TB0110	-	-	-	-	-	-
TJ1128	0.22	53	0	0.21	0	0
TJ1158	0.10	10	0	0.18	0	0
TB0070	0.05	1	0	0.05	0	0
TB0113-1	0.16	5	0	-	-	-
TB0113-2	0.03	31	0	-	-	-
TB0113-3	0.07	0	0	-	-	-
TB0029	-	-	-	-	-	-
TB0118	-	-	-	-	-	-
TB0115	-	-	-	-	-	-
TB0119	0.20	0	0	-	-	-
TB0034	-	-	-	-	-	-
TB0678	-	-	-	-	-	-
TA0089	0.26	50	0	0.24	0	0
TK0437	0.03	5	0	0.15	0	0
TK0408-2	0.03	28	0	0.03	0	0
TK0408-3	0.11	TNTC	0	0.04	1	0
TJ0002-1	-	44	0	0.16	0	0
TJ0002-2	0.06	15	0	0.06	0	0
TJ0002-3	0.03	4	0	0.18	0	0
TJ0002'	0.10	10	0	0.15	0	0
TJ0104-1A	0.22	3	0	0.19	0	0
TJ0104-1B	0.11	TNTC	0	0.30	0	0
TJ0104-2A	0.12	25	0	0.11	0	0
TJ0104-2B	0.29	10	0	0.36	0	0
TJ0103	-	-	-	0.10	0	0
TJ1107	0.05	0	0	-	-	-
TJ1236	-	-	-	-	-	-

APPENDIX 10.
PUBLICATIONS TO DATE

Published papers

1. Massoud M.A., Maroun R., Abdelnabi H., Jamali I., and El-Fadel M. 2012. Public Perception and Economic Implications of Bottled Water Consumption in Underprivileged Urban Areas. *Environmental Monitoring and Assessment*, DOI: 10.1007/s10661-012-2775-x.

2. El-Fadel M., Maroun R., Quba'a R., Mawla D., Sayess R., Massoud M.A., and Jamali I. 2013. Determinants of Diarrhea Prevalence in Urban Slums: Comparative Assessment Towards Enhanced Environmental Management. *Environmental Monitoring and Assessment*, DOI 10.1007/s10661-013-3406-x.

3. Maroun R., Alameddine M., Mawla D., Jamali I., Massoud M., and El Fadel M. The Burden of Water Quality in Disadvantaged Urban Communities: A Cost-Benefit Approach towards Sustainability. *Environmental Monitoring and Assessment. (Under Review)*

Planned publications

1. Identifying diarrhea determinants in a poor urban slum using logistic regression analysis

2. Towards a Sustainable Urban Development Framework in a Disadvantaged Urban Area

Conference Papers

1. El-Fadel, M. and Maroun, R. Environmental Health Risks in Disadvantaged Slums. *6th International Perspective on Water Resources and the Environment*. Izmir, Turkey, January 7-9, 2013. (Speaker)

2. Maroun, R., Mawla, D., and El-Fadel, M. Socio-Economics of Water Pollution as a Development Catalyst in Poor Urban Slums. *3rd International IWA Conference on Water Economics, Statistics and Finance.* Marbella, Spain, 24-26 April 2013. (Speaker)

3. R. Maroun and M. El-Fadel. A Cost-Benefit Approach to Water Quality Improvement in Disadvantaged Urban Communities . *IWA 1st Specialist Conference on Municipal Water Management and Sanitation in Developing Countries*, 2-4 December 2014, Bangkok, Thailand

Conference Posters

1. El-Fadel, M., Maroun, R., Alameddine, M., Mawla, D. Social Cost Benefit Analysis of Water and Sanitation Improvement in a Poor Urban Slum. *Environment and Health – Bridging South, North, East and West Conference of ISEE, ISES and ISIAQ*. Basel, Switzerland 19 - 23 August 2013.

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