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Review evidence on minimum household water security requirements for health protection

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1 Summary

The relative importance of water quantity, water quality, sanitation and hygiene in protecting and improving health has been subjected to extensive debate for many years. Studies that link water quantity with health are relatively few. In most studies, childhood diarrhea was used as an indicator of poor health. To the best of our knowledge, none of the studies available in the literature established minimum requirement of water consumption that ensures health protection and promotion. Although some projects, agencies, and organization suggested guidelines or norms for minimum water quantities, these norms were not supported by evidence from data. While a minimum amount of water supply of 20 liters per capita per day (L/C/d) was suggested by some experts, others recommended 50 L/C/d as a basic water requirement for human needs. The SPHERE project recommends 15 L/C/d as key indicator in meeting minimum standards for disaster relief.

Studying the relationship between water supply and health impact appeared to be a complicated issue because of the effects of several confounding variables that may interfere and obscure this relationship. Different approaches had been used to estimate per capita water consumption such as phone calls to ask people about their estimates of water amounts, using diaries to keep track of their use, and checking water bills. More complicated approaches were used in some research such as living for a period of time with people in their homes and using expensive techniques like installing miters on each water end use at selected houses. Some studies used cross sectional designs to estimates domestic water uses by asking people to report their water consumption within the survey duration, other studies based their estimates on previous water readings, and few studies followed up the water consumption pattern prospectively for several months. The results of these studies differ according to the settings and type of water using facilities.

Study designs used to assess the health impact of water supply included ecological (correlation) designs and cross-sectional designs (household’s surveys). The follow up (longitudinal) designs were very limited. Although that the ecological studies are quick and cheap to conduct, suitable to generate new hypotheses and identify new risk factors, they are limited by inability to control for confounding factors. In comparison, the household surveys although they require extensive preparation and manpower, they are expected to give more accurate domestic water

consumption pattern and its impact on health. On the other hand , previous studies did not expand the data collections to consider the seasonality. More than one season at least should be given to study fluctuations in water utilization and increase the probability of depicting water related cases of diarrhea.

Two study designs (the rapid assessment and the household survey) were proposed to correlate domestic water quantity and health (using childhood diarrhea as an indicator) to determine the minimum amount of domestic water consumption, in cold and hot seasons, that ensures health protection. The rapid Assessment **(**An ecological study design) will be utilized as a first step to uncover rapidly any relationship between the quantity of domestic water consumption and health indicators, mainly diarrhea among under five children. A total of 60 areas (billing zones) will be selected from different governorates of Jordan covering urban and rural areas and considering the socioeconomic variations of the population. Routinely available or secondary data pertaining to domestic water consumption and diarrhea diseases occurrence will be obtained from the records of ministries of water/irrigation and health. Descriptive statistics, cross-tabulations, and correlation analysis will be performed to reveal any possible associations between water quantity and diarrhea. To complement the rapid assessment and to control for the many confounding variables that may disturb the relation between water consumption and disease occurrence, a cross-sectional design will be conducted two times in a given year. One during August-September and another one during February- March. This approach is going to consider the seasonal variation in water consumption and diarrhea incidence and help to calculate the minimum amount of water needed for two types of seasons; the cold season and the hot season. The multistage cluster sampling approach similar to that implemented by the Department of Statistics (DHS survey) will be used. A total of 182 clusters will be selected and15 households will be sampled from each cluster. The selected households should have at least one child under 5 years. Data on domestic water consumption and water quality of the household during the reference month will be collected. Demographic and socio-economic data and data related to hygiene and sanitation of the household will be gathered. A questionnaire consisting of 45 questions will be used to collect the necessary data. The questionnaire will be filled through two visits to the household 30 days apart. In the first visit, most of the questions will be answered and the questions related to water consumption and diarrhea occurrence will be assessed in the second visit. To guard against recall bias, the householders are prepared during the first visit at the beginning of the month to record prospectively their water consumption and diarrhea occurrence during the following month. Data will be analyzed using SPSS (version 19) and SAS version 8.1). The household and individuals characteristics will be described using mean, standard deviation, frequencies and proportions wherever appropriate. Multilevel binary logistic regression that is appropriate for hierarchical datasets that take account of the clustering of persons in households and households in clusters will be used to conduct multivariate analysis. Receiver operating characteristics (ROC) analysis will be performed to identify the cutoff values for water quantity per capita that predicts the risk of diarrhea.

The results of the two study methods (the rapid assessment and the household survey) regarding the minimum amount of water for health will be compared to find the degree of agreement. A pilot testing of the questionnaire and an expert group workshop have been conducted in order to validate the proposed methods and tools.

2 Introduction

Since 1970, global demand for water has risen at roughly 2.4 percent per annum (Clarke 1993). The world's population is projected to reach 8 billion people by the year 2020. This is causing demand for water to rise, and growing dramatically water insecurity problem especially where supplies are the most constrained as in developing countries. WHO (1998) reported that there are 20 developing countries classified as 'water scarce' and extrapolated from recent trends, that the number of water-scarce countries will rise to 30 by the year 2020, According to FAO, 2004, water security is defined as "sufficient access by all people, at all times, to adequate water for an active and healthy lifestyle"

Gleick and Iwra (1996) explain in their article the developing of the concept of basic needs This article defines and quantifies "basic water requirements" (BWRs) in terms of quantity and quality for four basic human needs: drinking water for survival, water for human hygiene, water for sanitation services, and modest household needs for preparing food. Gleick (1996) suggested that the international community adopt a figure of 50 liters per capita per day as a basic water requirement for domestic water supply.

Standards for quantities of water to be supplied have been proposed for certain specific conditions. For example the SPHERE (1998) sets out 15 liters of water used per capita per day as being a key indicator in meeting minimum standards for disaster relief. WELL (1998) suggested that a minimum criterion for water supply should be 20 liters per capita per day in their guidance manual prepared for the Department for International Development (UK), A similar figure has been suggested by different organizations). The United States Agency for International Development, the World Bank and the World Health Organization have recommended between 20 ℓ and 40 ℓ/cap·d to meet basic needs.

Perhaps the most significant conclusions that can be drawn from these national and international standards regarding the water quantity required to satisfy minimum domestic water and sanitation needs are diverse and as yet questionable. Moreover, to date, no one including WHO has not yet provided guidance on the quantity of domestic water that is required to promote and insure good health.

Adequate water quantity is very important to protect human health from different diseases. This relationship has been recognized for many years. However, there has been an extensive debate about the relative importance of water quantity, water quality, sanitation and hygiene in protecting and improving health (Cairncross, 1990; Esrey et al., 1985; Esrey et al., 1991). According to Bradley (1977), there are four major categories of water-associated diseases; water-borne diseases, water-washed diseases, water-based diseases, and water-related diseases. WHO defined many Water-washed infectious diseases that are occurred due to insufficient quantities of water for personal or domestic hygiene or hygiene practices inside households, these infections are:

- Enteric infections, e.g. certain diarrheal diseases and gastroenteritis.
- Skin infections, e.g. scabies.
- Lice-borne infections, e.g. typhus.
- Eye and ear infections, e.g. otitis, conjunctivitis, Trachoma

However, Cairncross and Feachem (1993) suggest that water-washed diseases should be restricted only to skin and eye infections that solely relate to the quantity of water used for hygiene. An increase in water consumption (quantity) is more important for the prevention of diarrhea than water quality (van der Hoek et al. 2002; Kirchhoff et al., 1985). However, there are few published studies that directly address water quantity in relation to prevention of diarrhea. Some of these studies noticed that diarrheal incidence decreased through consumption of larger quantities of water. On the other hand, other studies suggest that personal hygiene activities such as washing hands particularly after defecation and before eating and cooking are very effective to prevent diarrhea (Curtis et al., 2000; Birmingham et al., 1997; Stanton and Clemens 1987).

In response to the relation between water quantity and health, World health Organization (WHO) and the United Nations Environment Program (UNEP) have launched the Health and Environment Linkages Initiative (HELI) in 2002 during the World Summit for Sustainable Development. The main goals of HELI are to promote and facilitate action in developing countries to reduce environmental threats to human health and to support sustainable development objectives. In 2004, World Health Organization, Regional Center for

Environmental Health Activities (WHO/CEHA) has invited Jordan to join HELI besides Thailand and Uganda. In 2004, HELI started a four-year process to generate evidence for WHO guidance on household water security for health and to derive the minimum household water security requirements for health.

In regional consultation on the Health and Environment Linkages Initiative (HELI) and Children's Environmental Health Indicators (CEHI) conducted in Amman 2005, WHO review lessons learned and tools used in HELI and CEHI pilots in selected EMR countries, the outcomes from this consultation are the followings:

- Health and Environment Linkages Initiative (HELI)-Jordan Pilot demonstrated clearly the inverse relationship between increased water consumption and reduced diarrhea incidence hygiene practices and socio-economic status of households.
- In reviewing evidence and generating guidance on minimum water requirements for health, the consultation suggest to apply risk assessment techniques to examine the linkages between water availability and consumption in and the incidence of disease. Studies were sponsored in Morocco and Lebanon, Jordan, Oman and Tunisia,
- Despite the evidence pointing to the benefits of increased quantities of water on health, the relationship is not simple and depends on several factors and conditions.

In summary, identifying minimum water requirements for health protection is becoming a very important concern, in particular to health authorities, to avoid human suffering and distress. The relation between minimum water quantity and the health inside the household is not well established and affected by some confounding variables. Therefore, there is a crucial need to determine if there is a relationship between water quantity and health, if so, what the best methodology explain that relationship.

3 Literature Review on minimum water requirements for health

3.1 The purpose of the literature review

The published literature on domestic water consumption and water requirements for health protection was obtained using different databases and resources to:

1. Conduct a comprehensive literature review of published studies and research that attempted to investigate and quantify the water requirements for health protection.
2. Conduct a comprehensive literature review of published studies and research that assess the impact of domestic water quantity on health.
3. Compare, summarize, and highlight the methodology that has been used globally in research conducted on water requirements.

The literature review focused mainly on the following:

- ✓ Definitions and concepts related to the water requirements for health protection
- ✓ Household water requirements for health protection
- ✓ The relationship between quantity of water supplied and health risks.
- ✓ The complex relationship between hygiene, sanitation, health and household water security.
- ✓ Incidence of water-related diseases (in particular diarrhea among children under five, and Water Washed diseases) globally.

- ✓ Indicators for the assessment of impact of water security on health.
- ✓ Water minimal needs.

3.2 A description of literature search

Literature review was based primarily on the published literature using different databases and resources such as: WHO/CEHA website and library, universities libraries (Jordan, JUST and PSUT), and Cambridge Scientific Abstracts (including Aqua-line, Water Resource Abstracts and Bacteriology Abstracts). Other databases available at CEHA library (including water resources abstracts, pollution abstracts, EMBASE/pollution and toxicology, Index Medicus for the Region, PubMed, MEDLINE (1966–2011) and Google scholar were searched for relevant literature. Google Scholar, which has the advantage of covering all disciplines and unpublished material, was searched heavily, using specific search terms. As the Google searches generated a large number of results, we limited our reviews to the most relevant literature. In addition to contacting key researchers working in the field of water, sanitation and hygiene, we also contacted and searched the websites of the different organizations including US Agency for International Development, European Commission, the World Bank (Office of Evaluation and Development), Pan American Health Organization, World Health Organization, UNICEF, UNEP, UNDP, UN-HABITAT, UNRISD, and Centers for Disease Control and Prevention.

It worth mentioning that WHO (2003) report entitled "Domestic water quantity, service level and health" was a valuable reference for our review and thus we used it and its cited references heavily.

Five reviewers with research interest and wide experiences in water, environmental health, public health, and epidemiology worked together to review the available literature and draft the current review.

3.3 Background

Domestic water supplies are essential requirements for human life. The lack of access to adequate water supplies leads to the spread of diseases including diarrhea diseases with children being the most affected group. The importance of water quality continues to be emphasized for its role in epidemics and endemic diseases that affects both developed and developing countries and mainly the children in developing countries. Although it is largely preventable, diarrhea diseases due to unsafe water, sanitation and hygiene constitute the 6^{th} highest burden of disease on a global scale as they account for 1.37 million deaths each year and contribute to about 54 million Disability Adjusted Life Years (1).

The 1990 (Base year for the MDGs) and 2008 statistics on urban water supply showed coverage rising from 95% to 96%. In rural areas, the coverage estimates were 64% and 78% for 1990 and 2008, respectively. Based on these statistics, it is predicted that the global MDG target on water supply is likely to be met, but will leave many hundreds of millions of people without an adequate water supply. However, the targets are highly unlikely to be met in sub-Saharan Africa (2).

In the year 2000, it was estimated that one-sixth of humanity (about 18%) have no access (often less than 5 liters per capita per day of more than 1000 m distance of their homes or 30 minutes total collection) to any form of improved water supply. This was found largely in Asia and Africa and particularly in rural populations which are typically less well served than urban populations, with 85 million of them being in EMRO countries. In the same year, 35% of the global population attained a level of basic access (Average per capita consumption per day is unlikely to exceed 20 liters within a distance of 100 – 1000 m of their homes and collection time of 5 to 30 minutes). Less than half (47%) had access to intermediate and optimal levels of service (average quantity of about 50 liters per capita per day and 100 liters per capita per day or more, respectively) (1).

The reasons behind the limited progress towards universal access to an adequate water supply include high population growth rates in developing countries, insufficient rates of capital investment, difficulties in appropriately developing local water resources, and the ineffectiveness in the management of water supplies in urban areas or in the support of community management in rural areas (2).

For many years there has been an extensive debate about the relative importance of water quantity, water quality, sanitation and hygiene in protecting and improving health (3,4). Despite this debate, international guidelines or norms for minimum water quantities that domestic water supplies should provide remain largely lacking.

3.4 Water in the Eastern Mediterranean Region (EMRO)

Despite the significant water scarcity in the EMRO, there is a lack of information on water issues including its quality, quantity and its relation to health. The quantity of water available at the household was measured in some studies, and its effect on health was investigated by some investigators. Very few studies have attempted to relate the type and level of water supply service to specific health effects. The majority of the population of the EMRO lives in countries facing moderate to high water scarcity, and the cost of producing and supplying domestic water to extend and sustain water supply services to people is rising. Due to water shortages, inadequate capacity and poor management of the supply system, water may be supplied intermittently, with supplies interrupted for as long as a week in some cases. Intermittent supplies may result in limited availability and inequitable availability of supply. Furthermore, intermittent supplies are associated with water quality deterioration in the supply system and in household storage facilities (5).

High-income groups in EMRO can afford to secure their water supplies through building large household storage facilities, purchasing additional trucked supplies, purchasing bottled water for drinking and installing household drinking-water quality control systems. The cost of such measures is however, beyond the reach of the poor.

Jordan is classified among the lowest countries in the world in terms of water availability with scarce water resources compared with other countries in the Middle East. Resources are seriously limited and considered to be far below the water poverty line of (1000) m^3 per capita per year. Jordan is a semi-arid to arid region with a climate that is predominantly Mediterranean; it is characterized by a hot dry summer and cool wet winter, with two transitional periods. Water resources in Jordan depend mainly on precipitation within the country. Climate change is expected to increase temperatures and change precipitation patterns, decrease surface water availability, and increase water scarcity in the country (6).

3.5 Impact of inadequate water supply on health

Poor access to sufficient quantities of water also can be a key factor in water-related disease, and is closely related to ecosystem conditions. About one-third of the world's population lives in countries with moderate to high water stress, and problems of water scarcity are increasing, partly due to ecosystem depletion and contamination. Two out of every three persons on the globe may be living in water-stressed conditions by the year 2025, if present global consumption patterns continue (7).

The diseases linked to poor hygiene include diarrhea and other diseases transmitted through the fecal- oral route; skin and eye diseases, in particular trachoma and diseases related to infestations, for instance louse and tick-borne typhus. Bradley suggested that there are four principal categories of diseases that relate to water (8):

- Water-borne: Caused through consumption of contaminated water (like diarrheal diseases, infectious hepatitis, and typhoid).
- Water-washed: Caused through the use of inadequate volumes for personal hygiene (like diarrheal disease, infectious hepatitis, typhoid, trachoma, skin and eye infections).
- Water-based: Where an intermediate aquatic host is required (like guinea worm and schistosomiasis).
- Water-related: Spread through insect vectors associated with water (like malaria and dengue fever).

Investigations of the costs and health benefits associated with improvements to drinking water supply in low income countries have concentrated almost exclusively on how these improvements affect the incidence of acute infectious diarrhea. This focus is not surprising given that diarrhea disease is the second most common contributor to the disease burden in developing countries (as measured by disability-adjusted life years [DALYs]), and poor-quality drinking water is an important risk factor for diarrhea. Most of the excess disease burden in developing countries falls on young children where 17% of all deaths in children under 5 years are attributed to diarrhea (9).

Inadequate water supply is considered a contributor to deaths in children under 5 years. It was found that both the Gross Domestic Product (GDP) per capita and the proportion of the population without access to improved water were highly correlated with infant mortality (10).

3.6 Water uses, needs and requirements

A good understanding of domestic water usage patterns and trends is essential to effectively plan for the present and future needs of people. White et al.(11) in his study on water use patterns in East Africa, defined three types of use for water domestic supply: Consumption (drinking and cooking), hygiene (including basic needs for personal and domestic cleanliness), and amenity use (for instance car washing, lawn watering). Many studies estimated the domestic water requirement by estimating the amount of water according to its use including hydration, cooking, hygiene and sanitation.

3.6.1 Hydration

Based on US National Research Council guidelines in relation to hydration needs resulting from average energy expenditure and environmental exposure in the USA, Kleiner suggested that in average conditions, male adults need a minimum of 2.9 liters per day, female adults need minimum of2.2 liters per day, and children need 1 liter per day (12). During manual labor in high temperature, the quantity rises to 4.5 liters per day. Approximately one third of this fluid is considered to be derived from food. In the WHO Guidelines for Drinking Water Quality (13), guideline values for chemical contaminants are based on the assumption of that a 60 kg adult consuming 2 liters per day from drinking water, which would be equivalent to 3 liters per capita per day including food consumption. For children, 1 liter per day for a 10 kg child or 0.75 liter per day for a 5 kg child are used by WHO Specific guidance is needed for vulnerable population.

On the other hand, White et al. and Gleick suggested that a minimum of 3 liters per capita per day is required for hydration for adults in most situations in developing countries (11, 14). Data from the US Army reported estimates of water quantity needs at different temperatures and activity levels (11). At 25 $^{\circ}C$ with moderate activity in the sun, approximately 4.5 liters are required to maintain hydration. This rises to about 6 liters at 30 $^{\circ}C$ or when hard work in the sun is undertaken at 25 $^{\circ}C$. It can be concluded that the quantity of water required for hydration (whether via direct ingestion or food) should be a minimum of 2 liters for average adults in average conditions, reaching a level of 4.5 liters per day under conditions typically facing the most vulnerable in tropical climates and higher in conditions of raised temperature and/ or excessive physical activity.

3.6.2 Cooking

Defining the requirements for water for cooking is difficult, as this depends on the diet and the role of water in food preparation (1). Review of the literature showed that there is a wide variation in the reported water requirements for food preparation depending on cooking practices. Gleick suggested that 10 liters on average per capita per day is required for food preparation (14), whilst Thompson et al. showed that in East Africa only 4.2 liters per capita per day were used for both drinking and cooking (15). While most detailed surveys of domestic water use in industrialized countries did not provide separate estimates of water used for cooking, Brooks and Peters estimated the amount of water use for food preparation in wealthy countries to range from 10 to 50 liters per capita per day with a mean of 30 liters per capita per day (16). In a study about the water provided for 1.2 million people in northern California, an average of 11.5 liters per capita per day was used for cooking, with an additional 15 liters used for dishwashing (14).

By adding the volume required for food preparation to the volumes of drinking, a figure for total consumption (i.e. drinking water plus water for foodstuffs preparation) of 7.5 liters per capita per day can be considered as the basic minimum of water required, taking into account the needs of lactating women (1).

3.6.3 Sanitation and Hygiene

Water and sanitation had a considerable recent attention as a result of the declaration by the United Nations General Assembly that the 1980s is the International Drinking-Water Supply and Sanitation Decade. Most of the research on the health impacts of water and sanitation has focused on the incidences of diarrhea diseases, malnutrition, and mortality of young children.

It was difficult to determine based on the published literature whether the differences in health conditions were due to increased amounts of water, improvements in its quality, or both. The majority of the studies that examined the effect of increased amounts of water specifically and independently of water quality reported a positive impact (17). Esrey conducted a review of data of Demographic Health Surveys from 11 developing countries concluded that improvements in sanitation resulted in more significant reduction of diarrhea than improvements in water supply (18).

Review of literature regarding hygiene practices and diseases did not define a minimum quantity of water recommended for use to ensure effective hygiene. The evidence emphasize that the effective use of both water and cleansing agents and the timing of hygiene practices are more important than quantity of water used (1). It was concluded that, water quantity affect hygiene badly only when it is available in very small quantities. It was also found that poor hand washing practice has been reported in countries with abundant in house water supplies and general availability of soap. Improvement in hygiene usually provided some improvements in health in any setting, irrespective of socioeconomic conditions or service level. The need for domestic water supplies for basic health protection exceeds the minimum required for consumption (drinking and cooking). Additional volumes are required for maintaining food and personal hygiene through hand and food washing, bathing and laundry.

Poor hygiene may in part be caused by a lack of sufficient quantity of domestic water supply. Studies in Kenya, Tanzania and Uganda indicated that the quantities of water used for bathing (including hand washing) and washing of clothes and dishes are affected by service level (15). For houses using water sources outside the home, an average of 6.6 liters per capita are used for washing dishes and clothes and 7.3 liters per capita for bathing. By contrast, houses with a connection to piped water supply use on average 16.3 liters per capita for washing dishes and clothes and 17.4 liters per capita for bathing. The authors suggested that for the households using a water source outside the home, the lesser volume collected has a negative impact on hygiene although this wasn't quantified (15).

Despite the evidence pointing to the benefits of increased quantities of water on health, the relationship is complex. Although hygiene is related to availability of water, specific hygiene behaviors such as hand washing at critical times are very important. Curtis et al. suggested that the critical time is post-defecation rather than before eating (19), while other studies found that hand washing before eating is more important in some situations (20). Others found a reduction in diarrhea incidence among young children to be influenced by maternal hand washing before preparing the food to the child (21). Studies suggested that hand washing with water only provided little or no benefit while using soap is the critical component of the hand washing behavior (22,23).

The amount of water required for hygiene purposes is more difficult to pinpoint. Its lack leads to diarrhea, trachoma, diseases related to infestations and diseases which are often transmitted by the fecal-oral route. Easier access to water reduces the time required to collect it, leaving more water for child hygiene and more time for child feeding.

A study on the effect of intensive hand washing promotion on childhood diarrhea among high risk communities was conducted in Pakistan revealed that personal hygiene is one of the detrimental factors in the occurrence of diarrhea and hand washing with soap significantly reduced the incidence of diarrhea by 39% in infants and by 57% in children aged 5-15 years. There were no significant differences between antibacterial soap and plain soap (24).

A review of other studies in North America and Europe suggested an average water use in industrialized nations for bathing to be about 70 liters per capita per day, with a range of 45 to 100 liters per capita per day. Data on water used for bathing in developing countries with no piped water are not widely available. Some studies suggest that minimum water needed for adequate bathing is about 5 to 15 liters per capita per day and that required for showering is 15 to 25 liters per capita per day (25). A basic level of 15 liters per capita per day for bathing is recommended (14).

3.7 The need for guidelines/norms for minimum water quantities

For many years there has been an extensive debate about the relative importance of water quantity, water quality, sanitation and hygiene in protecting and improving health (3,4).

Despite this debate, international guidelines or norms for minimum water quantities that domestic water supplies should provide are lacking.

The World Health Organization has not previously published specific guidance on the quantities of water needed for health protection and promotion (1). In its Guidelines for Drinking–Water Quality, WHO defines domestic water as being *"water used for all usual domestic purposes including consumption, bathing and food preparation"* (13). This implies that the requirements with regard to the adequacy of water should cover all these uses and not only the consumption of water.

Since the cost of producing and supplying domestic water to people is rising, WHO/ EMRO is receiving many requests from governments for guidance on the minimum amounts of water that should be supplied for domestic purposes. Such guidance is necessary to establish water supply service targets and provide an opportunity for WHO to encourage domestic water pricing policies which are sensitive to the health benefits of the population.

Experience in some countries of the eastern Mediterranean region suggested that even the provision of a piped water supply does not always ensure the enhanced availability of water to the whole population. Water shortages, inadequate capacity and poor management of the supply system can result in an intermittent water supply. Issues of inequitable supply and variations in ability to purchase additional water can also result in variations in water consumption even where there is a piped supply. Water quality is considered as important as its availability and it is generally assumed that the more improved the supply system, the better the water quality (26).

3.7.1 Levels of access to water

Ensuring at least a basic level of service remains a key international goal and it represents the primary objective of the Millennium Development Goal in relation to water. However, investment should not focus solely on this level of access, but should consider increasing numbers of people to an intermediate level of access (1).

Different levels of access to water have been suggested by Howard & Bartram; the no access level (quantity collected is often below 5 liters per capita per day), the basic access level (average quantity unlikely to exceed 20 liters per capita per day), the intermediate access level (average quantity about 50 liters per capita per day) and the optimal access (average quantity100 liters per capita per day and above). The access measures for these four levels of access in terms of distance and time for water collection are; More than 1000m or 30 minutes total collection time, between 100 and1000m or 5 to 30 minutes total collection time, water delivered through one tap on plot or within 100m or 5 minutes total collection time, and water supplied through multiple taps continuously respectively. The levels of health concern are considered very high, high, low and very low for no access, basic access, intermediate access and optimal access respectively. The group with no access has no household water security as the quantities collected are low, and quality cannot be assured. The group with basic access is considered to have basic household water security, while the group with intermediate access is considered to have effective household water security as sufficient water is available to meet domestic needs and quality can be assured. The group who has optimal access has optimal household water security with quantity, quality and continuity (1).

3.7.2 Domestic water supply and minimum requirements

Although the Millennium Declaration Goals include a target to "*halve the proportion of people who are unable to reach or to afford safe drinking water by 2015*", the quantity of such water that should be supplied was not specified.

Several publications and reports reported minimum water requirements for hydration of individuals according to their age, health condition, level of activity and environment. However, guidance on the minimum household water requirement for health is not available. Furthermore, international guidelines or norms for minimum water quantities that domestic water supplies should provide are lacking. Several references reported different values of minimum water requirements that should be satisfied. However, these references did not provide evidence that the reported minimum water requirements assure good health.

One of the studies that attempted to investigate the linkage between minimum household water requirement and health has been conducted in Greater Irbid area during the summer of 2005 in the north of Jordan by Abu-Ashour and Al-Sharif (27,28). The investigators conducted two types of methods; the primary method which was a household study and the secondary method which was a rapid assessment study (correlation study). In the primary approach they showed that the per capita daily consumption of water was positively associated with the percentages of diarrhea cases after adjusting for other factors. Results of this analysis indicated that diarrhea occurrence was not related to water consumption and there are other factors that could cause or prevent diarrhea.

In the secondary approach (rapid assessment) study they correlated the water supply and consumption with diarrhea in children under 5 years of age. They showed that water consumption was significantly associated with the number of diarrhea cases among children in

Irbid and by increasing the daily water consumption, a decrease in the incidence of diarrhea will result. Another study in Morocco concluded that water consumption of 70 liters per capita per day is the optimal water requirement for health (29).

The basic level of supply should be regarded as a minimum quantity of water and the first priority for interventions to improve access to water supplies is to ensure that at least basic access is achieved. At a basic level of service the volume of water collected is likely to be around 20 liters per capita per day, at this level of service, the effective use of the available water and timing of hand and face-washing and household water treatment are considered to be the most important in controlling infectious disease transmission (1).

The WHO/ UNICEF Joint Monitoring Program, which produces the Global Assessment of Water Supply and Sanitation data, defines reasonable access as "*the availability of at least 20 liters per capita per day from a source within one kilometer of the users dwelling"*(30). However, it should be noted that this definition considers the access and not necessarily be understood as evidence that 20 liters per capita per day is a recommended quantity of water for domestic use. The guidance manual prepared for the Department of International Development, UK by WELL (1998) suggested that a minimum amount of water supply should be 20 liters per capita per day, keeping in mind the importance of reducing distance and encouraging household connection (31). A similar figure has been suggested by other researchers (32).

Studies in both developed and developing countries (11, 33) suggested that an average of 10 to 20 liters per capita per day appear to satisfy most regional standards and that 10 liters per capita per day will meet basic needs. Others recommended that a basic water requirement of 25 liters per capita per day of clean water for drinking and sanitation is to be provided by water agencies or governments (14). This amount is just above the lower end of 20 to 40 liters per capita per day target set by the USAID, the World Bank and the WHO.

Suggesting a higher value, Gleick reported that the international community has to plan for a basic domestic water supply of 50 liters per capita per day. He recommends that international organizations, national and local governments and water providers should adopt a basic water requirement standard for human needs of 50 liters per capita per day. Furthermore, he stated that the access to this level has to be maintained for all people of different economic, social or political status. Unless this basic need is met, large- scale human suffering will continue and grow in the future. Using minimum levels of 15 liters per capita per day for bathing and 10 liters per capita per day for cooking, it was recommended that international organization and water providers adopt an overall Basic Water Requirement (BWR) of 50 liters per capita per day as a new standard for meeting the four domestic basic needs that include drinking, sanitation, bathing and cooking independent of climate, technology and culture. It is recommended that basic water requirement for drinking, basic sanitation services, human hygiene and food preparation be guaranteed to all humans. An amount of 50 liters per capita per day of clean water should now be considered a fundamental human right, in contrast to these figures domestic water use in all industrialized countries far exceeds the BWR, though the quality of this water varies widely. In the countries of Western Europe the recommended BWR is less than 25% of total domestic use. In the US and Canada a BWR of 50 liters per capita per day is less than 10% of total current domestic use (14).

Chenoweth in his paper on minimum water requirement for social and economic development stated that there is no common understanding of the minimum per capita fresh water requirement for human health and economic and social development. The existing estimates vary between 20 and 4654 liters per capita per day. The author concluded that these estimates are methodologically problematic as they consider only human consumption and hygiene needs, or they consider economic needs but not the effects of trade. Reconsidering the components of a minimum water requirement estimate for human health and for economic and social development, the suggestion was that a minimum of 135 liters per capita per day is required (34).On the other hand, different quantities of water to be supplied have been proposed for certain specific conditions. For instance, the SPHERE project sets out 15 liters of water used per capita per day as key indicator in meeting minimum standards for disaster relief (35).

3.8 Indicators to assess the impact of domestic water use on health

In most studies, childhood diarrhea, a leading cause of morbidity in developing countries, was used as a criterion for identifying a minimum requirement of water consumption that ensures health protection and promotion. Of the water associated diseases, diarrhea can be caused by both water-borne and water-washed (personal hygiene) factors (5). The evidence from the literature suggests that water availability has an important influence on health and diarrhea incidence in particular. Other indicators were used in some studies such as stunting, malnutrition, and mortality of young children. A study in Pakistan demonstrated that an increased quantity of water available at households was critical in preventing stunting (36). In another study, inadequate water supply was considered a contributor to deaths in children under 5 years (10).

3.8.1 Risk of diarrhea in relation to water supply and use

Small scale rapid assessments correlation studies on the relationship between water consumption and incidence of diarrhea were conducted in Oman, Tunisia, Saudi Arabia and Philippines as a preparation for the WHO/ EMRO/ CEHA consultation on minimum household water security requirements and health held in Amman/ Jordan, December 2003. The findings of these assessments were discussed by the workshop and found to be very modest, biased and it was very difficult to draw valid conclusions from these data (5).

As part of health and environment linkages initiative (HELI), the Jordan pilot conducted in 2005, the health group launched a study to understand the relationship between relative levels of water consumption and diarrhea incidence in Greater Amman and in 16 selected villages from the north of Jordan. The study revealed a marked inverse relationship between average water consumption levels and diarrhea incidence rates. The curve clearly showed as more water is made available to consumer, the less rate of diarrhea incidence to occur. The study concluded that there is a clear disparity in water consumption among the Jordanian population; about 40% used less than 51 liters per capita per day and 20% used more than 117 liters per capita per day. With an average of 51 liters per capita per day, the average incidence of diarrhea was 0.41 episodes per person per year. By adding 10 liters per capita per day to the above average consumption, the incidence of diarrhea will be reduced to 0.23 episodes per person per year. While by adding 15 liters per capita per day to the average consumption will reduce the incidence to about 0.2 episodes per person per year. The findings stress the need for improvements to the amount of water supply provided for the 56% of the Jordanian population using less than 74 liters per capita per day and water policy is an important initiative to improve the public health and the status of environment in Jordan (37).

A cross-sectional descriptive study was conducted in the immediate suburbs of the city of Beirut to identify the relationship between water consumption patterns and the incidence of diarrhea diseases in children less than five years of age. All the households of the selected sectors were screened. Only those having children less than five years of age were included in the study. The study showed that 68.9% of the samples relied on piped water sources to meet basic domestic needs, and 35.7% relied on private well sources. Furthermore, 17.4% depended exclusively on the provided piped water source in comparison to 6.2% depending on bottled water and 33.4% depending on water shop sources. The study showed a clear correlation of cases in children less than five years of age, with the following parameters: age and educational status of the mothers, employment, and socio-economic status of households. A significant correlation was noted between diarrhea and the intermittence and continuity of water supply. This finding lead to a preliminary conclusion that quantity of water supplied affects the occurrence of diarrhea among children. However, when considering the educational level of the parents, employment, and the monthly income of the households, the significance disappears. Correlating diarrhea with the different domestic water sources indicated the positive correlation with the piped water source and the use of private wells, but was not associated with the use of cisterns. However, when taking into account the income of the households, a statistically significant correlation was found. Diarrhea occurrence was significantly related to the treatment of domestic water regardless of the treatment methods applied. On the other hand, when personal and domestic hygiene habits were crossed with diarrhea incidence, no statistical significance was found. Solid waste and wastewater management in the study area were not related with the incidence of diarrhea occurrence (38).

As reported in the regional workshop (43) which was conducted in Morocco between December 2003 and November 2004 to assess the minimum water requirements for health by conducting population based surveys. The study showed that the annual average of water consumption is 73 liters per capita per day, which is similar to the national average. High consumption is recorded during the summer season (30% above average). Water consumption in villas was higher than other types of houses such as apartments. Drinking water quality in the study area was found to comply with Moroccan standards and WHO guidelines. The population diarrhea incidence rate in the study area ranged from 0.3% to 3.4%. Field surveys were conducted in October 2004 in 5 cities (Sidi Kacem, Oued Zem, Berkane, Khemisset and Ain Taoujdate) in order to verify the statistical data. Fifteen hundred and eleven households (7811 inhabitants) were surveyed. The findings showed that almost all the houses are equipped with toilets, more than 66% of the households have showers or baths and more than 60% have water heaters. More than 97% of the household were connected to the public drinking water network with satisfactory water quality and pressure. The whole population was connected to the sanitation network with the exception of a few locations in some localities. It was found that 10-15% of households in some localities use bottled water for drinking and almost all the people in households wash their hands before and after eating and after using toilets. Average incidence of diarrhea ranged between 1 and 7.2 cases per 1000, according to localities. The study concluded that there is no apparent link between water consumption and diarrhea incidence rate. It was observed that the rate of diarrhea incidence increases during summer seasons due to other factors that influence health which should be further investigated. The study concluded that water consumption of 70 liters per capita per day is the optimal water requirement for health.

The Palestinian Hydrology Group and United Nations Children's Fund (UNICEF) conducted a household survey during the period between August and December 2009 in Gaza to measure the status of domestic water, waste water, solid waste, hygiene and health in a sample of 1250 households. The findings indicated that 20% of the households had at least one child under the age of 5 years suffered from diarrhea during the four weeks preceding the survey due to poor hygiene and water quality (39).

Another study on diarrhea and effects of different water sources, sanitation and hygiene behavior was conducted in East Africa to carry out a repeat analysis of domestic water use and environmental health. From 1967 to 1997, the prevalence of diarrhea, in the week preceding the survey, increased from 6% to 18% in Kenya and from 16% to 21% in Uganda while it declined slightly in Tanzania (11–8%). Determinants of diarrhea morbidity included poor hygiene (unsafe disposal of feces and wastewater), education level of household head, obtaining water from surface sources or wells and per capita water used for cleaning. Hygiene practices were important complement to improved water and sanitation in reducing diarrhea morbidity (40).

Bukenya and Nwokolo reported that the presence of a standpipe at households in urban Papua New Guinea was associated with less incidence of diarrhea among the inhabitants of these households than among the inhabitants of households using communal sources of water supply. This finding was found across all socioeconomic groups (41). Gorter et al. found that in Nicaragua, children living in households with a water supply within 500m had 34% less diarrhea than children living in households whose water source was over 500m from the house (42).

A study to evaluate disease as a function of water quantity was conducted in Mozambican refugee households to compare those who consumed <15 liters per capita per day with those who consumed 16 – 20; 21 – 30 or >30 liters per capita per day. It revealed a steady association between consuming more water and experiencing less diarrhea among children and among all age groups combined. Households that consumed 10 to 15 liters per capita per day experienced 2.5 times more diarrhea than those that consumed more than 30 liters. While this analysis does not prove a direct causal relationship, since access to improved water service is likely to be accompanied by improvements of other services (such as sanitation), it is clear that a broad statistical relationship exists between improved water services and lower infant mortality for countries of similar GDP. The evidence that improving access to safe drinking water reduces the risk of diarrhea disease in children is strong (43).

A study was carried out on water usage habits and incidence of diarrhea in rural Ankara, Turkey in the villages of Gokcehoyuk, Beynam, Ahiboz and Karagedik, near the town of Golbasi, Ankara, in September 2003. A total of 2471 people lived in the 543 households were interviewed. The average water usage was 68.1 liters per capita per day. The chance of diarrhea disease decreased as the reported distance between the septic tank where the wastewater is discharged and the well increased. Households with a monthly income of less than US$ 216 had 3.5 times the risk of those with an income of more than this amount, while those experiencing water shortages had 10.2 times more risk than those not having water shortage (44).

In another study, Checkley et al. studied the effect of water and sanitation on childhood health in a poor Peruvian peri-urban community. This study showed that at 24 months of age, children with worst condition for water source, water storage and sanitation were 1 cm shorter than the WHO/National Center for Health Statistics reference had 54% more diarrhea episodes than those with best conditions. The risk of diarrhea did not change significantly with less adequate levels of water source and sanitation. Water and sanitation were not associated with diarrhea duration. The largest difference seen in diarrhea duration was between children in households with a latrine or equivalent and those with no facility available. The prevalence of Cryptosporidium parvum and Giardia lamblia was greater in children who did not have adequate sanitation than among those with adequate sanitation. Children without sewage had a 62% greater prevalence of C. parvum (45).

El Karim et al. assessed the relationship between water quantity and quality and prevalence of water-related diseases in Port Sudan and South Kordofan. They found that scarcity of water rather than bacterial contamination was the cause of alarmingly high prevalence of diarrhea, skin and eye communicable diseases (water-washed diseases) among children and adults of Port Sudan and South Kordofan Province in the Sudan (46).

In a study in rural areas of Turkey, Okzan et al. showed that water shortages of longer than 12 h had a significant effect on diarrhea incidence (44). In Ethiopia, the prevalence of diarrhea among under 2-years-old from families with higher water usage rates per person was less than that among comparable children from families with lower rates (17). In Lesotho, use of smaller amounts of water was associated with higher rates of infection with Giardia lamblia (47). In both of these studies, the amount of water used was more important than its source. Improvements in water quantity may have more impact on diarrhea than improvements in water quality alone, and this has been attributed to better personal and domestic hygiene (48). As a consequence, the promotion of hygienic behaviors is receiving increased attention as a preventive strategy against diarrhea diseases.

On the other hand, Pinfold et al. examined the seasonal variation in the reported incidence of acute diarrhea for selected areas in the northeast of Thailand (9). A retrospective study regarding gastrointestinal infections was carried out in the Rhine-Berg District (North Rhine-Westphalia, Germany), which is characterized by different drinking water supply structures. Parameters depicting the water supply structures, especially the amount of drinking water produced from surface or groundwater were correlated with the age-standardized incidence rates of gastrointestinal infections. The correlation models showed a trend of positive linkage between disease incidence and amount of groundwater (50).

3.9 Interventions addressing water quality, water availability, and excreta disposal

Esrey et al., in a review that was based on 67 studies, investigated the relationships between diarrhea disease and a number of factors including water quality, water availability and excreta disposal. The findings from this review suggested that median percentage reduction in diarrhea disease rates from water availability were higher than those from water quality improvements, while combined improvements in quality and availability resulted in greater reduction of disease incidence. The median of the percentage reduction in diarrhea disease rates was 16% when the improvements targeted water quality, 25% when improvements occurred in water availability, 37% when improvements targeted both water quality & availability, and 22% when improvements targeted excreta disposal (3).

In another study, Esrey et al. reviewed 144 studies looking at various different interventions in water and sanitation. Of those, 56 studies were classified to be rigorous and only 24 were used to calculate morbidity reduction (4). The data from the rigorous studies suggested that median reduction in morbidity were relatively low from all water improvements, unless these were combined with sanitation improvement. In this review, the combined improvement in water quality and quantity resulted in lower reductions than for water quantity interventions alone, which contradict the findings of the previous review. This study also identified that the benefits derived from increased water availability were not necessarily seen in all age groups (4). Herbert, who used nutritional status as a health indicator, suggested that water quality was the principal determinant for health in children under the age of three years whereas water quantity was most important for children above three years (51).

Fewtrell and Colford conducted a systematic review and meta-analysis on literature documenting intervention directed at water quality, water supply, hygiene and sanitation and their impact on diarrhea disease in non-outbreak conditions. The searches were limited to papers published between January 1, 1986 and June 26, 2003. A total of 2120 papers were identified. The authors mentioned that the published evidence suggested that hygiene interventions, such as hand-washing and hygiene education in child care centers significantly contributed to reducing diarrhea. Two studies suggested that water supply interventions at household level were effective in reducing diarrhea but in non-outbreak situation. The evidence does not suggest that water quality interventions effectively reduce levels of diarrhea in the study population. These interventions, represented additional treatment to water supplies that were already of reasonable quality, in populations where diarrhea prevalence was low. In developing countries the published evidence suggested that water quality interventions, specifically point-of-use treatment, reduced diarrhea illness. This evidence is consistent with the idea that water quality interventions may be more important than previously thought. There were few studies which examined the effect of sanitation interventions and, although existing data suggested that sanitation is effective in reducing diarrhea; further research is needed in this area. It is currently difficult to distinguish between health benefits resulting from water quality or water quantity. Water consumption levels in many cases are not documented and although water access is improved it is not clear that this translates to an increased use of water. Hygiene interventions are effective in reducing diarrhea, mainly hand-washing and other 'good' behaviors in the home. Many of the hygiene intervention studies have been conducted in areas which already have improved drinking water and sanitation, although these interventions are also effective in areas with poorer water and/or sanitation (52).

3.10 Methodologies used in previous studies

In investigation of the linkage between minimum household water requirement and health has been conducted in Greater Irbid area during the summer of 2005 in the north of Jordan by Abu-Ashour and Al-Sharif (27, 28). The investigators used two types of method, the analysis of primary data approach and the analysis of secondary data approach. In the primary data approach, a household survey was conducted where the investigators correlated the water supply and consumption with diarrhea in children under 5 years of age. The researchers used two types of questionnaires; the first one was utilized to gather general information about household conditions and inhabitants, while the second one used to assess water supply and sanitation at the households. The secondary data method was a sort of correlation study that assessed the general relationship between average per capita daily consumption of water and average diarrhea incidences for the years 2000-2004. Water data were collected from the Water Authority of Irbid for several areas within the governorate of Irbid. They included billed water quantities recorded every three months. The annual water consumption and the average daily per capita consumption were estimated. Health data collected consisted of the number of diarrhea cases among under 5 children reported to government health centers in the concerned study areas. The incidence of diarrhea per 1000 was calculated for different areas and for the years 2000-2004. A correlation between the average daily per capita consumption of water and the average incidence of diarrhea for different years was plotted.

As part of health and environment linkages initiative (HELI), the Jordan pilot conducted in 2005 (37), the health group launched a study to understand the relationship between relative levels of water consumption and diarrhea incidence in Greater Amman and in 16 selected villages from the north of Jordan. Water consumption data through water bills were collected according to billing districts from water utility company (LEMA) and the ministry of water and irrigation. Diarrhea incidence was determined by means of data from corresponding health center catchments areas and through calibration with the 2002 Demographic and Health Survey (DHS). It was hypothesized that improved water supplies used for hygiene and food production will reduce incidence of water-borne diseases with diarrhea as an indicator- yielding improvements in residents' health. To investigate this hypothesis, several types of data were used including data on incidences of diarrhea among the population in the study area obtained from diseases surveillance programs and health surveys. Data on water quality in the study area were obtained from water authorities and data on population of zones of the study areas were obtained from the department of statistics. The criteria for selecting the study areas were based on availability of data on household water consumption and the presence of health centers that can provide records on diarrhea cases. Water billing data were obtained for 72 billing zones in Amman and 16 villages in the north of Jordan for the years (2002 - 2004) for each billing cycle within the year (4 cycles/year) and by range of consumption as liters per capita per day (less than 53, 54-74, 75-117, 118-170, above 170). The health centers (MOH) in the study area from which data on diarrhea cases can be obtained were identified. The monthly data on cases of diarrhea for the whole population for 4 years 2001-2004 (surveillance data) were collected. Data were carefully processed to avoid including data of diarrhea outbreaks. The catchments areas of the health centers among billing zones were identified. Using the data on population of catchments areas, the incidence of diarrhea was estimated for the corresponding catchments areas. Data on diarrhea incidences reported in the health centers were plotted against the data on water consumption (liters per capita per day) for the corresponding catchments areas after excluding the higher 20% of consumers in each area (consumers who consume above 55 m^3/quarter). Higher consumer groups were excluded as they do not usually suffer from water shortage, hence they do not share in the diarrhea burden. Moreover, population of this category usually approaches private doctors for treatment. During the study period, there were a few localized diarrhea outbreaks associated with accidental breakdowns in water quality. These outbreaks were noted and excluded from the study, as they do not reflect the general quality of water supply. Regression analysis was used to analyze the data in which the dependent variable (Incidence per person per year) is regressed against the independent variable (liters per capita per day).

Small scale rapid assessments correlation studies on the relationship between water consumption and incidence of diarrhea were conducted in Oman, Tunisia, Saudi Arabia and Philippines as a preparation for the WHO/ EMRO/ CEHA consultation on minimum household water security requirements and health held in Amman/ Jordan, December 2003. The methodology and findings of these assessments were discussed during the workshop by the participants and found to be very modest, biased and it was very difficult to draw valid conclusions from these data (5).

Mahvi and Norouzi (53) selected 20 villages that have domestic water meters in buildings connection in Hamadan province in Iran. From each village, 10 buildings were selected by random sampling method. A questionnaire was completed for each building which gathered data on water meter code, number of residents, use of private bath, and use of domestic well, number of domestic animals, animal's water source, area of building, area of green built and situation of water supply system. The quantity of water consumed in each building during the period of March 2002-March 2003 was measured from rural water and waste water company documents archive for different seasons separately.

The Palestinian Hydrology Group and UNICEF (39) conducted a household survey during the period between August and December 2009 in Gaza/ Palestine to measure the status of domestic water, waste water, solid waste, hygiene and health on a sample of 1250 households. They used the questionnaire provided by the Global Wash Cluster after its modification and translation into Arabic. Gaza was divided into 62 numeration areas according to 2007 census. These areas were stratified according to governorate and community type (Urban, Rural and camps). They selected 50 of these areas randomly and the households within these areas were then randomly identified. The household was defined as one person or a group of people living in the same housing unit, sharing meals and jointly providing food and other essentials for living. The number of households selected from each area was 25. The questionnaire used contained questions related to family & shelter information, taste of water, storage capacity of water, frequency of running water in the network, availability of enough water, cost of water, type of toilet, presence of sewage network, disposal of solid waste, personal hygiene practices and occurrence of diarrhea diseases in the past four weeks among family members.

Loh and Coghlan (25) conducted a domestic water use study in Perth, Western Australia 1998-2001 to collect data on household water usage and identify water use patterns and trends. The information gathered were to be used by Water Corporation to improve forecasting of future demand and develop water use efficiency programs that are soundly based. The study utilized two phases; Phase 1 included single residential households and phase 2 which focused on multi residential households. In phase 1, household data were collected from 720 volunteer households across the Perth metropolitan area. The pilot group of 120 households at which special metering equipment was installed to continuously monitor water use from November 1998-June 2000 and the main group which consists of another 600 households at which total monthly usage was recorded from November 1998- to February 2000. All of the 720 households completed three questionnaire surveys covering demographic, appliance ownership and attitudes to water use. The pilot group was stratified into three sub-samples of 40 households each drawn from low, medium and high income locations. The main group was a stratified sample representing the Perth area. Data gathered from the main group were used to help validate the pilot group data on key variables. However, in phase 2, household data were collected from 297 volunteer multi- residential households across the Perth area which consisted of: A pilot group of 124 households at which special metering equipment was installed to continuously monitor water use from September 2000 and November 2001. A main group of another 173 households which provided questionnaire data only. Data from households in the main group were used to help validate the pilot group data on key variables.

In phase 1, data on household characteristics and attitudes were collected using three separate questionnaires. The first questionnaire surveyed all of the 720 households at the time of recruitment and covered ownership of water using appliances and demographics. The two additional questionnaires surveys, were used to cover attitudes to water use, one at the end of each of the two summer periods in the study time frame (i.e. 1998/1999 and 1999/2000).

In phase 2, all multi-residential households were surveyed at the time of recruitment using a questionnaire covering ownership of water using appliances, water use patterns and demographics. Pilot group households had meters and data loggers (referred to as smart meters) installed on their water services to continuously record water usage patterns. Existing service meters at main group households (both phases) were only read monthly by the householders.

Retamal et al. (54) conducted a water end-use survey in Vietnam during 2009-2010 to identify the main household end-use, the proportion of water demand for each end-use, the average total household water demand and the proportion of waste water that is grey water or black water. A total of 200 households were surveyed for the frequency and duration of their water use for end-uses such as taps, toilets and showers and for the volumes used for end-uses such as hand washing and washing clothes. In cases where householders had difficult in estimating their use, researchers from CTU extrapolated this from experience with other similar households and In order to account for uncertainties in the results from household survey, the calculations of total household water use were calibrated against each household's water bill, so that while there may be inaccuracies amongst end-uses, the total water use determined through the sum of end-uses does not exceed each household's actual water bill.

A study (40) on diarrhea and effects of different water sources, sanitation and hygiene behavior was conducted in East Africa to carry out a repeat analysis of domestic water use and environmental health. Field assistants spent at least 1 day in each household observing and conducting semi-structured interviews. They measured the amount of water collected, recorded the amount of water used in the home, and noted household socio-demographic characteristics, prevalence of diarrhea, state and use of latrines, sources of water and conditions of use. They surveyed 1015 households in 33 sites in Uganda, Tanzania and Kenya in 1997. From 1967 to 1997, the prevalence of diarrhea, in the week preceding the survey, increased from 6% to 18% in Kenya and from 16% to 21% in Uganda while it declined slightly in Tanzania (11–8%). Determinants of diarrhea morbidity included poor hygiene (unsafe disposal of feces and wastewater), education level of household head, obtaining water from surface sources or wells and per capita water used for cleaning. Hygiene practices are an important complement to improved water and sanitation in reducing diarrhea morbidity. Respondents were asked whether any cases of diarrhea had occurred in the household in the last 7 days. The proportion responding positively was used as the 7-day period prevalence of diarrhea. At each un piped household, semi-structured interviews with the head of the household or the spouse or the main drawer of water depending on who was available was conducted, data was collected on domestic water use, socio-demographic characteristics, prevalence of diarrhea, state and use of latrines, sources of water and conditions of use. Wherever possible, reported water use was cross-checked by interviewing other respondents in the household and by observing the actual number of trips to the water source(s). Observations were carried out for 1 day per household, from 6 a.m. to 8 p.m. The actual amount of water used was measured by weighing it on a scale. Water use between 8 p.m. and 6 a.m. was estimated by interviewing household members. Information on environmental health, particularly on the prevalence of diarrhea and state and use of latrines, was obtained by interview and observation. For piped households, meter readings for a full year were obtained, where available, from the local water or town council office. As in the un-piped households, the interviewers spent a whole day, from 6 a.m. to

8 p.m., in each house to cross-check the information on water use, state and use of toilets, socio-demographic characteristics and prevalence of diarrhea.

The UK domestic water consumption survey (55) included a sample of 2000 households. Within the 2000 households a sub-set of 100 for special investigation, called Golden 100, where in each a meter was constructed. A detailed socio economic questionnaire was completed including information regarding number and age of people in the household, their qualification and income and mater of hygiene (number of bathes per week as an example). A diary of water use were filled by householders for one week and matched against the meter recordings.

A study was carried out on water usage habits and incidence of diarrhea in rural Ankara, Turkey in the villages of Gokcehoyuk, Beynam, Ahiboz and Karagedik, near the town of Golbasi, Ankara, in September 2003 (44). A total of 2619 people lived in 590 households were enrolled in this study. Face-to-face interviews were implemented and one resident per household was interviewed. The father and/or mother were preferred for the interview; otherwise, a member of the household aged 18 years or over was interviewed. The questionnaire contained questions on water-transmitted diseases occurring during June, July and August 2003 and the factors determining the risk of disease. The first part of the questionnaire concerned the household. The second part included questions about the house and the interviewee lived in, while the third part was about the household's access to infrastructure. The fourth part consisted of questions related to water usage habits of the household and whether hygienic procedures are used during the consumption of water. All information was obtained verbally and no observations were conducted. The fifth part of the questionnaire concerned the incidence of diarrhea in the household during the 3 months before September 2003 (the month during which the questionnaire was implemented). Analysis of data related to the households was performed for

543 households. The incidence of having diarrhea at least once within the previous 3 months ((the number of those with at least one incident of diarrhea/total population) ×100) and the diarrhea episode rate ((the total number of diarrhea cases/total population) ×100) were calculated for those living in the study area. The statistical methods used were, McNemar's and Student's tests, and logistic regression analysis. Factors thought to influence diarrhea incidence rate and thus included in logistic regression were separating water for drinking and general usage (yes/no), continuous water shortage for longer than 12 h (yes/no), purifying water for drinking (yes/no), amount of water used, water bill amount, monthly household income and the reported distance between the septic tank where wastewater is disposed and the well. Univariate analysis was performed and the factors found to be significant were included in the logistic regression analysis. A total of 2471 people lived in the 543 households were interviewed.

A baseline survey on behavioral and environmental determinants of childhood diarrhea in Chikwawa/Malawi was conducted in four randomly selected villages where reported household data was collected (56). Households with children were included in this study. In total they were 1014 households. A diarrhea prevalence outcome was modeled to allow examination of water sources, sanitation and hygiene as determinants of child diarrhea. Diarrhea illness during the last six months was measured. Only those indicator variables whose independent relationships with diarrhea prevalence were statistically significant were included in the logistic regression model.

Checkley et al. (45) studied the effect of water and sanitation on childhood health in a poor Peruvian peri-urban community. They followed up children once a day for diarrhea and once a month for anthropometry, and obtained data for household water and sanitation at baseline between April 1995, and December 1998. Children were recruited at birth and followed up for

35 months. Only the first child born during the recruitment period was recruited in each household. At recruitment they conducted a survey of living conditions in the households including water source, water storage, and sanitation. Diarrhea surveillance was done once a day. A diarrhea episode began with the first day the mother indicated that the child had diarrhea and that the child passed three or more liquid or semi liquid stools, and ended when the child passed fewer than three liquid or semi liquid stools in each of two consecutive days. Stool samples were collected once a week and were tested for Giardia lamblia and Cryptosporidium parvum. The height of each child was recorded once a month to the nearest 0.1 cm.

A cross-sectional descriptive study (38) was conducted in the immediate suburbs of the city of Beirut to identify the relationship between water consumption patterns and the incidence of diarrhea diseases in children less than five years of age. All the households of the selected sectors were screened. Only those having children less than five years of age were included in the study. The study showed that 68.9% of the samples relied on piped water sources to meet basic domestic needs, and 35.7% relied on private well sources. Furthermore, 17.4% depended exclusively on the provided piped water source in comparison to 6.2% depending on bottled water and 33.4% depending on water shop sources. The study showed a clear correlation of cases in children less than five years of age, with the following parameters: age and educational status of the mothers, employment, and socio-economic status of households. A significant correlation was noted between diarrhea and the intermittence and continuity of water supply. This finding lead to a preliminary conclusion that quantity of water supplied affects the occurrence of diarrhea among children. However, when considering the educational level of the parents, employment, and the monthly income of the households, the significance disappears. Correlating diarrhea with the different domestic water sources indicated the positive correlation with the piped water source and the use of private wells, but was not associated with the use of cisterns. However, when taking into account the income of the households, a statistically significant correlation was found. Diarrhea occurrence was significantly related to the treatment of domestic water regardless of the treatment methods applied. On the other hand, when personal and domestic hygiene habits were crossed with diarrhea incidence, no statistical significance was found. Solid waste and wastewater management in the study area were not related with the incidence of diarrhea occurrence.

Another study (29) was conducted in Morocco between December 2003 and November 2004 to assess the minimum water requirements for health by conducting population based surveys. The study showed that the annual average of water consumption is 73 liters per capita per day, which is similar to the national average. High consumption is recorded during the summer season (30% above average). Water consumption in villas was higher than other types of houses such as apartments. Drinking water quality in the study area was found to comply with Moroccan standards and WHO guidelines. The population diarrhea incidence rate in the study area ranged from 0.3% to 3.4%. Field surveys were conducted in October 2004 in 5 cities (Sidi Kacem, Oued Zem, Berkane, Khemisset and Ain Taoujdate) in order to verify the statistical data. Fifteen hundred and eleven households (7811 inhabitants) were surveyed. The findings showed that almost all the houses are equipped with toilets, more than 66% of the households have showers or baths and more than 60% have water heaters. More than 97% of the household were connected to the public drinking water network with satisfactory water quality and pressure. The whole population was connected to the sanitation network with the exception of a few locations in some localities. It was found that 10-15% of households in some localities use bottled water for drinking and almost all the people in households wash their hands before and after eating and after using toilets. Average incidence of diarrhea ranged between 1 and 7.2 cases per 1000, according to localities. The study concluded that there is no apparent link between water consumption and diarrhea incidence rate. It was observed that the rate of diarrhea incidence increases during summer seasons due to other factors that influence health which should be further investigated. The study concluded that water consumption of 70 liters per capita per day is the optimal water requirement for health.

In a household cross section survey conducted by Jordan Ministry of Health during September 2003 and repeated during May 2004 (Study on Jordan burden of food borne diseases, unpublished report), respondents were asked about diarrhea occurrence during the preceding month of the survey (August and April respectively). The average incidence of diarrhea per month for August 2003 and April 2004 was 6.1% in the population aged one year and more. Since the incidence was not broken down for specific age groups in this survey, we tried to estimate the incidence during the same period for under 5 children only based on evidence from MOH surveillance data for diarrhea which indicate that more than halve of annual cases of diarrhea occurs among under 5 children (about 54%), then by extrapolation, the estimated average monthly incidence(average of August and April) for under 5 children for the above survey will be about 26% (29% during August and 23% during April) and it will be about 4% for the rest of population(4.4% during August and 3.5% during April). The study showed also, that the average proportion of diarrhea cases that sought medical care was about 34%, about 54% of those sought care did it at ministry of health facilities. Knowing that the diarrhea cases seen by MOH facilities are the cases that are usually reported and cases treated elsewhere are unlikely to be reported, this means that the proportion of diarrhea cases that are reported and registered at the MOH is around 20% and the under reporting rate is estimated to be about 80% (57).

As part of the IDARA project (Instituting Water Demand Management In Jordan) activities to understand the water use patterns in single family homes in Jordan, a pilot study was conducted in order to obtain data on end uses of water in Jordanian homes and to demonstrate how use of data loggers and water meters attached to the outlets of the homes' roof tanks can be used to obtain precise data on end uses of water inside the homes. A total of 15 homes were selected for the study, and flow trace data were obtained successfully from 14 of these homes. Three types of homes were included in the sample: apartments, individual homes and villas. Water meters were installed on the roof tank outlets during the month of September and October 2008. Data logging occurred in November and December 2008. Information was obtained for each home on its type such as the number of residents, the approximate income of the occupants, and the numbers and types of fixtures and appliances present. The data loggers and water meters have been attached to the outlets of the homes' roof tanks in order to collect precise end-use data by the household. water meters have pairs of magnets used to couple the register of the meter to the meter body. Specialized data loggers are capable of sensing the passage of the internal meters and recording the number of pulses per unit of time (normally 10 seconds for our purposes). Data from the loggers and water meters are imported into a program called Trace Wizard then calibrated by an analyst to match up events in the database with fixtures and appliances in the home. Using the combination of new meters installed on the roof tanks, data loggers, the Trace Wizard program and information collected by the technicians, end use data were collected from a series of homes in Jordan. The data collection portion of this project consisted of three steps: selection of study homes and installation of meters, installation of data loggers and collection of flow trace data and home data, analysis of flow trace data and assembly of water use database. The interpretation of the results was accomplished through statistical analyses of the results based on summary queries obtained from the database using standard spreadsheet analysis tools.The study concluded that even with low head meters and roof tanks it is feasible to use sub-meters and data loggers to obtain flow trace profiles for Jordanian homes. It is highly likely that the technique will be able to disaggregate water use into at least the following categories; Leaks, Faucets, Toilets, Showers, Clothes washers and Dishwashers. The data loggers and water meters provided accurate results for the most important end uses as following; Faucet 54.9%, Shower 19.0%, Clothes Washer, 9.6%, Toilet 9.7%, Dish Washer 0.9% , Bath1.5%, Other 1.4%, Leaks 2.9%. The average water consumption for household was estimated as 353 liters per capita per day which is heavier than “normal”. However, the study mentioned that it is not known how representative these data are of actual water us in Jordanian homes, especially that the size of the study sample was very small. Therefore, the study recommended to use the same approach on more representative samples (a sample in the range of 400 to 500 homes) in the Amman service area. The collected end-use data from carefully selected samples would yield invaluable information about actual water use patterns in Jordanian homes. Also, these figures are very crucial for any planning study to estimate the current and future water demand needs in Jordan (58).

3.11 Methodological difficulties

Many attempts to measure the health impact of water supplies and sanitation have been carried; however, many of them have produced almost useless or meaningless results, after taking years to complete and costing substantial sums of money. It was hoped that case-control method would provide a quicker, cheaper means of measuring the impact on diarrhea. However, several experimental studies of this type of studies produced disappointing results, and it became clear that they suffered from similar shortcomings to studies of the more conventional design.

One review of the literature listed eight common errors found in health impact studies; one or more of these shortcomings was found in every one of the studies reviewed. Epidemiological studies depend on the intervention studied (in this case, water and sanitation) and an outcome measure (the health impact). Part of the problem is the nature of the intervention. The ideal way to measure the impact of any health intervention, the double-blind, randomized, controlled trial, is not feasible for water and sanitation. There is no placebo for a pit latrine. Moreover, the unit of intervention usually has to be the community, rather than the household. Besides, it is almost impossible to allocate water supplies and sanitation at random-ethically, politically and practically.

The principal outcome is diarrhea disease; more than 90% of the health benefits of improved water supplies and sanitation arise from reduced diarrhea illness, most of it in children less than five years old. This raises other problems. Diarrhea is caused by a wide variety of micro-organisms, transmitted by a wide range of different routes. Water supply and sanitation affect only some of these. For these reasons, well-designed water supply and sanitation interventions typically reduce diarrhea incidence by only about 25%. With more than 3 million children dying of diarrhea disease each year, a 25% reduction is a very substantial public health benefit; however, with many other factors (education, nutrition, and climate) also affecting diarrhea rates, a percentage reduction of only 25% is extremely hard to measure reliably. Moreover, if detected, it is very difficult to attribute a reduction unambiguously to improved water and sanitation.

For these reasons, a review of the published and unpublished results of the best health impact studies of the Water Decade concluded that health impact studies are not an operational tool for project evaluation or 'fine tuning' of interventions. The results are not only unpredictable; they frequently offer no firm interpretation.

Moreover, by their very nature, epidemiological studies have little power to diagnose deficiencies and suggest improvements, a normal requirement of operational project evaluations. If no health impact is found, it could be because the water and sanitation facilities are not functioning, or because they are not used correctly. Functioning and use are the first questions to ask in any evaluation of a water and sanitation project. Whether or not a health impact is found, the study itself does not offer any guidance on how the project, and hence the impact, might be improved. What we do know from the existing literature on impact studies is that in those cases where a significant health impact was found, the provision of water supply or sanitation had been accompanied by improvements in hygiene. 'Hygiene' in this context refers to practices such as the washing of hands, food and utensils, or the disposal of children's stools. It may be promoted by better access to water and sanitation, or by hygiene education. Improvements in hygiene may be reflected in increased water consumption. If no such change in behavior results from improved water supply or sanitation, the only benefits which are likely to occur are those stemming from improved water quality; in many settings, these are relatively minor or even negligible. Instead of attempting to measure disease rates, studying patterns of hygiene behavior has far greater diagnostic power, in terms of indicating opportunities for project improvement. Since it is further back up the causal chain, it is easier to attribute to the project intervention. It is also quicker and cheaper than epidemiological studies. It can also be done at the project design stage. This will not only help to establish a baseline yardstick against which to compare evaluation results, but also improve project design. A convenient user-friendly manual is available, and so is a more detailed account with case studies (59).

3.12 Critical analysis and assessment of the literature

Articles reviewed from the literature covered those which studied the relation between domestic water supply and health and other studies which focused on studying water management issues like measurements of end uses and estimating the per capita consumption.

The studies that focused on the relation between water quantity and health impact were relatively few, some of them were in the sort of literature review and meta-analysis, and the others were actual surveys. The majority of the studies that investigated the relation with health impact were conducted in the developing countries while studies carried in developed countries focused on management and engineering aspects of water supply. One of the reasons for this is the fact that water related disease problem due to shortage of water is mainly developing countries problem. Developed countries investigations concentrate on approaches for better water resources managements and modes of reducing the amount of water used by consumers rather than the minimal amount of water for health. Developing countries studies were mainly carried in under privileged areas where accessibility to water resources was a major concern.

The relative importance of water quantity, water quality, sanitation and hygiene in protecting and improving health has been subjected to extensive debate for many years. Despite this debate, international guidelines or norms for minimum water quantities that domestic water supplies should provide remain largely lacking. The World Health Organization has not published specific guidance on the quantities of water needed for health protection and promotion. However, the guidance manual of the Department of International Development, UK suggested a minimum amount of water supply of 20 liters per capita per day; others recommended a basic water requirement standard for human needs of 50 liters per person per day. The SPHERE project recommends 15 liters per capita per day as key indicator in meeting minimum standards for disaster relief. Very few studies have attempted to relate the type and level of water supply service to specific health effects. Studies in both developed and developing countries suggested that an average of 10 to 20 liters per person per day appear to satisfy most regional standards. The set target by the US Agency for International Development (USAID), the World Bank and the World Health Organization for basic domestic water use is 20 to 40 liters per person per day. The WHO/ UNICEF Joint Monitoring Program defines reasonable access as 'the availability of at least 20 liters per person per day from a source within one kilometer of the users dwelling,' this definition considers the access and not necessarily be understood that 20 liters per capita per day is a recommended quantity of water for domestic use.

Reviewing the available literature revealed that a good relationship have been reported between water scarcity and health. In most studies, childhood diarrhea, a leading cause of morbidity in developing countries, was used as a criterion for identifying a minimum requirement of water consumption that ensures health protection and promotion; however, some investigators used other indicators including anthropometric measures (relatively an indicator for chronic outcome of scarcity of domestic water), mortality of young children, skin, and eye diseases. These studies, however, came short of answering the question of how much is the minimal amount of water for health.

Studying the relationship between water supply and health impact appeared to be a complicated issue because of the several confounding factors that may interfere and obscure this relationship. In general these variables include sanitation, hygiene practices, water quality, socioeconomic factors (education, poverty), food handling and others. The relative value of these variables were investigated and reviewed by various investigators either through experimental studies (hand washing with various soap types) or evaluating outcomes of intervention programs. Water quantity was found to be more important than water quality.

Hygiene practices were important complement to improved water and sanitation in reducing diarrhea morbidity. The effective use of both water and cleansing agents and the timing of hygiene practices are more important than quantity of water used .It was concluded that, water quantity affect hygiene badly only when it is available in very small quantities. Improvements in sanitation resulted in more significant reduction of diarrhea than improvements in water supply.

Median percentage reduction in diarrhea disease rates from water availability was higher than those from water quality improvements and combined improvement in water quality and quantity resulted in lower reductions than for water quantity interventions. It was found that households with better access to water supply experience less incidence of diarrhea than households with less access. People experiencing water shortages had 10.2 times more risk than those not having water shortage, It was found in Sudan that scarcity of water rather than bacterial contamination was the cause of high prevalence of diarrhea, skin and eye communicable diseases (water-washed diseases) among children and adults. Water shortages and low water usage had shown a significant effect on the increase of diarrhea incidence among children in Turkey and Ethiopia and the increased quantities of water available at households were shown to be critical in preventing stunting in Pakistan and the inadequate water supply was considered a contributor to deaths in children under 5 years in another study. However, the health benefits from increasing the water availability was influenced by the mother level of education as found in one of the studies.

Different attempts took place to estimate the quantities of domestic water used for different purposes (drinking, coking, bathing, flushing, cloth washing, amenity uses etc.). Per capita water consumption can be measured (or estimated) through metered supply, surveys, water diary, or total amount supplied to a community divided by number of inhabitants. The 'water diary' was developed to provide a reliable, robust and transferable method to collect water use data. Studies have followed different approaches to estimate per capita water consumption, some of which were simple like phone calls asking people about their estimates of these amounts, using diaries to keep track of their use and checking water bills, to a more complicated approaches by living for a period of time with people in their homes, to a much more sophisticated and expensive techniques like installing miters on each water end use at selected houses. Some studies based their estimates of domestic water uses on cross sectional study designs asking people to report their water consumption within the survey duration, other studies based their estimates on previous water readings, and few studies follow up the water consumption pattern prospectively for several months. The results of these studies differ according to the settings and type of water using facilities, a factor to be taken in consideration in estimating domestic water use. Studies that went further and tried to link this use with health, followed rapid simple approach using the available disease statistics and the total area water consumption, or a more costly and complicated approach (household surveys), asking people about their disease experienced in a given period of time (a week or a month) and the amount of their domestic water use.

Review of the published literature on the health impacts of water supply and the determination of water requirement for health protection, revealed several methodological problems that hamper the drawing of definitive conclusions from these studies. Eventually, correct inferences cannot be drawn from studies that are poorly designed, executed, and analyzed. It is evident that, although some common problems such as small sample sizes simply increase the noise. However still there are common sources of error that introduce systematic biases that lead to consistent underestimates of the effect of water supply and its improvements on health.

Designs used for health impact studies of water supply included ecological (correlation) designs and cross-sectional designs (household's surveys). The follow up (longitudinal) designs were very limited. The findings of the small scale rapid assessments correlation studies on the relationship between water consumption and occurrence of diarrhea as well as the findings of studies that used the secondary data approach should be interpreted cautiously. The ecological correlation studies looked for associations between water quantity and diarrhea in populations rather than in individuals. They used data that has already been collected for other purposes. Although these studies are quick and cheap to conduct, suitable to generate new hypotheses and identify new risk factors, they have many disadvantages such as inability to control for confounding factors, referred to as the 'ecological fallacy', where two variables seem to be correlated but their relationship is in fact affected by confounding factor(s). This type of studies use the average water quantity level that may mask more complicated relationships with diseases such as diarrhea, and use population as a unit of analysis rather than individuals. Therefore, the diarrhea rates linked with population characteristics and the association observed at group level does not reflect association at individual level. In addition, most episodes of diarrhea morbidity in developing countries are not reported to the health system, so the number of the diarrhea cases is underestimated leading to biased estimates and wrong conclusions. In comparison, the household surveys although they require extensive preparation and manpower; it is expected to give more accurate domestic water consumption pattern and its impact on health provided that a good representation to the population has been achieved with high degree of cooperation from the selected householders.

For cross-sectional studies that attempted to show patterns of water consumption of families having children less than five years of age to meet personal and domestic needs, and to show the effect on health, their finding are limited for many reasons. Many studies did not expand the data collections to consider the seasonality. More than one season at least should be given to study fluctuations in water utilization and increase the probability of depicting water related cases of diarrhea.

In developing countries, a significant percentage of diarrhea morbidity is not reported to the health system, so that active surveillance involving home visits is used to detect them, often with excessive recall periods. The most important limitation in these studies is that the measurements of the household's water consumption were questionable in many of these studies. Conducted surveys had different types of biases such as recall bias. Recall bias may be responsible for either under or overestimation as respondents may forget relevant episodes or they may report an episode from outside the period of interest as if it had happened within the period and vice versa. Whilst sophisticated water meters are available that can, in theory, measure the volume of in-house and outside house water usage at individual taps, their use is somewhat problematic in an extensive household water usage survey. This is because of cost and logistical considerations associated with meter installation to a large number of households, meter calibration (e.g. to match water usage events such as toilet flushing or showering with recorded data 'spikes') and the lack of sensitivity of meters to detect single tap usage. In addition, the volume of water used at a particular tap is not a true measure of exposure because factors such as human behavior and the type of water-using equipment also determine the exposure volume. However, diary responses are not subject to recall bias (assuming prospective completion) hence it is probable that the diary information provides the more accurate figure, compared with the other methods. Some studies showed that it is possible to successfully 'remotely' coordinate diary completion providing that adequate instructions are given and that diary recording forms are well designed. In addition, good diary return rates can be achieved using a monetary incentive and the diary format allows for collective recording, rather than an individual's estimation, of household water usage. Compared with a telephone interview, the use of a household diary has a clear advantage in determining household exposure to a particular water supply. This is because the diary provides a collective measure of household exposure compared with an individual's estimate of household exposure. Acknowledging that the household diary cards may have in some instances been completed by one individual, it is more likely that they were completed by the householder performing the activity (ies) of interest. This assumption is based on the cards being placed in the location of water use (if instructions were followed) and/or that responsibility for diary card recording is likely to have been allocated within the household, to the household member with greatest familiarity with household water-using practices. In contrast, the telephone questionnaire may have been answered by an adult not fully familiar with the household water usage.

Serious methodological problems exist in the vast majority of the published studies on the impact of water supply on diarrheal diseases, or on infections related to diarrhea. The literature remains "heterogeneous in design, method and conclusion" with important methodological problems. The methodological problems include lack of adequate control, the one to one comparison, inadequate adjustment for confounding variables, misclassification bias, recall bias in ascertaining disease status amongst others (health indicator recall), health indicator definition, failure to analyze by age, failure to record usage, and the seasonality of impact variables. Furthermore, inadequate sample size was a limiting factor in some of these studies.

The following conclusions can be drawn from literature review:

1. Limitation in number of studies estimating domestic water used.
2. Few studies tried to link minimal domestic water to health.
3. No study came up with an accurate figure for minimal domestic water use for health.
4. No general agreement on the best method to evaluate domestic water use.
5. The used methodologies include: rapid assessment (ecological studies), household surveys (cross sectional, longitudinal and interventional studies).
6. Correlating water consumption levels with health impacts is not an easy task due to many existing confounding variables that should be adjusted for before drawing valid conclusions.

4 Methods and tools for establishing minimum water requirements for health

Two study designs are suggested to examine the association between water consumption and health:

1. **Rapid Assessment,** utilizing existing routinely available information at the Ministry of water and irrigation, ministry of health, and department of statistics.

2. **Household Survey.**

4.1The Rapid Assessment

4.1.1 Study design

An ecological (correlation) study design. This design being quick and cheap to conduct will be utilized as a first step in the proposed study to uncover rapidly any relationship between the quantity of domestic water consumption and health indicators, mainly diarrhea among under five children. The study is to be conducted in a retrospective manner where water consumption data, health data, and population data will be obtained.

A total of 60 areas (billing zones) will be selected from different governorates of Jordan covering urban and rural areas and considering the socioeconomic variations of the population. Each zone to be selected should:

1. Be served by known health center (centers).

2. Have available data related to water consumption and diarrhea morbidity for at least one calendar year preceding the start of the survey.

3. Have a number of households of more than 500.

4.1.2 Study objectives

1. To identify the overall average minimum amount of domestic water consumption for health.

2. To identify minimum consumption requirement for cold and hot seasons.

4.1.3 Sampling

Six governorates, 2 from each region (Central, Northern and Southern Regions) were selected to represent the country. The selected governorates are Amman and Balqa representing Central Region, Irbid and Mafraq representing Northern Region, Maan and Karak representing Southern Region. The list of the billing zones in these governorates were obtained from the ministry of water and irrigation (see Annex1).The distribution and the number of billing zones according to governorate are shown in the following table:

Governorate	Number of subscribers	Number of billing zones	Number of zones selected
Amman	266612	64	31
Balqa	46892	37	5
Irbid	121258	67	14
Mafraq	19947	22	3
Maan	20173	3	3
Karak	39248	4	4
Total	514130	197	60

The "Rule of thumb" in ecological studies is to select a sample of at least 30 for a statistical test to have adequate power. However, we decided to select a total of 60 billing zones to ensure representativeness by distributing the samples throughout the spatial dimensions of the country, capture wide variations in the quantity of water consumption and incidence of diarrhea, and to represent the zones in the urban and rural areas. To select a total of 60 zones from the six governorates proportional to the population size of each governorate. The zone to be selected should have a minimum of 500 subscribers. Within each governorate, billing zones will be selected at random using random numbers generated by Excel sheet. This sampling approach that is based on good number of zones as stratified by governorates is very useful because the final sample includes areas that contain within it socio-economic variations and a mixture of urban and rural communities. The more variation in water consumption and rates of diarrhea within the study area, the more useful the data yield will be. Then, all health centers within each zone will be identified and selected.

4.1.4 Data to be collected and methods of data collection

Routinely available or secondary data pertaining to domestic water consumption and diarrhea diseases occurrence are to be obtained from the records of ministries of water/irrigation and health. Demographic data for various billing zones will be obtained from the department of statistics.

Water billing data for the calendar year preceding the start of this assessment for all subscribers of each zone will be collected. The billing cycles are expected to be either on quarterly or monthly basis or both, in any case, the consumption will be converted into liters per capita per day. Water quality data (Water quality monitoring intensity, defined as the number of valid water samples per thousand people per year and water quality index defined as the percentage of valid water samples that pass the quality requirements of the national drinking water quality standards) for each governorate are to be obtained from the concerned authorities. Any incident of water pollution will be reported and considered.

Health data in the form of diarrhea incidence among under 5-years children will be utilized as a health indicator for this assessment since most cases of diarrhea occur among this age group and they are the cases that are more likely to reach health services and to be recorded and reported, while the occurrence of diarrhea among adults is less common and unlikely to be reported. Monthly incidence of diarrhea will be obtained from the records of diarrhea surveillance in the health centers (or from health directorates to which these centers belong) for all areas and for the same year used for water data. Outbreaks of diarrhea in the study areas will be ascertained and excluded from the total number of reported cases of diarrhea. The global problem; that the majority of mild cases of diarrhea don’t seek health care and accordingly they are not going to appear in the official records, apply for Jordan, furthermore, not all cases that consult health care facilities will be reported, especially those consult the private sector health services. This problem limits the validity of routinely available data unless a certain adjustment for the unreported figures is considered. To account for this problem the reported diarrhea cases to health centers will be corrected to the actual diarrhea occurrence by considering the underreporting rate (80%) as estimated by the study on Jordan burden of food borne diseases conducted during September 2003 and May 2004 (57).

4.1.5 Plan for data analysis

The data collected in this rapid assessment are going to be presented in the dummy tables below, where the monthly incidence of diarrhea and the monthly water consumption will be presented for each zone (Tables 1, 2). Table 3 which is a summary table presents the yearly average water consumption and diarrhea incidence among under 5 children, water quality monitoring intensity, and water quality index according to zones. Another summary table (Table4) presents the daily per capita average water consumption in liters and the average incidence of diarrhea among under 5 years children.

The analysis will firstly be done in terms of the overall averages for the entire study period. If data presentation quarterly or monthly shows significant differences, then this will be analyzed and the results compared and discussed. The water quality data will be also analyzed quantitatively.

The results of this multiple-group comparison study will be analyzed by looking at the overall association between the per capita water consumption and incidence of diarrhea. for the ecological units (billing zones) being compared. Typically, a scatter plot will be constructed and an overall measure of correlation will be calculated using Pearson correlation coefficient (r), which measures the degree of linear relationship between two continuous variables. The r-value quantify the degree of association between the two studied variables and the scatter plots give one a visual sense of the degree of association and the type of correlation (linear or curvilinear) if present. Also, each point on the scatter plot represents one unit of analysis (billing zone). The R^2 will be calculated to represents the proportion of the variability between group variance in the incidence of diarrhea that is explained by the per capita water consumption.

Furthermore, the correlation between the incidence rate of diarrhea and the water consumption will be calculated using partial correlation coefficients adjusting for water quality monitoring intensity, water quality index, and other relevant variables. In addition to producing a scatter plot and calculating the correlation coefficient, the relationship between the two variables will be quantified using a form of regression analysis. Simple linear regression analysis and multiple linear regression analysis will be used.

For trends and relationships analysis, graphs will be produced. Qualitative analysis will be attempted to correlate the outbreaks of diarrhea (if any), and their causes to water quantity and quality. Any relationship between incidence of disease and incidents of water contamination in the study area will be noted and discussed. Any apparent relationship between the average water consumption per capita and the disease outbreak incidences will be also be noted and discussed.

Table (1): Shows the monthly incidence rates of diarrhea among under-5 year's children (cases per 1000 child) for different areas (zones) according to months of the reference year.

Area (zone)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Average incidence of the year per month
Zone1													
Zone2													
:													
Zone60													
All													

Table (2): Shows the average daily domestic water consumption (liters per capita per day) for different areas (zones) according to months of the study year.

Area (zone)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Average consumption of the year

Zone1													
Zone2													
:													
Zone60													
All zones combined													

Table(3): A summary table showing the yearly average water consumption and diarrhea incidence among under 5 children, water quality monitoring Intensity and water quality index according to areas during the reference year.

Area (zone)	Average Water consumption of the year (liters/capita/day)	Average incidence of the year(cases per 1000 child per month)	Water Quality* Monitoring Intensity (number of valid water samples per thousand people per year)	Water Quality* Index (% of valid samples passing national drinking quality standard)
Zone1				
Zone2				
:				
Zone60				

Table (4): A summary table showing the daily per capita average water consumption in liters and the average incidence of diarrhea among under 5 years children for all zones combined according to months of the reference year

Month	Zones average water consumption (L / C / D)	Zones average incidence (Cases/1000 child)
January		
February		

March		
April		
May		
June		
July		
August		
September		
October		
November		
December		

Receiver operating characteristics (ROC) analysis will be done to identify the cutoff values for water quantity per capita that predicts the risk of diarrhea. The diarrheal diseases among children under five will be considered as the main outcome variable. Sensitivity and specificity will be calculated and the point having highest sum will be taken as cut-off value for the water quantity per capita (Un-adjusted cutoff value). The overall performance of the ROC test will be quantified by computing the area under the curve (AUC). An AUC of 1 indicates perfect performance of water quantity to discriminate between those with risk and those with no risk, whereas 0.5 indicates a performance that is not significantly different from chance. AUC and 95% confidence intervals will be calculated using the SPSS. Likelihood ratio (LR)) test [sensitivity/(1-specificity)] to estimate the risk of developing diarrhea in subjects with various cut-off values of the water quantity per capita will be calculated to find the optimum cutoff values.

4.2 The Household Survey

4.2.1 Introduction

Because of the many shortcomings of the rapid assessment approach using ecological designs, since they are unable to control for confounding factors, hence they are frequently exposed to bias which is often referred to as 'ecological fallacy', where two variables seem to be correlated but their relationship is in fact affected by confounding factor(s). This type of study uses the average water quantity level that may mask more complicated relationships with diseases such as diarrhea, and use population as a unit of analysis rather than individuals. Therefore, the diarrhea rates linked with population characteristics and the association observed at group level does not reflect association at individual level. In addition, most episodes of diarrhea morbidity in developing countries are not reported to the health system, so the number of the diarrhea cases is underestimated leading to biased estimates and wrong conclusions, therefore another methodology will be needed to compliment and validate this assessment which is going to be a household survey that enable the study of the relationship between water consumption and occurrence of diseases on the level of households and it becomes possible to control for the many confounding variables such as:

1. Additional sources of water used by the population like bottled water, rain water, wells and tankers.
2. Water used for other purposes in the household such as irrigation, recreation and for animals, etc.
3. Sanitation, hygiene practices and food handling in the household.
4. Socioeconomic variations like size of house, family size, income and educational level.
5. Place of residence.
6. Breastfeeding practices.

Household surveys, although they require extensive preparation and manpower; it is expected to give more accurate and reliable data on domestic water consumption pattern and diarrhea occurrence provided that a good representation to the population has been achieved with high degree of cooperation from the selected householders. It is going to compliment and validate the findings of the rapid assessment.

4.2.2 Study design

A cross-sectional design to be conducted two times in a given year, the first survey is to be launched during August-September and the second survey during February- March. This approach is going to consider the seasonal variation in water consumption and diarrhea incidence and help to calculate the minimum amount of water needed for two types of seasons; the cold season and the hot season.

4.2.3 Objectives

1. To identify the overall average minimum amount of domestic water consumption for health.

2. To identify minimum consumption requirement for cold and hot seasons.

4.2.4 Sampling

The sampling approach for the household survey will follow the one that implemented by the Department of Statistics (DHS survey). Administratively, Jordan is divided into 12 governorates; each governorate is subdivided into districts; each district into sub-districts; each sub-district into localities; and each locality into areas and then sub-areas. In addition to these administrative units, during the 2004 Jordan Population and Housing Census (JPHC 2004), each sub-area was subdivided into convenient area units called census blocks. The census blocks are grouped to form a general statistical unit of moderate size (30 households or more), called a cluster. An electronic file of a complete list of all the census blocks and clusters will be obtained from the Department of Statistics. This frame excludes the population living in remote areas, as well as those living in collective housing units, such as hotels, hospitals, and work camps. In total, there are 13,025 clusters in Jordan. The average size of a cluster is 72 households. In the urban areas, the average is 74 households, and the average in the rural areas is 62.

A stratified sample will be selected in two stages from the census frame. Stratification will be achieved by separating each governorate into urban and rural areas. The rural areas of each governorate form a single stratum. The urban areas of each governorate form a single stratum if the governorate has no cities having a population of 100,000 or more; otherwise, the urban areas are further stratified in such a way that each city having a population of 100,000 or more forms a single stratum and the rest of the urban areas together form another stratum.
Therefore, the number of urban strata in a governorate depends on the number of cities having a population of 100,000 or more. In total, 30 sampling strata have been constructed.
Samples will be selected independently in each stratum, by a two-stage selection process, using a probability proportional to size selection during the first sampling stage, an implicit

stratification and proportional allocation will be achieved at each of the lower administrative levels. This is done by sorting the clusters within each sampling stratum, according to the administrative levels and then by their socioeconomic characteristics.

In the first stage, clusters will be selected (see sample size calculations) with a probability proportional to the cluster size and with an independent selection in each sampling stratum. The cluster size is the number of residential households residing in the cluster given in the sampling frame. The sample allocation will be designed to take the governorate level into account. Household selection in the second stage will be an equal probability systematic selection of fixed size: 15 households per cluster. With a fixed second stage sample size, it is easy to allocate the fieldwork load to different interviewers and easy to control the fieldwork quality.

4.2.4.1 Sample size calculation

The sample size was calculated using web based calculator (http://sampsize.sourceforge.net/iface/s1.html#comp) to take into account the sampling design by considering the intraclass (or intracluster) correlation coefficient (ICC) which is the common correlation among pairs of observations from the same cluster. A value of 0.1 for "intraclass correlation" is used. The sample size is calculated under the following assumptions: (1) There are on average two children per house; (2) A fixed number of 15 households will be selected from each cluster; (3) Level of significance of 0.05 and Power of 80%; (4) The proportion of households in which at least one child reported diarrhea in the last month preceding survey is expected to be 25%(57). The needed number of clusters to be sampled, adjusted for cluster design, to detect a difference of 7% in the rate of diarrhea between households with sufficient water consumption and households with insufficient water consumption is estimated as 165 clusters at minimum. This means that the 15 households will be sampled from each of the selected 165 clusters giving a total sample of 2475 households. Assuming a response rate of 90%, the adjusted number of households to be selected is 2723. Then, the number of clusters needed to select 2723 households having at least one child under 5 years per each household is approximately 182 clusters (see Annex 2). According to the department of statistics of Jordan, it is expected that about 50% of households in each cluster contain under 5 children, in order to select 15 houses that each contains at least one under 5 child from each cluster, any house that has no children will be substituted by next house in the list until we complete the required number of houses in each cluster.

4.2.5 Data collection

4.2.5.1Types of data

1. Domestic water consumption of the household during the reference month will be collected. This consumption includes all types of water from different sources (network water and supplementary water) used by the house occupants during the reference month. The amount of water used outside the house (for amenity purposes) shall be estimated and subtracted from the total amount reached the house; this will result in calculating the total indoor per capita consumption per day. Data on water quality are also to be gathered, the indicators to be used for estimating the quality consist of; taste, smell, impurities, color of water, frequency of water distribution in the supply system, status of storage containers of water in the house and measurement of residual chlorine in the house.

2. Diarrhea occurrence among children of under-5 years of age during the reference month will be utilized as a proxy indicator for health level measurement since diarrhea is easily recognized by the population and it is considered as key health indicator by WHO and other international organizations. The standard WHO case definition of diarrhea will be adopted.
3. Demographic and socio-economic data like family size, age composition and education of the head of the household and the mother, character of the house, place of residence and family income.
4. Data related to Hygiene and sanitation of the household:
    - Number of rooms in the house.
    - Sanitary status of the kitchen
    - Sanitary status of latrines.
    - Excreta disposal (waste water & solid waste).
    - Personal hygiene practices of the mother (or care taker).

- Personal hygiene practices of under 5 children.
- Breast feeding practices.

4.2.5.2 Study tool

An interview questionnaire has been developed; this questionnaire consists of 45 questions to gather all types of data related to the main study variables (water consumption quantity of the household inhabitants and diarrhea occurrence among children of under 5 years of age) and other variables related to water quality, water storage, indoor versus outdoor water consumption, demography, socioeconomic, sanitation and hygiene of the house. The questionnaire is divided into sections; each section covers certain group of questions that pertain to a specific variable or a group of related variables. The sections cover; general information, socioeconomic, child feeding practices and diarrhea, water quantity, water quality, sanitation questions related to toilet and kitchen hygiene, waste disposal and status of basins in the house and their hygiene (see Annex 3-B). The questionnaire will be reviewed by a group of experts and pilot tested in the field before the study period.

4.2.5.3 Methods of data collection

For measurement of the amount of water consumed during the reference month, the following procedures will be taken:

1. The interviewer takes the first reading of water meter belonging to the house during the first visit at the beginning of the month and takes the second reading of the meter 30 days later during the second visit. The amount of tap water reached the house during the month through the general supply system is calculated by subtracting the first reading from the second reading.

2. The interviewer estimates the amount of water stored in the house at the time of first visit.

3. The interviewer estimates the amount of supplementary water purchased or brought from different sources other than the amount reached through the supply system during the reference month.

4. Total amount of water reached the house will be calculated by adding the amount of tap water representing the difference between the two readings to the amount of supplementary water and the amount of stored water in the house at the first visit.

5. The interviewer estimates the amount of water used outside the house (for amenity uses like irrigation, swimming pool, car washing, animal drinking, construction, leakage from the system, etc.) during the reference month.

6. The interviewer estimates the amount of unused stored water in the house at the time of second visit.

7. Net amount of water consumed inside the house during the reference month is calculated by subtracting both amenity water and the water stored at the second visit from the total amount of water reached the house.

8. The net amount of water is calculated in liters.

9. Net amount of water in liters is divided by number of inhabitants to give the monthly Per Capita consumption, and then it is divided by 30 to give the daily Per Capita consumption in liters.

The data needed will be gathered through two visits one month apart to each household. In the first visit, the following activities are to be done by the interviewers:

1. Meeting with the head of the household, introducing himself, explain the study objectives and the importance of the needed information and its confidentiality and asking for continuous cooperation during the following month after explaining to him/her what is needed from them. A signed informed consent form should be obtained (see Annex 4). A special diary will be provided for each householder to record the data related to purchased water amount, amenity water uses, water losses and diarrhea occurrence among children during the reference month (see Annex 5).
2. Filling all the questions of the questionnaire <u>except</u> *questions 14, 15, 16, 17, 19, 21, 22 that should be filled during the second visit.*

3. Asking the head of the household to record any amount of supplementary water (other than the network water) to be purchased or brought to the house in addition to the

amount of water used outdoor for amenity purposes and major water losses or leakages if any during the month.

4. Asking the mother or care taker of children to record any episode of diarrhea among under 5 children during the following month.

Activities done in the second visit include filling questions number *14, 15, 16, 17, 19, 21, 22 of the questionnaire.*

Scoring for certain variables were done to come up with a sort of summary index for certain variables to simplify the process of statistical analysis of these variables. This type of scoring has been developed by the study team and has been shared with other external and internal experts. The variables that have been scored are; quality of water, mother and child hygiene, breast feeding practices, kitchen hygiene, toilet hygiene, availability and accessibility and hygienic status of basins and status of waste disposal. Arbitrary scores have been agreed upon and given to each question according to consensus of the group of experts. The different scores used are shown on the attached questionnaire.

4.2.6 Plan for data analysis

4.2.6.1Conceptual Framework

The conceptual framework that will guide our analysis of children's diarrhea identifies four groups of biological and behavioral factors that directly determine child health: maternal factors, environmental contamination, nutrient deficiency, and personal illness control (Mosley and Chen 1984). The specific factors within these four groups, such as the presence of an indoor toilet or breastfeeding duration, are determined by the parents' demographic and socioeconomic characteristics. Attributes of the child may also have an influence. Combining the two separate concepts that child's health outcomes are produced by a set of factors, and that these factors reflect parental parents' background, and child characteristics, then we can derive simplified, reduced-form relationships that will be the focus of our analysis. We investigate how water quantity influence the risk of diarrhea after considering the influences of child characteristics such as age and sex; parents' characteristics such as socioeconomic status and family composition; and contextual factors such as region and rural–urban place of residence. The child health factors will be included in the reduced-form equation for child health to examine how the effect of water quantity is changed by including these factors in the model.

Child health outcomes are determined not only by measured factors classified within the four groups mentioned before, but also by unmeasured factors that reflect parents' abilities to promote the health of their children or unobservable aspects of the home or community environment. Therefore, the effects of unobserved heterogeneity at the family and community levels are of substantive interest in this analysis. In particular, the variance of the distribution of unobserved heterogeneity provides us with an indication of the strength of unmeasured effects.

4.2.6.2 Model Covariates

Briefly, the variables that will be controlled in the multivariate analysis include:

1. Individual level variables: Education of the mother, age of the mother at birth of child, family size, family income, sex of child, length of birth interval, and whether the child was ever breastfed.

2. Household level variables: Number of rooms in the house, type of floor in dwelling, type of water facility, food handlings and storage, status of the kitchen, excreta disposal (waste water & solid waste), number and types of latrines, personal hygiene practices, laundry practice, and access to media.

3. Community level variables: Whether the household is located in an urban or rural area and region.

4.2.6.3 Modeling Approach

Data will be analyzed using three statistical software (SPSS, version 19, SAS version 8.1, Mplus). The household and individuals characteristics will be described using mean, standard deviation, frequencies and proportions wherever appropriate.

Multilevel approaches offer substantive improvements over traditional regression methods, particularly for hierarchical datasets to take account of the clustering of persons in households and households in clusters when estimating standard errors. In our research plan, individuals (level 1) are nested within households (level 2), within clusters (level 3). The multilevel analysis has the advantage of allowing the proportion of variability attributable to each level of analysis to be determined. Base models will be used to estimate associations with each contextual (level 3) variable prior to adjusting for individual and household level characteristics. Each model will be then adjusted for individual and household level variables.

We will use multilevel logistic regression to model a child's risk of having diarrhea. The probability of a child having diarrhea is defined as $p_{ijk} = Pr(y_{ijk} = 1)$; where $y_{ijk} = 1$ indicates that that the i^{th} child of the j^{th} family living in the k^{th} cluster had diarrhea in the past 2 weeks (or in the last month), and a logit transformation of p_{ijk} is modeled as a linear function of the covariates in the model:

$$\log\left[p_{ijk}/(1-p_{ijk})\right] = X'_{ijk}\beta_1 + X'_{jk}\beta_2 + X'_{k}\beta_3 + u_{jk} + v_k \quad (1)$$

Here, u_{jk} represents a family-level random effect and v_k a cluster-level random effect that are each normally distributed with a zero mean.

One concern in applying this model is the endogenous nature of the intermediate factors, which may be reflected in the correlation between these covariates and the error components. However, the cross sectional structure of the data and the absence of any plausible instrumental variables mean that there is no convincing approach to correct for endogeneity. Unmeasured child-specific factors may be present, but are unidentifiable with the single observation we have for each child.

We assume that the observations are independent once we condition on u_{jk} and v_k, which capture any unobserved effects common to children from the same family and the same community. We can summarize the strength of unobserved family and cluster effects with the intra-class correlation coefficients for families (r_f) and clusters (r_c).

We first estimate the reduced form model shown in Eq. 1 that includes only the background child (X_{ijk}), family (X_{jk}), and cluster (X_k) covariates. We next add intermediate child (W_{ijk}) and family (W_{jk}) covariates to the model:

$$\log\left[p_{ijk}/(1-p_{ijk})\right] = W'_{ijk}\gamma_1 + W'_{jk}\gamma_2 + X'_{ijk}\beta_1 + X'_{jk}\beta_2 + X'_{k}\beta_3 + u_{jk} + v_k \quad (2)$$

By comparing the estimates obtained from Eqs. 1 and 2, we can examine how background factors affect the risk of diarrhea directly and indirectly. In particular, results based on Eq. 1 shows the total effect of each background factor on diarrhea (net of other background factors in the model). Comparing these results with those from Eq. 2 shows how the background factors operate through the intermediate variables that are added to the model. Adjusted odds ratios and 95 % confidence intervals will be calculated.

Receiver operating characteristics (ROC) analysis will be done to identify the cutoff values for water quantity per capita that predicts the risk of diarrhea. The diarrheal diseases among children under five will be considered as the main outcome variable. However, individual and combined diseases risks will be tested in separate ROC analysis. Sensitivity and specificity will be calculated and the point having highest sum will be taken as cut-off value for the water quantity per capita (Un-adjusted cutoff value). The overall performance of the ROC test will be quantified by computing the area under the curve (AUC). An AUC of 1 indicates perfect performance of water quantity to discriminate between those with risk and those with no risk, whereas 0.5 indicates a performance that is not significantly different from chance. AUC and 95% confidence intervals will be calculated using the SPSS. Likelihood ratio (LR) test [sensitivity/ (1-specificity)] to estimate the risk of developing diarrhea in subjects with various cut-off values of the water quantity per capita will be calculated to find the optimum cutoff values.

To find the optimum cutoff value of water consumption that predict the risk of diarrhea after adjusting for covariates, the regression analysis followed by ROC analysis will be conducted. Utilizing the function of logistic regression, the predicted probabilities from the final logistic regression model will be saved as a new variable in the SPSS sheet. The predicted probabilities variable will be used as a test variable in the ROC graph procedure to construct receiver-operating characteristic (ROC) curves and calculate the sensitivities and specificities of predicted probabilities values to find the optimum cutoff value. The optimum cutoff value of the predicted probability value will be used to calculate the corresponding value of water consumption from the final logistic regression model. This value is the optimum one taking into account of other covariates (Adjusted cutoff value). Furthermore, we will use the ROC regression methodology.

4.2.6.4 Comparing the results of the two study methods

The minimum amount of water for health obtained by the two methodologies will be compared to find the degree of agreement.

4.2.6.5 Dummy tables

The following four tables are suggested by the team to be utilized for data summarization and presentation.

Table (1): Distribution of the heads of households according to gender, age, education and relation to the family

Item	Number	%
1. Gender:		
• Male		
• Female		
• Total		
2. Age groups:		
• Less than 35 years		
• 35-54 years		
• 55 years and more		
• Total		
3. Education:		
• Illiterate		
• Less than intermediate		
• Intermediate		
• Secondary/ Diploma		
• Bachelor and more		
• Total		
4. Relation to the family:		

• Father		
• Mother		
• Oldest son		
• Other adult person in the house		
• Total		

Table (2): Distribution of the mother/care taker according to gender, age and education

Item	Number	%
1. Gender		
• Male		
• Female		
• Total		
2. Age groups		
• Less than 35 years		
• 35-54 years		
• 55 years and more		
• Total		
3. Education		
• Illiterate		
• Less than intermediate		
• Intermediate		
• Secondary/ Diploma		
• Bachelor and more		
• Total		

Table (3): Distribution of children according to type of feeding, methods of preparation of the formula and hygiene of the mother before preparing the formula

Item	Number	%

1. **Type of feeding:**		
• Breast feeding		
• Formula feeding		
• Combined (breast + formula)		
• Not applicable		
• Total		
2. **Water used for formula preparation:**		
• Taps or stored water without boiling		
• Boiled tap or stored water		
• Bottled water without boiling		
• Boiled bottled water.		
• Water from the cooler without boiling		
• Boiled cooler water		
• Total		
3. **Sterilization of the bottle:**		
• Boiling the bottle before preparing the formula		
• Cleaning the bottle with water and soap		
• Cleaning the bottle with water only		
• Use disinfection solutions		
• Use sterilizing machine		
• Do nothing		
• Total		
4. **Hygiene of mother before preparation of the**		
• Wash hands with water and soap		
• Wash hands with water only		
• Don't wash hands		
• Total		

Table (4): Cross tabulations between diarrhea incidence (the dependent variable) and the daily per capita water consumption (the main independent variable) and other independent variables (confounders) as shown in the table.

Various independent variables	Incidence of diarrhea(the dependent variable)	Statistical significance
1. Daily per capita water consumption (the main independent variable):		
2. Family size:		
3. Quality of water: • Good • Fair • Bad		
4. Child feeding practices: • Good • Fair • Bad		
5. Education of mother: • Illiterate • Less than intermediate • Intermediate • Secondary/Diploma		

• Bachelor and more		
6. Education of father: • Illiterate • Less than intermediate • Intermediate • Secondary/Diploma • Bachelor and more		
7. Family income: • Less than 300 JD • 300- 499 JD • 500- 699 JD • 700- 899 JD • More than 900 JD		
8. Hygiene of mother: • Good hygiene • Bad hygiene		
9. Hygiene of child: • Good hygiene • Bad hygiene		

10. Hygiene of the toilets: • Good • Fair • Bad		
11. Hygiene of kitchen: • Good • Fair • Bad		
12. Status of waste disposal: • Good • Fair • Bad		
13. Status of basins: • Accepted • Not accepted		
14. Area of house:		
15. Crowding index(inhabitants / rooms):		
16. Age of mother:		
17. Age of head of household:		
18. Type of house:		

• Apartment • Individual dwelling • Villa • Tent or Shacks		
19. Place of residence: • Urban • Rural		

4.2.7 Ethical consideration

Official clearance will be obtained from the government of Jordan, represented by the Ministry of Health and Ministry of water and irrigation on the conduction of the study. An informed written consent will be obtained from each household head (participants will be told about objectives of the study, importance of information given by them, and the harmless effect of the study on them). Any subject will feel free to choose to enter in this study or not. The obtained data will be kept confidential and used only for scientific purposes.

4.2.8 Quality Control Measures

Ensuring high quality of collected data will be attempted as follows:

1- The questionnaire will be reviewed by a group of experts and modified accordingly.
2- A pilot study will be conducted on a group of participants in the same study area. Needed modifications in the methodology or questionnaire will be performed accordingly.
3- Data will be collected by experienced well-trained interviewers using a standardized methodology to avoid inter-observer bias and to assure good quality data.
4- Each completed questionnaire will be re-checked to ensure completeness and consistency of data.

5- Verification of the study design will be achieved through the followings:

- Using two different epidemiological designs which by themselves are considered to be a good method of verification and validation of the study.
- Discussion with expert's group panel and their approval.
- Feedback from national workshop.
- Conducting a small scale pilot testing of household questionnaire.

It is suggested that during the implementation of the study (both the rapid assessment and the household survey), at least three national experts from ministries of water and health and department of statistics (one from each institution) should be included in the study team in order to facilitate the process of data collection.

4.2.9 Pilot testing results

A pilot study was carried to have feedback regarding the study tool. Four field investigators divided in tow teams were trained by the study team the way to fill the questionnaire and were asked to give feedback about the questionnaire. A total of 40 households were selected to be visited twice a month a part. The first visit was completed. The following are some feedback based on that visit:

- On average the questionnaire needs 45-60 minutes to be filled.
- There is a need to have a female in each team to facilitate the process of interview.
- The best time to carry the house visits was the afternoons to assure the presence of the head of the family.
- The signature of the household on the consent form was difficult to obtain.
- Some houses don't have a separate water meter; they chair it with others in the same building.
- Caution is needed when checking the basins and the kitchen situations.

5. Expert group meeting workshop

A workshop involved expert group and national stakeholders was conducted at Royal Scientific Society (RSS) during the period 21-22 of September 2011 (The workshop program is shown in Annex 7).

5.1 Objectives

The main objectives of the expert group meeting workshop are:

- Presenting the proposed methodologies by research team at national level to the key government stakeholders, primarily; Ministry of Health (MoH) and Ministry of Water and Irrigation (MoWI), and national and international experts.
- Reviewing and discussing the proposed methodology and tools at science-based consultations and meetings with national and international experts and key stakeholders.
- Collecting and reporting the feedbacks, suggestions and comments in order to enrich the proposed methodology and tools.
- Reaching a final consensus on the proposed methodology and tools incorporating the outcomes of the expert consultations in order to be submitted to the WHO/CEHA.

5.2 Participants

A national and international experts from Lebanon and Jordan, primarily MoH and MoWI as well as other research centers and universities (Figure 1), were officially invited to participate at the activities of the workshop with CEHA officials and the research team (A list of invited participants are shown in Annex 8).

Figure 1: Participants of the expert group meeting workshop.

5.3 Activities, outcomes and conclusions

Day one: Discussing the proposed study methods

Following the welcoming ceremony, the group was briefed by the study teem about the project, its history, objectives, and stages carried by research team. After that, the Task Manager presented an overview and analysis of the literature review as an introduction, and then he presented the proposed methodology and study designs. The Biostatistician expert team member presented the sampling technique and the plan for data analysis for both designs (the Rapid Assessment and the Household Survey). After that the floor was opened for discussions and comments. The followings comments have been raised and discussed by experts:

1- The socioeconomic impact on the amount of water consumption was stressed. The attention was brought to the fact that water supplies in Jordan is regulated and meet the National Guidelines add to this the role of Ministry in following and monitoring the tankers, however, It was advised to carry residual chlorine testing together with TDS (being a cause of diarrhea) on water samples taken from every house in the study, and a microbiological testing on a one random sample taken from each cluster to assure water quality at house level.

2- The importance of hygiene as a confounder in the relation between water quaintly and diarrhea was discussed. It was advised to add a question regarding people awareness regarding importance of hygiene.

3- The use of the incidence of diarrhea, skin diseases, eye diseases, infant mortality ,and anthropological measurements as indicators of health impact of water quantity on health was extensively discussed .It was concluded that diarrhea among under 5 years children, as recommended by many investigators, Is the indicator to be used in the coming survey.

4- Finally the group agreed on the importance of such survey and its usefulness for the Ministry of Water.

Second day: Discussion of the survey tool (The questionnaire)

During the second day, the Environmental Public Health Expert team member presented the questionnaire to be used as a tool for data collection. Each question was discussed extensively till consensus was reached on the final format of each question. The followings comments have been raised and discussed by experts:

1- It was agreed on the way houses will be included in the survey. A house with one or more under five will be included. If the house has no under five children it will be excluded and the next house will be checked. Since each block has an average of 72 households, and the fact that 50% of the households in Jordan do have under five children, and since 15 households will be selected from each block, then no problem is expected in having the required number of households from each block.

2- It was agreed that scoring of some of the questions is necessary but should not be within the questionnaire, and not to be done by the field investigators. The scoring system should have the same basis for all the scored questions of 0.0, 0.25, 0.5, 0.75, and 1.0.

3- The estimation of total amount of in hose stored water is somewhat difficult yet, due to its importance in having more accurate estimate of the real amount of consumed water, It should to be done in both visits to the house

4- The group agreed on the idea of using diary (to avoid recall bias) to keep records of all supplementary water and advice to have to cover the thirty days interval between the two visits to the house.

5- It was advice to replace the question regarding the water taste, smell, and color by a question inquiring about the feeling toward tap water.

6- A question is to be added to the questions inquiring about the kitchens conditions regarding the availability of food preparation area, and to inquire about ventilation and smell in one question.

As a result of the activities conducted on the two days of the workshop, the group came up with the following conclusions:

- They complimented the huge effort conducted by the research team during the literature review phase and the methodology development phase.
- They approved the two proposed study designs, which are the Rapid Assessment and the Household Survey.
- They approved the proposed questionnaire and considered it as a valid tool to collect the required data; they were highly satisfied with the team initiative of making scoring of certain questions in order to create some summary indices to be used during analysis of the confounding variables. However, the group suggested the following points to be taken into consideration:
    - Adding additional indicators to best estimate the quality of water, like the measurement of residual chlorine and total dissolved solids (TDS) in the kitchen tap of each house, in addition to taking random water samples for bacteriology testing. This point has been discussed carefully; the final consensus was to consider residual chlorine measurement only for obvious reasons related to validity and resources.
    - A question related to frequency of cleaning the water storage container at the house was added to the questionnaire to substitute the question related to cleanliness of the storage container.
    - A question related to closure of the storage container was added to the questions of water quality.
    - Presence of impurities was added to taste, smell and color of water as a proxy question for quality of water.
    - A question on Perception of water safety by householders was added as another proxy indicator for water quality.
    - Reordering of some questions related to quality of water.
    - Adding the presence of running water to the questions related to assessment of kitchen, toilet and basin hygiene.

- Adding the presence of suitable surface for food preparation in the kitchen for kitchen hygiene assessment.
- Categorizing the question on family income instead of leaving it as open question.
- The group suggested some minor modification on certain scores weights for few questions.
- The group suggested removing the scores from the questionnaire to be delivered to the interviewers and to be kept only for use during data entry and analysis.
- One participant suggested adding other diseases related to water deficiency besides diarrhea as health indicators, but the group consensus was with considering diarrhea incidence as sufficient.

The research team met after closure of the workshop and made the amendments of the methods and tool (questionnaire) according to the agreed upon comments and additions of the expert group workshop.

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7 Annexes

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- **Annex 2: List of selected clusters**
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Annex 1: List of billing zones

List of total number of billing zones which has 500 subscribers and more in the governorates of Amman, Balqa, Irbid, Mafraq, Karak and Maan.

عدد المشتركين	مناطق محافظة العاصمة	الرقم
9219	ماركا الجنوبية/ النصر	.1
3803	أبو نصير	.2
5366	مرج الحمام	.3
3903	مخيم الحسين/ السفح	.4
4430	المقابلين/ أم قصير	.5
3803	الجبيهه	.6
1695	ناعور	.7
11638	الشميساني	.8
2425	واد السير/ وسط البلد	.9
3933	النهارية/ الشمالي	.10
1473	إسكان أم نواره	.11
4737	تلاع العلي	.12
5448	خريبة السوق والناجرة	.13
4637	جبل النزهة	.14
1953	الهاشمي الجنوبي	.15
2690	الجوفه الغربي	.16
6942	الهاشمي الزغاتيت	.17
5201	الحسين الشرقي	.18
4909	ضاحية الأمير حسن	.19

.20	جبل عمان/ عبدون	6505
.21	إسكان أبو نصير	3671
.22	سحاب	3238
.23	جبل المريخ	2829
.24	الفيصلية/ الرجيب	4604
.25	أم السماق الشمالي	3508
.26	جبل الزهور	2554
.27	جبل الحديد	2511
.28	واد الحدادة	1498
.29	جبل القصور	3722
.30	وسط البلد/ سقف السيل	1433
.31	ضاحية الرشيد	3284
.32	أم تينه الشمالي	2794
.33	الأشرفية	3863
.34	جبل القلعة	1557
.35	أم اذينة/ جبل عمان	9699
.36	الصويفيه	4783
.37	حي نزال/ الأخضر	10811
.38	جبل عمان/ شارع منكو	2321
.39	ماركا/ الونانات	7000
.40	اللويبده/ مديرية الأمن	2304
.41	الهاشمي/ نايفه	4421
.42	صويلح الغربي	7129
.43	صويلح الشرقي	4185

.44	حي الدبايبه	2247
.45	اللويبده	2812
.46	تلاع العلي الشمالي	3619
.47	الجندويل	3705
.48	الوحدات	5975
.49	شفا بدران	3386
.50	أبو علندا	2815
.51	بيادر واد السير	5117
.52	ماركا/ حي العبداللات	6888
.53	ذراع نزال	5442
.54	أم السماق الجنوبي	3836
.55	إسكان الأمير هاشم	3957
.56	خلدا	4092
.57	جبل التاج	3510
.58	الحسين الغربي	4290
.59	جبل عمان/ وسط البلد	1189
.60	أم الحيران/ الطيبة	4771
.61	الجوفه الشرقي	4356
.62	جبل عمان	1855
.63	جبل النظيف	2174
.64	قرى واد السير	2147
.65	مجموع عدد المشتركين	266612

الرقم	مناطق محافظة البلقاء	عدد المشتركين
1.	الخندق/ قصبة السلط	1186
2.	البقيع/ قصبة السلط	1520
3.	الميدان/ قصبة السلط	747
4.	البقعان/ قصبة السلط	2670
5.	الجدعه/ قصبة السلط	954
6.	المنشيه/ قصبة السلط	1522
7.	السلالم/ قصبة السلط	3021
8.	الصافح/ قصبة السلط	1905
9.	أم عطيه/ قصبة السلط	1600
10.	زي/ قصبة السلط	587
11.	الصبيحي/ قصبة السلط	2099
12.	يرقا/ قصبة السلط	849
13.	المغاريب/ قصبة السلط	747
14.	عيرا/ قصبة السلط	570
15.	السرو/ قصبة السلط	727
16.	حي قتيبه	1085
17.	أبو نصير	702
18.	موبص	622
19.	المضمار	542
20.	عين الباشا	1980
21.	حي القدس	1803
22.	المخيم الجديد	1672

1664	حي الأمير علي	23.
1491	حي الخليل	24.
1349	حي الكرامة	25.
1254	أم الدنانير	26.
1094	حي نابلس	27.
684	معدي	28.
601	ضرار	29.
598	الصوالحه	30.
1274	الكرامة	31.
1141	الروضة	32.
1069	الجوفة	33.
761	الشونه الجديدة	34.
671	مركز الشونة الجنوبية	35.
2139	ماحص	36.
1992	الفحيص	37.
46892	مجموع عدد المشتركين	38.

عدد المشتركين	مناطق محافظة اربد	الرقم

.1	المنطقة الثانية	9899
.2	حي المدينة الصناعية	4308
.3	البارحه	6165
.4	شارع أيدون	11683
.5	حي المكارم	5686
.6	حواره	2366
.7	الطيبه	1912
.8	المزار	1633
.9	بيت راس	2409
.10	بشرى	1811
.11	سال	966
.12	المغير	1305
.13	كفر يوبا	1771
.14	كفر أسد	1303
.15	دير يوسف	828
.16	صما	1175
.17	حكما	1228
.18	عنبه	787
.19	إرحابا	898
.20	بيت يافا	1098
.21	قميم	816
.22	سوم الشناق	857
.23	علعال	596
.24	حوفا الوسطيه	609

632	دوقره	.25
660	دير السعنه	.26
604	زحر	.27
1006	زبدة فركوح	.28
1070	رمثا 31	.29
2640	رمثا 32	.30
2667	رمثا33	.31
1890	رمثا34	.32
578	البويضه	.33
1738	الطره	.34
1402	الشجرة	.35
1993	شونه شمالية/ إسكان	.36
706	شونه شمالية/ وقاص	.37
2137	شونه شمالية 241	.38
917	شونه شمالية 242/ اليابس	.39
747	شونه شمالية 244	.40
1323	الحصن 24	.41
1819	الحصن 25	.42
1255	الحصن 26	.43
2883	الصريح	.44
6825	أيدون	.45
2060	النعيمه	.46
2392	مخيم عزمي المفتي	.47
799	كتم	.48

الرقم	مناطق محافظة المفرق	عدد المشتركين
49.	ملكا	991
50.	سحم	885
51.	كفر سوم	1033
52.	حرثا	638
53.	خرجا	801
54.	سمر	527
55.	أم قيس	628
56.	يبلا	584
57.	حاتم	710
58.	دير أبي سعيد	2381
59.	جديتا	1596
60.	كفر عوان	1336
61.	كفر أبيل	1034
62.	سموع	893
63.	الأشرفيه	1123
64.	كفر الماء	1359
65.	تبنه	662
66.	بيت إيدس	577
67.	كفر راكب	648
68.	مجموع عدد المشتركين	121258

.1	الخالديه	2067
.2	سما السرحان	565
.3	مغير السرحان	741
.4	الحمراء	898
.5	المبروكه	621
.6	الباعج	549
.7	بلعما	1402
.8	المنشيه	1059
.9	الزنيه	848
.10	إرحاب الجديد	681
.11	الحي الجنوبي	2373
.12	حي شويكه	930
.13	حي الخربه	530
.14	حي الحسين	723
.15	حي الجيعه	793
.16	حي التل	1334
.17	وسط البلد	608
.18	حي الضباط	770
.19	صبحا وصبحيه	707
.20	روضة بسمه	589
.21	أم القطين	580
.22	الرويشد	579
.23	مجموع عدد المشتركين	19947

الرقم	مناطق محافظة معان	عدد المشتركين
1.	معان القصبه	11311
2.	لواء البتراء	6410
3.	لواء الشوبك	2452
4.	مجموع عدد المشتركين	20173

الرقم	مناطق محافظة الكرك	عدد المشتركين
1.	قصبة الكرك	17971
2.	المزار الجنوبي	10942
3.	غور الصافي	4766
4.	القصر	5569
5.	مجموع عدد المشتركين	39248

Annex 2: List of selected clusters

الرقم المتسلسل	حضر – ريف**	المحافظة	اللواء	القضاء	التجمع	المنطقة	الحي	البلوك	عدد الأسر	SOCIOECO*	المحافظة	اللواء	القضاء	التجمع	المنطقة	الحي
1	1	11	5	1	12	15	3	3	55	1	العاصمة	لواء وادي السير	قضاء وادي السير	بدر الجديدة	بدر الجديدة	بلال
2	1	11	3	1	11	11	3	37	130	1	العاصمة	لواء القويسمة	قضاء القويسمة	القويسمة والجويدة وابو علندا والرجيب	القويسمة وابو علندا	النهارية
3	1	11	3	1	11	11	7	6	65	1	العاصمة	لواء القويسمة	قضاء القويسمة	القويسمة والجويدة وابو علندا والرجيب	القويسمة وابو علندا	الرجيب
4	1	11	3	1	13	13	2	10	51	1	العاصمة	لواء القويسمة	قضاء القويسمة	ام قصير والمقابلين	ام قصير والمقابلين	المقابلين
5	1	11	3	1	12	12	2	9	147	1	العاصمة	لواء القويسمة	قضاء القويسمة	خريبة السوق وجاوا واليادودة	خريبة السوق وجاوة	الطيبة وخريبة السوق
6	1	11	2	1	13	10	3	63	94	1	العاصمة	لواء ماركا	قضاء ماركا	طارق	طارق	الشهيد

7	1	11	6	1	11	1	3	15	94	1	العاصمة	لواء سحاب	قضاء سحاب	سحاب	سحاب	الثالث
8	1	11	4	1	12	16	5	28	92	2	العاصمة	لواء الجامعة	قضاء الجامعة	صويلح	صويلح	الكمالية
9	1	11	5	1	12	15	2	8	62	2	العاصمة	لواء وادي السير	قضاء وادي السير	بدر الجديدة	بدر الجديدة	ام الاسود
10	1	11	3	1	11	11	3	56	116	2	العاصمة	لواء القويسمة	قضاء القويسمة	القويسمة والجويدة وابو علندا والرجيب	القويسمة وابو علندا	النهارية
11	1	11	3	1	11	11	6	1	96	2	العاصمة	لواء القويسمة	قضاء القويسمة	القويسمة والجويدة وابو علندا والرجيب	القويسمة وابو علندا	حطين
12	1	11	3	1	11	11	11	16	90	2	العاصمة	لواء القويسمة	قضاء القويسمة	القويسمة والجويدة وابو علندا والرجيب	القويسمة وابو علندا	ام نوارة
13	1	11	3	1	13	13	1	3	125	2	العاصمة	لواء القويسمة	قضاء القويسمة	ام قصير والمقابلين	ام قصير والمقابلين	ام قصير
14	1	11	2	1	13	10	1	19	114	2	العاصمة	لواء ماركا	قضاء ماركا	طارق	طارق	طبربور

15	1	11	4	1	14	20	2	8	85	3	العاصمة	لواء الجامعة	قضاء الجامعة	اسكان ابو نصير	ابو نصير	حي السعاده
16	1	11	4	1	11	18	4	35	35	3	العاصمة	لواء الجامعة	قضاء الجامعة	الجبيهة	الجبيهة	قطنة
17	1	11	4	1	12	16	7	22	69	3	العاصمة	لواء الجامعة	قضاء الجامعة	صويلح	صويلح	الفضيلة
18	1	11	4	1	13	17	6	56	55	3	العاصمة	لواء الجامعة	قضاء الجامعة	تلاع العلي وخلدا وام السماق	تلاع العلي وخلدا وام السماق	التلاع الشمالي
19	1	11	5	1	13	1	5	13	107	3	العاصمة	لواء وادي السير	قضاء وادي السير	مرج الحمام	مرج الحمام	الخامس
20	1	11	2	1	13	10	2	11	120	3	العاصمة	لواء ماركا	قضاء ماركا	طارق	طارق	الخزنة
21	1	11	4	1	14	20	4	17	121	4	العاصمة	لواء الجامعة	قضاء الجامعة	اسكان ابو نصير	ابو نصير	حي الامانه
22	1	11	4	1	11	18	5	11	67	4	العاصمة	لواء الجامعة	قضاء الجامعة	الجبيهة	الجبيهة	الرشيد
23	1	11	4	1	12	16	9	1	89	4	العاصمة	لواء الجامعة	قضاء الجامعة	صويلح	صويلح	الفروسية
24	1	11	4	1	13	17	4	32	151	4	العاصمة	لواء الجامعة	قضاء الجامعة	تلاع العلي وخلدا وام	تلاع العلي وخلدا وام	الصالحين

														السماق	السماق	
25	1	11	4	1	13	17	5	7	77	4	العاصمة	لواء الجامعة	قضاء الجامعة	تلاع العلي وخلدا وام السماق	تلاع العلي وخلدا وام السماق	التلاع الشرقي
26	1	11	4	1	13	17	7	12	47	4	العاصمة	لواء الجامعة	قضاء الجامعة	تلاع العلي وخلدا وام السماق	تلاع العلي وخلدا وام السماق	بركة
27	1	11	5	1	13	1	8	1	75	4	العاصمة	لواء وادي السير	قضاء وادي السير	مرج الحمام	مرج الحمام	الثامن
28	2	11	9	1	21	1	1	1	97	0	العاصمة	لواء ناعور	قضاء ناعور	العامرية	العامرية	العامرية
29	2	11	7	1	14	1	1	9	45	0	العاصمة	لواء الجيزة	قضاء الجيزة	اللبن	اللبن	اللبن
30	2	11	7	2	11	1	1	1	52	0	العاصمة	لواء الجيزة	قضاء ام الرصاص	ام الرصاص	ام الرصاص	ام الرصاص
31	2	11	8	2	12	1	1	2	41	0	العاصمة	لواء الموقر	قضاء رجم الشامي	سالم	سالم	سالم
32	1	11	1	1	113	1	5	7	76	1	العاصمة	لواء قصبة عمان	قضاء عمان	المدينه	المدينة	وادي السرور

33	1	11	1	1	116	7	1	19	124	1	العاصمة	لواء قصبة عمان	قضاء عمان	بدر	بدر	الذراع
34	1	11	1	1	112	6	2	45	104	1	العاصمة	لواء قصبة عمان	قضاء عمان	راس العين	راس العين	الزهور
35	1	11	1	1	115	5	5	49	97	1	العاصمة	لواء قصبة عمان	قضاء عمان	اليرموك	اليرموك	جبل التاج
36	1	11	1	1	115	5	2	21	74	1	العاصمة	لواء قصبة عمان	قضاء عمان	اليرموك	اليرموك	العودة
37	1	11	1	1	111	9	1	18	96	2	العاصمة	لواء قصبة عمان	قضاء عمان	العبدلي	العبدلي	جبل اللويبدة
38	1	11	1	1	114	8	1	63	97	2	العاصمة	لواء قصبة عمان	قضاء عمان	زهران	زهران	جبل عمان
39	1	11	1	1	116	7	1	52	32	2	العاصمة	لواء قصبة عمان	قضاء عمان	بدر	بدر	الذراع
40	1	11	1	1	112	6	1	82	109	2	العاصمة	لواء قصبة عمان	قضاء عمان	راس العين	راس العين	النظيف
41	1	11	1	1	115	5	5	85	99	2	العاصمة	لواء قصبة	قضاء	اليرموك	اليرموك	جبل التاج

												عمان	عمان			
42	1	11	1	1	115	5	1	75	95	2	العاصمة	لواء قصبة عمان	قضاء عمان	اليرموك	اليرموك	الاشرفية
43	1	11	1	1	111	9	4	17	61	3	العاصمة	لواء قصبة عمان	قضاء عمان	العبدلي	العبدلي	المدينة الرياضية
44	1	11	1	1	113	1	7	3	70	3	العاصمة	لواء قصبة عمان	قضاء عمان	المدينه	المدينة	المهاجرين
45	1	11	1	1	116	7	2	56	43	3	العاصمة	لواء قصبة عمان	قضاء عمان	بدر	بدر	الاخضر
46	1	11	1	1	116	7	4	33	117	3	العاصمة	لواء قصبة عمان	قضاء عمان	بدر	بدر	الهلال
47	1	11	1	1	112	6	3	45	68	3	العاصمة	لواء قصبة عمان	قضاء عمان	راس العين	راس العين	الروضة
48	1	11	1	1	115	5	5	67	52	3	العاصمة	لواء قصبة عمان	قضاء عمان	اليرموك	اليرموك	جبل التاج
49	1	11	1	1	111	9	4	32	42	4	العاصمة	لواء قصبة عمان	قضاء عمان	العبدلي	العبدلي	المدينة الرياضية

50	1	11	1	1	111	9	1	43	95	4	العاصمة	لواء قصبة عمان	قضاء عمان	العبدلي	العبدلي	جبل اللويبدة
51	1	11	1	1	114	8	4	6	100	4	العاصمة	لواء قصبة عمان	قضاء عمان	زهران	زهران	ام اذينة الشرقي
52	1	11	1	1	114	8	3	27	30	4	العاصمة	لواء قصبة عمان	قضاء عمان	زهران	زهران	الرضوان
53	1	11	1	1	112	6	3	27	74	4	العاصمة	لواء قصبة عمان	قضاء عمان	راس العين	راس العين	الروضة
54	1	11	2	1	114	2	3	145	100	1	العاصمة	لواء ماركا	قضاء ماركا	بسمان	بسمان	الهاشمي الشمالي
55	1	11	2	1	111	3	2	55	84	1	العاصمة	لواء ماركا	قضاء ماركا	ماركا	ماركا	حمزة
56	1	11	2	1	112	4	4	17	94	1	العاصمة	لواء ماركا	قضاء ماركا	النصر	النصر	المنارة
57	1	11	2	1	112	4	7	9	53	1	العاصمة	لواء ماركا	قضاء ماركا	النصر	النصر	الصالحية
58	1	11	2	1	114	2	3	19	122	2	العاصمة	لواء ماركا	قضاء ماركا	بسمان	بسمان	الهاشمي الشمالي
59	1	11	2	1	111	3	2	77	71	2	العاصمة	لواء ماركا	قضاء ماركا	ماركا	ماركا	حمزة

60	1	11	2	1	112	4	4	42	58	2	العاصمة	لواء ماركا	قضاء ماركا	النصر	النصر	المنارة
61	1	11	2	1	112	4	5	44	66	2	العاصمة	لواء ماركا	قضاء ماركا	النصر	النصر	الربوة
62	1	11	2	1	114	2	6	21	45	3	العاصمة	لواء ماركا	قضاء ماركا	بسمان	بسمان	رغدان
63	1	11	2	1	114	2	1	61	87	3	العاصمة	لواء ماركا	قضاء ماركا	بسمان	بسمان	القصور
64	1	11	2	1	112	4	3	29	112	3	العاصمة	لواء ماركا	قضاء ماركا	النصر	النصر	جبل النصر
65	1	11	2	1	112	4	1	62	146	3	العاصمة	لواء ماركا	قضاء ماركا	النصر	النصر	الاميرالحسن
66	1	11	2	1	114	2	4	50	59	4	العاصمة	لواء ماركا	قضاء ماركا	بسمان	بسمان	الجرن
67	1	11	2	1	114	2	6	14	81	4	العاصمة	لواء ماركا	قضاء ماركا	بسمان	بسمان	رغدان
68	1	11	2	1	111	3	1	26	74	4	العاصمة	لواء ماركا	قضاء ماركا	ماركا	ماركا	المطار
69	1	11	2	1	112	4	1	60	96	4	العاصمة	لواء ماركا	قضاء ماركا	النصر	النصر	الاميرالحسن
70	1	11	5	1	11	14	5	9	127	1	العاصمة	لواء وادي السير	قضاء وادي السير	وادي السير	وادي السير	وادي السير

71	1	11	5	1	11	14	2	34	38	1	العاصمة	لواء وادي السير	قضاء وادي السير	وادي السير	وادي السير	الصويفية
72	1	11	5	1	11	14	3	38	77	2	العاصمة	لواء وادي السير	قضاء وادي السير	وادي السير	وادي السير	الجندويل
73	1	11	5	1	11	14	1	76	60	3	العاصمة	لواء وادي السير	قضاء وادي السير	وادي السير	وادي السير	الروابي
74	1	11	5	1	11	14	7	8	57	4	العاصمة	لواء وادي السير	قضاء وادي السير	وادي السير	وادي السير	السهل
75	1	12	2	1	13	1	1	24	83	1	البلقاء	لواء الشونة الجنوبية	قضاء الشونة الجنوبية	الكرامة	الكرامة	الكرامة
76	1	12	4	1	24	1	1	21	129	1	البلقاء	لواء عين الباشا	قضاء عين الباشا	البقعة	البقعه	الجنوبي
77	1	12	4	1	24	1	2	8	59	2	البلقاء	لواء عين الباشا	قضاء عين الباشا	البقعة	البقعه	الشمالي
78	1	12	4	1	24	1	1	56	95	2	البلقاء	لواء عين الباشا	قضاء عين الباشا	البقعة	البقعه	الجنوبي
79	1	12	1	1	111	2	2	3	84	3	البلقاء	لواء قصبة	قضاء قصبة	السلط	الثانية	سوادا

												السلط	السلط			
80	1	12	1	1	111	1	3	4	72	3	البلقاء	لواء قصبة السلط	قضاء قصبة السلط	السلط	الاولى	الميدان
81	1	12	4	1	11	1	1	29	96	3	البلقاء	لواء عين الباشا	قضاء عين الباشا	عين الباشا	عين الباشا	عين الباشا
82	1	12	1	1	111	1	2	1	121	4	البلقاء	لواء قصبة السلط	قضاء قصبة السلط	السلط	الاولى	وادي الحلبي
83	1	12	4	1	12	1	1	15	109	4	البلقاء	لواء عين الباشا	قضاء عين الباشا	صافوط	صافوط	صافوط
84	2	12	3	1	25	1	1	6	57	0	البلقاء	لواء دير علا	قضاء دير علا	ميسرة فنوش	ميسرة فنوش	ميسرة فنوش
85	2	12	1	3	11	1	1	5	87	0	البلقاء	لواء قصبة السلط	قضاء زي	علان	علان	علان
86	2	12	4	1	25	1	1	3	74	0	البلقاء	لواء عين الباشا	قضاء عين الباشا	الحنو	الحنو	الحنو
87	1	13	1	3	11	1	1	31	104	1	الزرقاء	لواء قصبة الزرقاء	قضاء الضليل	الضليل	الضليل	الضليل

88	1	13	2	1	13	1	1	43	114	2	الزرقاء	لواء الرصيفة	قضاء الرصيفة	مخيم حطين	مخيم حطين	مخيم حطين
89	1	13	2	1	13	1	1	30	131	3	الزرقاء	لواء الرصيفة	قضاء الرصيفة	مخيم حطين	مخيم حطين	مخيم حطين
90	1	13	3	1	12	1	1	5	54	4	الزرقاء	لواء الهاشمية	قضاء الهاشمية	السخنة	السخنة	السخنة
91	2	13	2	1	12	1	1	1	34	0	الزرقاء	لواء الرصيفة	قضاء الرصيفة	ابو صياح	ابو صياح	ابو صياح
92	1	13	1	1	111	3	5	25	44	1	الزرقاء	لواء قصبة الزرقاء	قضاء قصبة الزرقاء	الزرقاء	عوجان	الملك طلال
93	1	13	1	1	111	2	2	53	73	1	الزرقاء	لواء قصبة الزرقاء	قضاء قصبة الزرقاء	الزرقاء	الثوره العربيه الكبرى	جناعه
94	1	13	1	1	111	1	11	21	57	1	الزرقاء	لواء قصبة الزرقاء	قضاء قصبة الزرقاء	الزرقاء	الوسط التجاري	الغويريه
95	1	13	1	1	111	4	1	34	49	2	الزرقاء	لواء قصبة الزرقاء	قضاء قصبة الزرقاء	الزرقاء	الزواهره	الزواهره
96	1	13	1	1	111	2	2	29	65	2	الزرقاء	لواء قصبة	قضاء قصبة	الزرقاء	الثوره العربيه	جناعه

												الزرقاء	الزرقاء		الكبرى	
97	1	13	1	1	111	1	9	13	63	2	الزرقاء	لواء قصبة الزرقاء	قضاء قصبة الزرقاء	الزرقاء	الوسط التجاري	معصوم
98	1	13	1	1	111	1	11	26	89	2	الزرقاء	لواء قصبة الزرقاء	قضاء قصبة الزرقاء	الزرقاء	الوسط التجاري	الغويريه
99	1	13	1	1	111	3	6	3	52	3	الزرقاء	لواء قصبة الزرقاء	قضاء قصبة الزرقاء	الزرقاء	عوجان	عوجان
100	1	13	1	1	111	1	1	1	66	3	الزرقاء	لواء قصبة الزرقاء	قضاء قصبة الزرقاء	الزرقاء	الوسط التجاري	الحديقه
101	1	13	1	1	111	1	6	40	60	3	الزرقاء	لواء قصبة الزرقاء	قضاء قصبة الزرقاء	الزرقاء	الوسط التجاري	رمزي
102	1	13	1	1	111	1	12	30	138	3	الزرقاء	لواء قصبة الزرقاء	قضاء قصبة الزرقاء	الزرقاء	الوسط التجاري	الامير محمد
103	1	13	1	1	111	2	3	49	72	4	الزرقاء	لواء قصبة الزرقاء	قضاء قصبة الزرقاء	الزرقاء	الثوره العربيه الكبرى	الثوره العربيه الكبرى
104	1	13	1	1	111	1	6	24	67	4	الزرقاء	لواء قصبة الزرقاء	قضاء قصبة الزرقاء	الزرقاء	الوسط التجاري	رمزي

105	1	13	1	1	111	5	2	5	61	4	الزرقاء	لواء قصبة الزرقاء	قضاء قصبة الزرقاء	الزرقاء	الزرقاء الجديده	البتراوي
106	1	13	1	1	111	5	1	46	105	4	الزرقاء	لواء قصبة الزرقاء	قضاء قصبة الزرقاء	الزرقاء	الزرقاء الجديده	الزرقاء الجديده
107	1	13	2	1	11	5	7	4	111	1	الزرقاء	لواء الرصيفة	قضاء الرصيفة	الرصيفة	حطين	ابو غليون
108	1	13	2	1	11	3	1	40	59	1	الزرقاء	لواء الرصيفة	قضاء الرصيفة	الرصيفة	اليرموك	عوجان الغربي
109	1	13	2	1	11	1	9	3	96	2	الزرقاء	لواء الرصيفة	قضاء الرصيفة	الرصيفة	العامرية	الحسين
110	1	13	2	1	11	3	2	5	91	2	الزرقاء	لواء الرصيفة	قضاء الرصيفة	الرصيفة	اليرموك	ام جرادة الشمالي
111	1	13	2	1	11	1	9	10	127	3	الزرقاء	لواء الرصيفة	قضاء الرصيفة	الرصيفة	العامرية	الحسين
112	1	13	2	1	11	3	6	2	47	3	الزرقاء	لواء الرصيفة	قضاء الرصيفة	الرصيفة	اليرموك	الرازي
113	1	13	2	1	11	1	8	9	78	4	الزرقاء	لواء الرصي	قضاء	الرصيفة	العامرية	العرب

												فة	الرصيفة			
114	1	13	2	1	11	3	7	33	98	4	الزرقاء	لواء الرصيفة	قضاء الرصيفة	الرصيفة	اليرموك	التطوير
115	1	14	1	1	111	1	22	21	54	1	مادبا	لواء قصبة مادبا	قضاء قصبة مادبا	مادبا	مادبا	العلماء
116	1	14	1	1	111	1	7	6	54	2	مادبا	لواء قصبة مادبا	قضاء قصبة مادبا	مادبا	مادبا	المخيم
117	1	14	1	1	111	1	12	1	56	3	مادبا	لواء قصبة مادبا	قضاء قصبة مادبا	مادبا	مادبا	حنينا
118	2	14	1	2	11	1	1	3	112	0	مادبا	لواء قصبة مادبا	قضاء جرينه	جرينه	جرينه	جرينه
119	1	21	5	1	15	1	1	21	61	1	اربد	لواء الاغوار الشمالية	قضاء الاغوار الشمالية	الشيخ حسين	الشيخ حسين	الشيخ حسين
120	1	21	5	1	13	1	1	21	70	1	اربد	لواء الاغوار الشمالية	قضاء الاغوار الشمالية	كريمه	كريمه	كريمه
121	1	21	7	1	11	1	1	5	91	1	اربد	لواء المزار الشمالي	قضاء المزار الشمالي	المزار الشمالي	المزار الشمالي	المزار الشمالي

122	1	21	6	1	14	1	1	4	49	1	اربد	لواء بني عبيد	قضاء بني عبيد	ايدون	ايدون	ايدون
123	1	21	5	1	11	1	1	8	77	2	اربد	لواء الاغوار الشمالية	قضاء الاغوار الشمالية	الشونة الشمالية	الشونة الشمالية	الشونة الشمالية
124	1	21	3	1	13	1	1	21	83	2	اربد	لواء الكوره	قضاء الكوره	كفر الماء	كفر الماء	كفر الماء
125	1	21	1	1	22	1	1	7	117	2	اربد	لواء قصبة اربد	قضاء اربد	بيت يافا	بيت يافا	بيت يافا
126	1	21	2	1	11	1	1	32	94	2	اربد	لواء الرمثا	قضاء الرمثا	الرمثا	الرمثا	الاول
127	1	21	8	1	11	1	1	6	75	3	اربد	لواء الطيبة	قضاء الطيبة	الطيبة	الطيبة	الطيبة
128	1	21	7	1	14	1	1	2	54	3	اربد	لواء المزار الشمالي	قضاء المزار الشمالي	عنبة	عنبة	عنبة
129	1	21	1	1	14	1	1	53	77	3	اربد	لواء قصبة اربد	قضاء اربد	بيت راس	بيت راس	بيت راس
130	1	21	2	1	15	1	1	2	74	3	اربد	لواء الرمثا	قضاء الرمثا	البويضة	البويضة	البويضة
131	1	21	4	1	12	1	1	12	74	4	اربد	لواء بني كنانة	قضاء بني كنانة	كفر سوم	كفر سوم	كفر سوم

132	1	21	1	1	15	1	1	7	65	4	اربد	لواء قصبة اربد	قضاء اربد	بشرى	بشرى	بشرى
133	1	21	2	1	11	1	7	16	133	4	اربد	لواء الرمثا	قضاء الرمثا	الرمثا	الرمثا	السابع
134	1	21	6	1	13	1	1	9	45	4	اربد	لواء بني عبيد	قضاء بني عبيد	الصريح	الصريح	الصريح
135	1	21	6	1	12	1	1	9	73	4	اربد	لواء بني عبيد	قضاء بني عبيد	النعيمة	النعيمة	النعيمة
136	2	21	4	1	35	1	1	2	86	0	اربد	لواء بني كنانة	قضاء بني كنانة	ابدر	ابدر	ابدر
137	2	21	4	1	17	1	1	13	65	0	اربد	لواء بني كنانة	قضاء بني كنانة	خرجا	خرجا	خرجا
138	2	21	8	1	16	1	1	1	59	0	اربد	لواء الطيبة	قضاء الطيبة	زبدة الوسطية	زبدة الوسطية	زبدة الوسطية
139	2	21	3	1	21	1	1	1	45	0	اربد	لواء الكوره	قضاء الكوره	جفين	جفين	جفين
140	2	21	1	1	24	1	1	3	80	0	اربد	لواء قصبة اربد	قضاء اربد	دوقره	دوقره	دوقره
141	2	21	1	1	27	1	1	2	53	0	اربد	لواء قصبة اربد	قضاء اربد	مرو	مرو	مرو

142	1	21	1	1	111	1	5	2	81	1	اربد	لواء قصبة اربد	قضاء اربد	اربد	الهاشمية	الميدان
143	1	21	1	1	111	2	3	1	73	1	اربد	لواء قصبة اربد	قضاء اربد	اربد	النصر	الكرامة
144	1	21	1	1	111	6	4	40	82	2	اربد	لواء قصبة اربد	قضاء اربد	اربد	المناره	المناره
145	1	21	1	1	111	2	2	7	51	2	اربد	لواء قصبة اربد	قضاء اربد	اربد	النصر	النصر
146	1	21	1	1	111	6	5	3	101	3	اربد	لواء قصبة اربد	قضاء اربد	اربد	المناره	الصوانيه
147	1	21	1	1	111	3	5	5	106	3	اربد	لواء قصبة اربد	قضاء اربد	اربد	الروضة	الايمان
148	1	21	1	1	111	6	1	7	85	4	اربد	لواء قصبة اربد	قضاء اربد	اربد	المناره	الابرار
149	1	21	1	1	111	4	1	10	105	4	اربد	لواء قصبة اربد	قضاء اربد	اربد	النزهه	الجامعه
150	1	21	1	1	111	1	6	25	64	4	اربد	لواء قصبة	قضاء	اربد	الهاشمية	السلام

												اربد	اربد			
151	1	22	1	2	11	1	1	3	75	1	المفرق	لواء قصبة المفرق	قضاء بلعما	بلعما	بلعما	بلعما
152	1	22	2	2	11	1	1	8	70	2	المفرق	لواء البادية الشمالية	قضاء صبحا	صبحا	صبحا	صبحا
153	1	22	1	1	111	1	11	31	65	4	المفرق	لواء قصبة المفرق	قضاء المفرق	المفرق	المفرق	النهضه
154	2	22	3	1	16	1	1	2	48	0	المفرق	لواء البادية الشمالية الغربية	قضاء البادية الشمالية الغربية	الزبيدية	الزبيدية	الزبيدية
155	2	22	1	3	28	1	1	4	52	0	المفرق	لواء قصبة المفرق	قضاء ارحاب	عين بني حسن	عين بني حسن	عين بني حسن
156	2	22	2	3	12	1	1	5	61	0	المفرق	لواء البادية الشمالية	قضاء ام الجمال	روضة بسمة	روضة بسمة	روضة بسمة
157	2	22	2	1	15	1	1	2	72	0	المفرق	لواء البادية الشمالية	قضاء الصالحية	الاشرفية	الاشرفية	الاشرفية
158	1	23	1	1	49	1	1	2	88	1	جرش	لواء قصبة	قضاء قصبة	مخيم غزة	مخيم غزة	مخيم غزة

												جرش	جرش			
159	1	23	1	1	12	1	1	23	58	2	جرش	لواء قصبة جرش	قضاء قصبة جرش	سوف	سوف	سوف
160	1	23	1	1	13	1	1	22	80	3	جرش	لواء قصبة جرش	قضاء قصبة جرش	ساكب	ساكب	ساكب
161	2	23	1	1	17	1	1	9	89	0	جرش	لواء قصبة جرش	قضاء قصبة جرش	بليلا	بليلا	بليلا
162	2	23	1	1	18	1	1	6	43	0	جرش	لواء قصبة جرش	قضاء قصبة جرش	قفقفا	قفقفا	قفقفا
163	1	24	1	2	11	1	1	23	82	2	عجلون	لواء قصبة عجلون	قضاء صخره	صخره	صخره	صخره
164	1	24	1	1	12	1	1	7	55	3	عجلون	لواء قصبة عجلون	قضاء قصبة عجلون	عنجره	عنجره	عنجره
165	1	24	2	1	11	1	1	49	61	4	عجلون	لواء كفرنجة	قضاء كفرنجة	كفرنجة	كفرنجة	كفرنجة
166	2	24	1	1	24	1	1	1	34	0	عجلون	لواء قصبة عجلون	قضاء قصبة عجلون	الطياره	الطياره	الطياره

167	1	31	4	1	11	1	1	8	104	2	الكرك	لواء الاغوار الجنوبية	قضاء غور الصافي	غور الصافي	غور الصافي	غور الصافي
168	1	31	2	1	11	1	1	21	35	4	الكرك	لواء المزار الجنوبي	قضاء المزار الجنوبي	المزار الجنوبي	المزار الجنوبي	المزار الجنوبي
169	2	31	3	1	11	1	1	3	61	0	الكرك	لواء القصر	قضاء القصر	القصر	القصر	القصر
170	2	31	4	2	12	1	1	6	130	0	الكرك	لواء الاغوار الجنوبية	قضاء غور المزرعة	غور الحديثة	غور الحديثة	غور الحديثة
171	2	31	1	1	21	1	1	5	60	0	الكرك	لواء قصبة الكرك	قضاء الكرك	مدين	مدين	مدين
172	2	31	5	1	11	1	1	1	65	0	الكرك	لواء عي	قضاء عي	عي	عي	عي
173	2	31	2	1	22	1	1	4	56	0	الكرك	لواء المزار الجنوبي	قضاء المزار الجنوبي	شقيرا الغربيه	شقيرا الغربيه	شقيرا الغربيه
174	1	32	2	1	11	1	1	17	79	2	الطفيلة	لواء بصيرا	قضاء بصيرا	بصيرا	بصيرا	بصيرا
175	1	32	1	1	111	1	2	7	87	4	الطفيلة	لواء قصبة الطفيلة	قضاء قصبة الطفيلة	الطفيلة	الطفيلة	الثاني

176	2	32	1	1	34	1	1	1	79	0	الطفيلة	لواء قصبة الطفيلة	قضاء قصبة الطفيلة	عرفه	عرفه	عرفه
177	1	33	4	1	11	1	1	3	105	1	معان	لواء الحسينية	قضاء الحسينية	الحسينية	الحسينية	الحسينية
178	1	33	2	1	11	1	1	40	53	3	معان	لواء البتراء	قضاء البتراء	وادي موسى	وادي موسى	وادي موسى
179	2	33	4	1	12	1	1	5	73	0	معان	لواء الحسينية	قضاء الحسينية	الهاشمية	الهاشمية	الهاشمية
180	1	34	2	1	11	1	1	6	64	1	العقبة	لواء القويره	قضاء القويره	القويره	القويره	القويره
181	1	34	1	1	111	1	7	2	68	3	العقبة	لواء قصبة العقبة	قضاء قصبة العقبة	العقبة	العقبة	الرضوان
182	2	34	2	1	12	1	1	5	70	0	العقبة	لواء القويره	قضاء القويره	الراشديه	الراشديه	الراشديه

* : ريف: 0،

أقل نوعية خصائص اجتماعية واقتصادية: 1،

أعلى نوعية خصائص اجتماعية واقتصادية: 4

** : حضر: 1،

ريف: 2

Annex 3-A: Scored Household questionnaire:

1. **Questionnaire number:**
2. **Cluster ID:**
3. **House number :**
4. **Name of street:**
5. **Area name:** **(Urban, Rural) ( )**
6. **Governorate:**
7. **Date of first visit: ( )**
8. **Date of second visit: ( )**

Instructions to the interviewer:

1.When entering the house ask the head of the household (The head of the house could be the father or the mother or the oldest son or any other adult person taking the responsibility in the house.)about the presence of children less than 5 years in the house?

If yes: Continue the interview *If no: go to the next house in the list*

2.All questions are to be answered by the head of the house ***except*** *questions14,15,16,17,,41,42 that should be answered by the mother(caretaker of children).*

3.Each household will be visited twice 30 days apart by the interviewer.

*4.All questions are asked during the first visit of the household **except** questions14 ,15, 16,17,19,21,22 that should be asked during the second visit.*

A. General information questions:

Q.1 Head of the House name -------------------------------Telephone no. ( )

Q.2 Relationship of the head to the family:

□ Father

□ Mother

□ Oldest son

□ Other adult person in the house

Q.3 Gender of the head:

□ Male

□ Female

Q.4 Age of the head in years: ( )

Q.5 Education of the head:

□ Illiterate □ No formal schooling but read and write □ Primary

□ Intermediate □ Secondary □ Diploma

□ Bachelor degree □ More than Bachelor degree

Q.6 Age of the mother (care taker of under 5 children): ( )

Q.7 Education of the mother (care taker of under 5 children):

□ Illiterate □ No formal schooling but read and write □ Primary

□ Intermediate □ Secondary □ Diploma

□ Bachelor degree □ More than Bachelor degree

Q.8 What is the average total family monthly income in Jordanian Dinar?

□ Less than 300 JD

□ 300- 499 JD

□ 500- 699 JD

□ 700- 899 JD

□ 900 JD and more

Q.9 What is the total area of the house (in square meter)?

( ) square meter.

Q.10 How many rooms in the house (excluding kitchen)?

( )

Q.11 What is the type of the house? (By observation)

□ Apartment.

□ Individual dwelling.

□ Villa.

□ Tent or Shack

Q.12 Number of inhabitants in the house: ( )

Q.13 Number of children bellow 5 years in the house: ( )

B. <u>Child feeding practices and diarrhea questions</u>:

Q.14 Type of feeding and Diarrhea in the household:

Child's name (ordered from youngest to oldest)					
Age (Year)					
Gender ("M" male or "F" female)					
Current Feeding pattern:					
Breast feeding					
Bottle feeding					
Mixed					
Not applicable					
Diarrhea during the last month ("Y" Yes, "N" No)					
Number of episodes during the last month (if no diarrhea write "zero")					
Total number of diarrheal episodes during the last month (if no diarrhea write "zero")					

If any child in the household is on bottle or mixed feeding, answer Q15, 16,17. If not go to Q.18

Q.15 Type of water used for preparing the formula: (Don't read options)(More than one option is allowed)

□ Use taps or stored water without boiling score= zero

□ Use boiled tap or stored water score= 1

□ Use bottled water without boiling score= 1

□ Use Boiled bottled water score= 1

□ Use water from the cooler without boiling score= zero

□ Use boiled cooler water score= 1

Q.16 Sterilization of bottle: (Don't read options) (More than one option is allowed)

□ Boiling the bottle before preparing the formula score= 1

□ Cleaning the bottle with water and soap score= zero

□ Cleaning the bottle with water only score= zero

□ Use disinfection solutions score= 1

□ Use sterilizing machine score= 1

□ Do nothing score= zero

Q.17 Ask the mother of children on formula about her usual hygiene before preparing the formula: (N.B: Don't read options)(one choice)

□ 1. Wash hands with water and soap 1

□ 2. Wash hands with water only 0.5

□ 3. Don't wash hands zero

Scoring:

Q. 15 If Answer is 2 or 3 or 4 or 6 or combination of them gives score 1

If answer is as above but combined with 1 or/and 5 give score 0.5

If answer is 1 or/and 5 give score 0

Q.16 If answer is 1 or/and 4 or/ and 5 give score 1

If answer is as above but combined with 2 or/ and 3 or/ and 6 give score 0.25

If answer is 2 or/ and 3 or/ and 6 give score 0

Q. 17 If answer is 1 give score 1

If answer is 2 give score 0.5

If answer is 3 give score 0

Total scoring for formula feeding hygiene:

If total scores for Q. 15, 16, 17=2 and more (Acceptable)

If total scores for Q., 15, 16, 17= less than 2(Not acceptable)

□ **1.Acceptable** □ **2. not acceptable**

C. Water quantity questions:

Q.18 The interviewer takes the first reading of water meter belonging to the house and record it in the space below:

( )

Q.19 The interviewer take the second reading of water meter belonging to the house and record it in the space below:

( )

Amount of tap water reached=Second reading - first reading ( ) Cubic meter

Q.20 Estimation of amount of water stored in the house at the time of first visit ( ) cubic meter or ( ) liters

Q.21 What is the amount of supplementary water purchased or brought from different sources other than the amount reached through the supply system during the reference month? (Depending on the diary left in the house).

□Tanker truck ( ) Cubic Meter

□Spring ( ) liter

□Well of rainwater collection ( ) liter

□Well water from other source ( ) liter

□Bottled water ( ) liter

□Other source (specify) ( ) liter

Amount of supplementary water reached= ( ) cubic meter <u>Or</u> ( ) liters

Total amount of water reached the house = Amount of tap water representing the difference between the two readings + Amount of supplementary water + amount of stored water in the house at the first visit = ( ) cubic meter Or ( ) liters

Q.22 How much you estimate the amount of water used outside the house (for amenity uses like irrigation, swimming pool, car washing, animal drinking, construction, leakage from the system, etc.) during the reference month? (Depending on the diary left in the house).

( ) cubic meter <u>or</u> ( ) liters

Estimation of amount of water stored in the house at the second visit ( ) cubic meters or ( ) liters

Net amount of water consumed inside the house during the reference month = Total amount of water reached the house - Amenity water – water stored in the house at the second visit.

D. <u>Water quality questions:</u>

Q.23 On average how frequent you receive public water? (one choice)

- □ **Daily** **score= 1**
- □ **Two times / week** **score= 0.5**
- □ **Once/week** **score= 0.25**
- □ **Once every more than one week** **score= Zero**

Q.24 Do you store water in your house?

□ **Yes** □ **No**

Q.25 If yes, how do you store water in house?(mark all relevant)

- □ **Storage well**
- □ **Storage tanks**
- □ **Any available containers (barrels)**

Q.26 How do you perceive the quality of water reaching your house?

□ **Safe** **Score 1**

□ Not safe Score 0

Q.27 Are you satisfied with quality of piped water in terms of?

Taste: □ Yes □ No

Color: □ Yes □ No

Smell: □ Yes □ No

Impurities □ Yes □ No

Scoring: If 4 yes give score 1

If 3 yes give score 0.5

If one yes or no yes give score zero

Q .28 How frequent you clean the storage container?

□ Twice or more per year score= 1

□ Once per year score= 0.5

□ Once per more than year score= zero

□ None score= zero

Q.29 Closure of the storage container (as observed by the interviewer):

□ Tightly closed Score 1

□ Partially closed Score 0.5

□ Not closed Score Zero

Q.30 Residual chlorine in kitchen tap as measured by the interviewer:

□ Present Score 1

□ Absent **Score Zero**

Total score for quality = score of Q.23+score of Q.26+ score of Q. 27+ score of Q. 28+ score of Q.29+ Q.30

If total=4-6 (good), if total=3-less than 4(fair), if total= less than 3 (bad).

□ Good **□ Fair** **□ Bad**

Q.31 what is the main source of water used for drinking? (One choice)

- **□ Piped water**
- **□ Bottled water**
- **□ Water from local purification plants**
- **□ Collected rain water**
- **□ Tank trucks water**
- **□ Spring water**

E. Sanitation questions:

E.1 Toilet facility:

Q.32 How many toilet per person you have in the house?

- **One toilet/ two or less persons** **Score:1**
- **One toilet/three persons** **Score:0.5**
- **One toilet/ four persons or more** **Score: 0.25**
- **No toilet** **Score: zero**

Q.33 What is the type of toilet facilities did you have? (Mark all relevant)

- □ **Sit down or Squat toilet with Negara flush** **Score: 1**
- □ **Sit down or Squat toilet with Bucket flushes** **Score: 0.5**
- □ **Pit latrine** **Score: 0.25**
- □ **No toilet facilities** **Score: zero**

Q.34 Assessment of the general conditions and cleanliness of the toilet facilities as seen by the interviewer: (by observation)

1.Availability of soap	**Yes**	**NO**
2.Drainage	**Yes**	**NO**
3.Absence of bad Smell	**Yes**	**No**
4.Availability of toilet paper	**Yes**	**No**
5.Clean floors	**Yes**	**No**
6.Clean walls	**Yes**	**No**
7. Running water	**Yes**	**No**

Scoring:

If 5 Yes or more = 1

If 3-4 Yes = 0.5

If Less than 3 Yes = zero

Total scoring for toilet hygiene (Q.32, 33, 34):

If total is more than 2 will be considered as good

If total is 1- 2 will be considered as Fair

If total is less than 1 will be considered as bad

□ **Good** □ **Fair** □ **Bad**

E.2 Waste discharge:

Q.35 What type of toilet waste water discharge services you have?

- □ **Piped sewer system.** **Score= 1**
- □ **Cess pool.** **Score= 0.5**
- □ **Septic tank.** **Score= 0.5**
- □ **Out door.** **Score= zero**

Q.36 Where do you discharge your cleaning water (dishes washing, cloth washing, bath water, house cleaning)?

- □ **Sewer system.** **Score= 1**
- □ **Cess pool.** **Score= 0.5**
- □ **Septic tank.** **Score= 0.5**
- □ **Outdoor drainage.** **Score= zero**

Q.37 How do you dispose garbage?

- □ **Collected by municipality.** **Score= 1**
- □ **Burned.** **Score=0.5**
- □ **Buried** **Score=0.5**
- □ **Thrown outside the house.** **Score=zero**

Q.38 How frequent garbage is removed from your house?

- □ **Daily or every other day** **Score= 1**

□ Twice/week Score= 0.5

□ Once /week Score= 0.25

□ Once every 2 weeks or more Score= zero

Total scoring for waste discharge: Score of Q. 35+ Score of Q. 36 + Score of Q.37 + Score of Q. 38

If total=3-4 (Good)

If total=2- less than 3(Fair)

If total=Less than 2 (Bad)

□ Good □ Fair □ Bad

E.3 Kitchen:

Q.39 What type of kitchen do you have?

□ Separate kitchen

□ Part of other rooms in the house

□ No kitchen

Q.40 What facilities present in the kitchen? (Mark all relevant through interviewer observation).

1.Working refrigerator	**□ YES**	**□ No**
2.Dish washing sink	**□ YES**	**□ No**
3.Closed places to keep the utensils	**□ YES**	**□No**
4.Enough Space:	**□ YES**	**□ No**
5. Easy cleaned Floor:	**□YES**	**□ No**
6.Good drainage	**□YES**	**□ No**
7.Easy cleaned Walls:	**□ YES**	**□ No**
8.Good Ventilation:	**□YES**	**□ No**
9.Surface for food preparation	**□YES**	**□ No**

10.Availability of Detergents □ YES □ No

11. Running water □ YES □ No

Scoring of the kitchen:

8 Yes or more= Good

5-7 Yes =Fair

Less than 5 Yes=Bad

□ Good □ Fair □ Bad

F. Hygienic practices 0f mother and children questions:

Q.41 When do you wash your hands with soap? (Mark all relevant)

□ After using toilet

□ Before eating

□ Before cooking

□ After touching something not clean

Scoring:

4 marked= Good hygiene

Less than 4= Bad hygiene

□ Good hygiene □ Bad hygiene

Q.42 When do your children wash their hands with soap? (Mark all relevant)

□ After using toilet

□ Before eating

□ After touching something not clean

Scoring:

3 marked= Good hygiene

Less than 3= Bad hygiene

□ 1. Good □ 2. Bad

G. <u>Status of basins hygiene questions:</u>

Q. 43 The interviewer observes the number of hand washing basins in the house and related to family size:

□ Basin for 2 persons or less score= 1

□ Basin for 3-4 persons score= 0.5

□ Basin for 5 persons and above score= 0.25

□ No Basins score= zero

Q.44 The interviewer assesses the accessibility of basins to the toilets by observation:

□ Inside the bath room score= 1

□ In front of the door score=0.75

□ Faraway of the toilet score= 0.25

□ Basins not found score=zero

Q.45 The interviewer observes the presence of running water and soap on the basins:

□ Present on all basins score= 1

□ Present on 50%of basins and more score= 0.75

□ Present on less than 50%of basin score= 0.25

□ Not present on any bas **score= 0**

If total score of Q. 42, Q. 43, Q. 44= 2 0r more (Accepted)

If total score of Q. 40, Q. 41, Q. 42=Less than 2(not accepted)

□ Accepted **□ Not accepted**

Annex 3-B: Un-scored Household questionnaire:

1. **Questionnaire number:**
2. **Cluster ID:**
3. **House number :**
4. **Name of street:**
5. **Area name: (Urban, Rural) ( )**
6. **Governorate:**
7. **Date of first visit: ( )**
8. **Date of second visit: ( )**

Instructions to the interviewer:

1.When entering the house ask the head of the household (The head of the house could be the father or the mother or the oldest son or any other adult person taking the responsibility in the house.)about the presence of children less than 5 years in the house?

If yes: Continue the interview *If no: go to the next house in the list*

*2.All questions are to be answered by the head of the house **except** questions14,15,16,17,41,42 that should be answered by the mother(caretaker of children).*

3.Each household will be visited twice 30 days apart by the interviewer.

*4.All questions are asked during the first visit of the household **except** questions14 ,15, 16,17,19,21,22 that should be asked during the second visit.*

A. General information questions:

Q.1 Head of the House name -------------------------------Telephone no. (   )

Q.2 Relationship of the head to the family:

□ Father

□ Mother

□ Oldest son

□ Other adult person in the house

Q.3 Gender of the head:

□ Male

□ Female

Q.4 Age of the head in years: (   )

Q.5 Education of the head:

□ Illiterate □ No formal schooling but read and write □ Primary

□ Intermediate □ Secondary □ Diploma

□ Bachelor degree □ More than Bachelor degree

Q.6 Age of the mother (care taker of under 5 children): (   )

Q.7 Education of the mother (care taker of under 5 children):

□ Illiterate □ No formal schooling but read and write □ Primary

□ Intermediate □ Secondary □ Diploma

□ Bachelor degree □ More than Bachelor degree

Q.8 What is the average total family monthly income in Jordanian Diner?

□ Less than 300 JD

□ 300- 499 JD

□ 500- 699 JD

□ 700- 899 JD

□ 900 JD and more

Q.9 What is the total area of the house (in square meter)?)

( ) square meter.

Q.10 How many rooms in the house (excluding kitchen)?

( )

Q.11 what is the type of the house? (By observation)

□ Apartment.

□ Individual dwelling.

□ Villa.

□ Tent or Shack

Q.12 Number of inhabitants in the house: ( )

Q.13 Number of children bellow 5 years in the house: ( )

B. Child feeding practices and diarrhea questions:

Q.14 Type of feeding and Diarrhea in the household:

Child's name (ordered from youngest to oldest)					
Age (Year)					
Gender ("M" male or "F" female)					
Current Feeding pattern:					
Breast feeding					
Bottle feeding					
Mixed					
Not applicable					
Diarrhea during the last month ("Y" Yes, "N" No)					
Number of episodes during the last month (if no diarrhea write "zero")					
Total number of diarrheal episodes during the last month (if no diarrhea write "zero")					

If any child in the household is on bottle or mixed feeding, answer Q15, 16,17. If not go to Q.18

Q.15 Type of water used for preparing the formula: (Don’t read options)(More than one option is allowed)

□ Use taps or stored water without boiling

□ Use boiled tap or stored water

□ Use bottled water without boiling

□ Use Boiled bottled water

□ Use water from the cooler without boiling

□ Use boiled cooler water

Q.16 Sterilization of bottle: (Don’t read options) (More than one option is allowed)

□ Boiling the bottle before preparing the formula

□ Cleaning the bottle with water and soap

□ Cleaning the bottle with water only

□ Use disinfection solutions

□ Use sterilizing machine

□ Do nothing

Q.17 Ask the mother of children <u>on formula</u> about her usual hygiene before preparing the formula: (N.B: Don’t read options)(one choice)

□ Wash hands with water and soap

□ Wash hands with water only

□ Don’t wash hands

C. Water quantity questions:

Q.18 The interviewer takes the first reading of water meter belonging to the house and record it in the space below:

( )

Q.19 The interviewer take the second reading of water meter belonging to the house and record it in the space below:

( )

Amount of tap water reached=Second reading - first reading ( ) Cubic meter

Q.20 Estimation of amount of water stored in the house at the time of first visit ( ) cubic meter or ( ) liters

Q.21 What is the amount of supplementary water purchased or brought from different sources other than the amount reached through the supply system during the reference month? (Depending on the diary left in the house).

- **□Tanker truck : ( ) Cubic Meter**
- **□Spring : ( ) liter**
- **□Well of rainwater collection ( ) liter**
- **□Well water from other source ( ) liter**

□**Bottled water** ( ) **liter**

□**Other source (specify)** ( ) **liter**

Amount of supplementary water reached= ( ) cubic meter **<u>Or</u>** **( ) liters**

Total amount of water reached the house = Amount of tap water representing the difference between the two readings + Amount of supplementary water + amount of stored water in the house at the first visit = ( ) cubic meter Or ( ) liters

Q.22 How much you estimate the amount of water used outside the house (for amenity uses like irrigation, swimming pool, car washing, animal drinking, construction, leakage from the system, etc.) during the reference month? (Depending on the diary left in the house).

( ) cubic meter **<u>or</u>** **( ) liters**

Estimation of amount of water stored in the house at the second visit ( ) cubic meters or ( ) liters

Net amount of water consumed inside the house during the reference month = Total amount of water reached the house - Amenity water – water stored in the house at the second visit

D. <u>Water quality questions:</u>

Q.23 On average how frequent you receive public water? (one choice)

□ **Daily** □ **Two times / week**

□ **Once/week** □ **Once every more than one week**

Q.24 Do you store water in your house?

□ **Yes** □ **No**

Q.25 If yes, how do you store water in house?(mark all relevant)

- □ **Storage well**
- □ **Storage tanks**
- □ **Any available containers (barrels)**

Q.26 How do you perceive the quality of water reaching your house?

- □ **Safe**
- □ **Not safe**
- □ **Don't know**

Q.27 Are you satisfied with quality of piped water in terms of?

Taste:	□ **Yes**	□ **No**
Color:	□ **Yes**	□ **No**
Smell:	□ **Yes**	□ **No**
Impurities	□ **Yes**	□ **No**

Q .28 How frequent you clean the storage container?

- □ **Twice or more per year**
- □ **Once per year**
- □ **Once per more than year**
- □ **None**

Q.29 Closure of the storage container (as observed by the interviewer):

- □ **Tightly closed**

□ Partially closed

□ Not closed

Q.30 Residual chlorine in kitchen tap as measured by the interviewer:

□ Present

□ Absent

Q.31 what is the main source of water used for drinking? (One choice)

- **□ Piped water**
- **□ Bottled water**
- **□ Water from local purification plants**
- **□ Collected rain water**
- **□ Tank trucks water**
- **□ Spring water**

E. <u>Sanitation questions:</u>

E.1 Toilet facility:

Q.32 How many toilet per person you have in the house?

□ One toilet/ two or less persons

□ One toilet/three persons

□ One toilet/ four persons or more

□ No toilet

Q.33 What is the type of toilet facilities did you have? (Mark all relevant)

- □ **Sit down or Squat toilet with Negara flush**
- □ **Sit down or Squat toilet with Bucket flushes**
- □ **Pit latrine**
- □ **No toilet facilities**

Q.34 Assessment of the general conditions and cleanliness of the toilet facilities as seen by the interviewer: (by observation)

Availability of soap	**Yes**	**NO**
Drainage	**Yes**	**NO**
Absence of bad Smell	**Yes**	**No**
Availability of toilet paper	**Yes**	**No**
Clean floors	**Yes**	**No**
Clean walls	**Yes**	**No**
Running water	**Yes**	**No**

<u>E.2 Waste discharge:</u>

Q.35 what type of toilet waste water discharge services you have?

- □ **Piped sewer system.**
- □ **Cess-pool.**
- □ **Septic tank.**
- □ **Out door.**

Q.36 Where do you discharge your cleaning water (dishes washing, cloth washing, bath water, house cleaning)?

- □ **Sewer system.**
- □ **Cess pool.**
- □ **Septic tank.**
- □ **Outdoor drainage.**

Q.37 How do you dispose garbage?

- □ **Collected by municipality.**
- □ **Burned.**
- □ **Buried**
- □ **Thrown outside the house.**

Q.38 How frequent garbage is removed from your house?

- □ **Daily or every other day**
- □ **Twice/week**
- □ **Once /week**
- □ **Once every 2 weeks or more**

E.3 Kitchen:

Q.39 What type of kitchen do you have?

- □ **Separate kitchen**
- □ **Part of other rooms in the house**

□ **No kitchen**

Q.40 What facilities present in the kitchen? (Mark all relevant through interviewer observation).

Working refrigerator	□ **YES**	□ **No**
Dish washing sink	□ **YES**	□ **No**
Closed places to keep the utensils	□ **YES**	□ **No**
Enough Space:	□ **YES**	□ **No**
Easy cleaned Floor:	□ **YES**	□ **No**
Good drainage	□ **YES**	□ **No**
Easy cleaned Walls:	□ **YES**	□ **No**
Good Ventilation:	□ **YES**	□ **No**
Surface for food preparation	□ **YES**	□ **No**
Availability of Detergents	□ **YES**	□ **No**
Running water	□ **YES**	□ **No**

F. Hygienic practices 0f mother and children questions:

Q.41 When do you wash your hands with soap? (Mark all relevant)

□ **After using toilet**

□ **Before eating**

□ **Before cooking**

□ **After touching something not clean**

Q.42 When do your children wash their hands with soap? (Mark all relevant)

□ After using toilet

□ Before eating

□ After touching something not clean

G. <u>Status of basins hygiene questions:</u>

Q. 43 The interviewer observes the number of hand washing basins in the house and related to family size:

□ Basin for 2 persons or less

□ Basin for 3-4 persons

□ Basin for 5 persons and above

□ No Basins

Q.44 The interviewer assesses the accessibility of basins to the toilets by observation:

□ Inside the bath room

□ In front of the door

□ Faraway of the toilet

□ Basins not found

Q.45 The interviewer observes the presence of running water and soap on the basins:

□ **Present on all basins**

□ **Present on 50%of basins and more**

□ **Present on less than 50%of basin**

□ **Not present on any basin**

Annex 4: Informed Consent Form

I have been informed and fully understand the purpose for which the information I provide will be collected and used. I voluntarily and freely consent to participation in this interview.

Signature of the interviewee

Name & signature of interviewer **Date: / /**

نموذج الموافقة على إجراء المقابلة

لقد تم إبلاغي عن هدف جمع واستخدام المعلومات المطلوب مني تقديمها, وأنا أوافق بطوع مني وبمحض إرادتي على المشاركة بهذه المقابلة حيث إنني أدرك وأفهم بشكل كامل محتويات هذا النموذج والذي تمت قراءته على مسمعي.

توقيع الشخص المشارك:

أسم وتوقيع الشخص الذي قام بإجراءالمقابلة **تاريخ إجراء المقابلة:**

Annex 5: A special diary

رقم الإستبانة:

إسم صاحب المنزل:

تاريخ زيادة الباحث:__/__/_____

*الرجاء تسجيل جميع المعلومات الوارد أدناه خلال (30يوماً) من زيارة الباحث لمنزلكم.

		الكمية	التاريخ	الكمية	التاريخ	الكمية	التاريخ	الكمية	التاريخ	الكمية	التاريخ	الكمية	التاريخ	الكمية	التاريخ	الكمية	التاريخ	الكمية	التاريخ	الكمية	التاريخ
كمية المياه المشتراه أو أكثر تم احضارها خلال (30) يوماً من زيارة	*مياه معباة للشرب/لتر*																				
	مياه صهاريج م3																				
	مياه أبار أو ينابيع /لتر/																				
	المجموع																				
كمية المياه المستهلكه خارج المنزل	*ري المزوعات/لتر*																				
	سقاية الحيوانات /لتر/																				
	غسل السيارات/لتر																				
	برك السباحة																				
	مياه فاقدة																				
	المجموع																				
حالات الاسهال في المنزل للأطفال		اسم الطفل	التاريخ	اسم الطفل	التاريخ	اسم الطفل	التاريخ	اسم الطفل	التاريخ	اسم الطفل	التاريخ	اسم الطفل	التاريخ	اسم الطفل	التاريخ	اسم الطفل	التاريخ	اسم الطفل	التاريخ	اسم الطفل	التاريخ

Annex 6: List of study team and their typology

The main team; Dr. Saad Kharabsheh (Ex-Minister of Health) as an epidemiologist and Task manager of the study, Dr. Madi Jaghbir as an environmental health expert from Jordan university and Dr. Adel Belbeisi as a public health expert from Jordan Ministry of Health.

The support team; Dr. Yousef Khader as a biostatistician expert from Jordan university of science and technology and Dr. Othman Al-Mashaqbeh as a water engineering expert from RSS.

Annex 7: Expert group meeting workshop program

Expert Group Meeting Program

Review evidence on minimum household water security requirements for health protection

(21-22 / 9 / 2011)

DAY ONE

(Wednesday, 21-9-2011)

10:00	-	10:15	Registration
10:15	-	10:45	Opening

- Royal Scientific Society
- World Health Organisation/ Regional Centre for Environmental Health Activities (WHO/CEHA)

- Short introduction of each expert

10:45	-	11:00	Coffee Break
11:00	-	11:15	Presentation by Research Team Members • Project Description and Activities
11:15	-	11:30	Presentation by Research Team Members • Proposed Methodology
11:30	-	12:30	Questions and Answers Session
12:30	-	13:00	Completion of Feedback Form
13:00	-	13:30	Discussion and Close Out
13:30			Lunch

DAY TWO

(Thursday, 22-9-2011)

10:00	-	10:15	Registration
10:15	-	10:30	Summary of Day One Outcomes
10:30	-	11:30	Presentation by Research Team Members • Household Questionnaire
11:30	-	11:45	Coffee Break
11:45	-	12:30	Continue the Presentation by Research Team Members for the Household Questionnaire
12:30	-	13:00	Questions and Answers Session
13:00	-	13:15	Completion of Feedback Form
13:15	-	13:30	Discussion and Close Out
13:30			Lunch

Annex 8: List of invited experts in the expert group meeting workshop

1- Dr.Mey Al-Jurdi. The Professor and Chair, Environmental health department Faculty of Health Sciences, **American University of Beirut / Lebanon.**
2- Eng. Bassam Saleh, Assistant secretary general for technical affairs, **Water Authority of Jordan (WAJ)**
3- Dr. Muna Hindiyeh, Assistant Secretary General for Laboratories & Quality at Water Authority of Jordan, **Water Authority of Jordan (WAJ)**
4- Dr. Khair Al-Hadidi, Assistant Secretary General for Water Transport and Production at Water Authority of Jordan. **Water Authority of Jordan (WAJ)**
5- Dr. Atallah Z. Rabi, / Department of Community Medicine / Faculty of Medicine/**Jordan University Of Science And Technology (JUST)**
6- Dr. Jamal S. Abu-Ashour,/ Department of Civil Engineering / Faculty of Engineering/ **Jordan University Of Science And Technology (JUST)**
7- Dr. Munjed Al-Sharif, / Coordinator and Chief Technical Advisor / **United Nations Country Team (UNCT)** Joint Programme (JP) / Ministry of Water and Irrigation (MWI).
8- Dr. Kamel Abu Sal , **Ministry of Health (MoH),** Infectious Disease Directorate
9- Eng Nisreen Hadadin, **Ministry of Water and Irrigation (MWI)**
10- Eng. Salah Hyari, Director of Environmental Health Directorate **Ministry of Health (MoH).**
11- Eng. Susan Kilani, **Centre for Environmental Health Activities (CEHA/ WHO).**
12- Mr. Hamed Bakir, **Centre for Environmental Health Activities (CEHA/ WHO).**
13- Dr. Basel Al-Yousfi **Director / Centre for Environmental Health Activities (CEHA/ WHO).**
14- Dr. Saad Al-Kharabsheh, **Task Manger / Research Team**
15- Dr. Madi Al-Jaghbir, Environmental Health Expert / **Research Team**
16- Dr. Adel Al-Belbeisi, Public Health Expert / **Research Team**
17- Dr. Yousef Saleh Khader, Biostatistician Expert / **Research Team.**
18- Eng. Tharwa Qtaish, Head of the water quality studies division / **Royal Scientific Society.**
19- Dr. Eshaq Shishani, The executive director of scientific affairs / **Royal Scientific Society.**
20- Dr. Othman Al-mashaqbeh, Water engineering expert / **Research Team**