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Management of Household Water Tanks in Irbid Governorate of Jordan

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Abstract

Household water tanks are a common method of collecting water from municipal source supply and are the primary means of meeting daily needs. These tanks are frequently installed to endure a long time, and the water is stored permanently without any monitoring of water quality or even cleaning and maintenance.

This study aims to investigate the management of household water tanks in Jordan. A questionnaire was distributed to 116 householders to assess their management of water tanks and the applied practice using the statistical package program (SPSS), as well as descriptive and statistical analyses.

The result of the survey showed that 67.2% of households utilize plastic tanks, while 32.8% use galvanized (iron) tanks. Approximately 50% of people don't clean their tanks and there is a strong correlation (-0.859) between storage cleaning and the presence of impurities inside the tank. About 93.1% of people use water for domestic purposes (cooking, showering, irrigation, etc..) and only <1% use it for drinking after membrane filtration. About 7.8% of the householders reported being affected by a specific disease/sickness because of water quality and 11.2% believe that water quality is poor from the source. It is recommended to enhance public awareness for better management of water storage and best practices for protecting water from various causes of contamination, as well as taking the necessary actions to guarantee high-quality drinking water.

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1 Introduction

Water is widely recognized as a crucial natural resource that significantly impacts human life, offering unparalleled applications across various fields. Its value extends to pivotal sectors such as agriculture, industry, tourism, and services. Recognizing the escalating water demands resulting from population growth, agricultural needs for food security, industrial development, and urbanization, alike are taking proactive measures to ensure the availability of this precious resource. Water plays a pivotal role in progress and development, making it imperative to prioritize its sustainability and accessibility.

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Jordan is one of the most water-scarce regions in the world and is highly vulnerable to extreme droughts and rainfall variability (Al-Kilani et al. 2025; 2024) and is considered the second most water-stressed nation in the world. The available renewable water resources in Jordan are less than 100 m3 per capita, much below the water scarcity level (500 m3/c.y) (UNICEF, 2022, Al-Kharabsheha and Al-Zboon, 2021). Moreover, Jordan's rapid economic development, coupled with a significant population growth rate, has led to a sharp increase in water demand. Unfortunately, this increase comes at a time when the country's available water resources are both limited and diminishing (Alzboon & AlAnanzeh, 2008).

Water storage tanks are commonly utilized in rural regions and areas where the supply of municipal water is intermittent. The primary goal of home storage tanks is to maintain a continuous and reliable water source. Except for Amman and Aqaba, other cities and communities receive water on a weekly or bimonthly basis. Many people have expressed concern over this, as it affects their daily lives in a variety of ways. Water supply to a certain community is strongly dependent on the availability of water resources and the type of investment in the area. In the event of a sudden drop in water supply owing to any reason, the water authority provides priority to Amman, the capital of Jordan, followed by the other communities. So that Amman residents do not suffer from a lack of water while people in the villages and rural areas suffer from limited water supply.

Water tanks are typically utilized in areas where water is limited or scarce. Water must be treated before storage in tanks, and the tank must be disinfected regularly to maintain its purity. Public health considerations necessitate maintaining water quality at the highest level possible, as lengthy storage of water can cause changes in its quality due to chemical and physical processes occurring in the tank. Alzboon et. al., (2024), found that 12.6% of the households reported complaints because of poor water quality, and some of them went to the hospital as a result. Despite the householders' reports of water pollutants, color, and taste in the tanks, the majority of them rely on visual assessment of the water quality rather than physical sampling. Thus, it is critical to maintain safe water quality when using home water storage (Slavik et al., 2020). However, to ensure the safety and quality of water for consumers, a monitoring process is necessary, and any pollutants that may represent a health concern must be removed (Slavik et al., 2020). Das et. al., (2024), investigated the impact of the tank's material on the temperature of water and they found that the temperature of water in the plastic tanks followed the ambient temperature and rosed more quickly than water in concrete tanks, while water in the concrete tanks cooled down more quickly than water in the plastic tanks. Hima et al., 2024, investigated the change in water quality in different types of storage materials and they found that water can be stored in plastic containers, clay pots, steel containers, and cement concrete for 25, 5, 20 and 15 days respectively make the plastic containers as the best option for water storage.

Managing a household water tank can be challenging, and poor management can lead to a deterioration of water quality. Water tanks may contain various pathogens that can cause a variety of diseases, and if not properly managed, can lead to the spread of infectious diseases. Bacteria growth in contaminated residential water tanks can cause waterborne illnesses, thereby increasing the risk of spreading these infections (Manga et al., 2021).

Ogbozige and Badiru (2018), studied the impact of storage period on water quality inside different types of container materials. The findings showed that the optimum retention period for clean water in different container materials was around 21 days, except for clay-pot containers, which should not last more than 6 days. However, due to poor water quality, it was not recommended to utilize non-coated steel tanks. In comparison to coated steel containers, clay pots, galvanized iron, and colored plastic containers, the study found that black plastic containers were the best at preserving the quality of the water while it was being stored.

Similarly, Evison and Sunna (2001), investigated the regrowth characteristics of bacteria in various types of domestic storage tanks in Amman, Jordan. They found that the number of heterotrophic bacteria increased from log 1.7 up to log 5.2 after four days and to log 5.7 CFU/mL after seven days. The most dominant species of microbial regrowth were Moraxella, Pseudomonas, and Actinomycete. The type of household tank has no significant impact on the overall bacterial number in stored water, however, temperature is the most important factor determining microbial regrowth in the tanks. Measures like secondary chlorination in residential tanks and yearly tank cleaning have been suggested to prevent the public health risk of drinking stored water.

Chalchisa et al. (2017), evaluated the water quality inside the storage tanks in Ethiopia, the results showed that the collected water samples from the storage tanks were contaminated with total coliforms and fecal coliforms, and the drinking water was biologically contaminated in all sites. It was claimed that the elevated temperature in the storage tanks (about 23.1°C) was a contributing factor to the increased number of fecal coliforms. The study demonstrated that storing water can have a major impact on quality in different ways.

Radaideh et al. 2009, investigated water quality in rainwater storage in four governorates in Jordan (Irbid, Zarqa, Ajloun, and Jerash). Ninety water samples were collected and analyzed for physiochemical and biological indicators. Additionally, 120 questionnaires were distributed to the homeowners, including questions regarding the location, type, and capacity of their water tanks. The results of the water sample analysis indicated that the water was unsuitable for drinking but may be used for irrigation purposes.

The purpose of this study is to assess the management of household water storage through the analysis of a distributed questionnaire. The study's findings will assist households in better managing water storage, reducing health risks associated with poor water quality, and providing a comprehensive picture of current practices, weaknesses, and strengths points.

2 Materials and Methods

2.1 The Study Area

Irbid governorate is located in the northern part of Jordan **Figure 1**. The governorate covers a total area of 1572 km² and is located at 32° 33' 20" N, 35° 51' 0" E. Irbid climate is similar to the Mediterranean, with dry, hot summers and rainy cold winters. During the summer season, temperatures reach about 35 °C and drop to around 5 °C or less in winter. The average rainfall in Irbid is about 488 mm, concentrated in the western to southwestern highlands of Irbid and 158 mm in the eastern vicinity close to Al-Mafraq Governorate (AL Azzam & L Kuisi, 2021).
In the spring, green grass sprouts and flowers flourish, especially in valleys and plains. In 2017, the population of Irbid Governorate reached about 1,867,000, making it the second-largest Jordanian governorate in terms of population density behind Amman, Jordan's capital. The governorate is also divided into nine provinces or districts, namely, AL- Kasbah, AL-Ramtha, AL-Kora, Bani Kinanh, Bani Obaid, the Northern Jordan Valleys, the Northern Mazar, AL-Wastiyah and AL-Taibe (DOS, 2017). The most well-known water sources in Irbid are the Yarmouk River, Al-Wahda Dam, and Wadi Al-Arab Dam (Al-Karablieh and Salman, 2016).

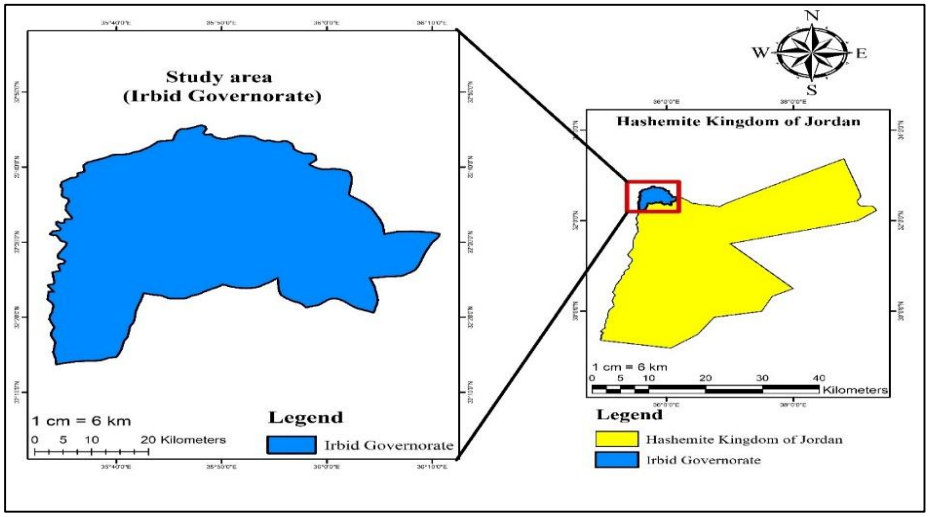

Fig. 1. The location of Irbid Governorate

2.2. Data collection:

A survey was conducted in Irbid Governorate to assess the management of the household water tanks using a predesigned questionnaire. The questionnaire has three sections and was distributed to 116 householders. Yes, /No questions and multiple-choice questions are the most common types of questions.

2.3.Questionnaire structure:

The first section of the questionnaire focuses on the characteristics of household water tanks, such as: the tank's capacity, tank's location, tank's material, tank's age, and tank's location. The second part discussed the practices of water usage and the applied measures for cleaning and conservation. The third section addressed the assessment of water quality inside the tanks, health risks, complaints, and

observations about water qualityaddressed the assessment of water quality inside the tanks, health risks, complaints, and observations about water quality.

2.4. Statistical Analysis Methods

Following the distribution of the questionnaire and field survey, the data was analyzed by encoding it using Excel software, which was then analyzed using statistical analysis software (SPSS) version 26. The data was analyzed into percentages, frequencies, and correlation coefficients

3 Results and Discussion

3.1. Characteristics of the household tanks

This section focuses on the characteristics of the tanks, which were assessed through nine questions in the questionnaire. These questions regarding the age of the tank, the tank material, capacity, location, the presence of a cover, the number of tanks in the household, and water sources. The statistical analysis of these questions was conducted, and the findings are presented below.

3.1.1. Material of Tank

In general, there are several types of household tanks available. However, in Jordan, plastic and galvanized iron tanks are the two most common types. Among these, plastic tanks are the most used. Approximately 67.2% of the surveyed tanks were made of plastic, and 32.8% were made of galvanized iron.

It was reported that plastic tanks have better-preserved water quality during storage compared to steel metal tanks (coated or galvanized). In the case of galvanized iron tanks, the water may exhibit discoloration due to rust formation caused by the reaction between high concentrations of iron and the oxygen present in the water. This phenomenon can also lead to an increase in the total solids present in the water (Ogbozige et al., 2018).

3.1.2. Tank Age

In terms of tank age, **Table 1** illustrates that the highest proportion (47.4%) falls within the range of 10 to 4 years old, while only 7% of tanks are older than 20 years.

The age of a tank can have a significant impact on water quality. Older tanks are more susceptible to material deterioration caused by exposure to sunlight, heat, and erosion. This deterioration can lead to water leakage, which increases the risk of contamination from various sources such as air pollutants, debris on the roof, and bird droppings. Consequently, it is crucial to give careful attention and promote awareness regarding the maintenance of older tanks to ensure water quality and reduce potential health risks.

Table 1: Age of the tanks used.

Tank Age, y	Frequency	Percentage, %
0-3	52	21.14
10-Apr	117	47.56
20-Nov	62	25.2
>20	15	6.1
Sum	246 tanks in 110 houses.	

3.1.3. Tank Capacity

The tank's capacity is a key element for meeting people's daily needs depending on water availability, particularly in hot and dry conditions. Approximately 61.2% of tanks have a capacity of 2m3, 25.0% have a capacity of 1m3, and 13.8% have a capacity of less than 0.5m3. Tanks with a larger capacity have the advantage of providing water for a longer period; nevertheless, a longer storage period may result in a deterioration of water quality. The extended storage of water in tanks raises the risk of microbial growth, sediment accumulation, and potential contamination. As a result, regardless of tank capacity, proper water quality procedures, such as frequent tank cleaning and disinfection, must be implemented.

3.1.4. Tanks Count

Analysis of the questionnaire results revealed that most of the householders use two or three tanks (43.5%), with only 8.6% using more than three tanks **Figure 2**. The number and capacity of tanks used are governed by water consumption patterns, family size, and the frequency with which the water authority supplies water. If the authority only supplies water at particular times, it is important to have a large enough tank system to ensure an adequate water supply that can meet the household's needs throughout the week.

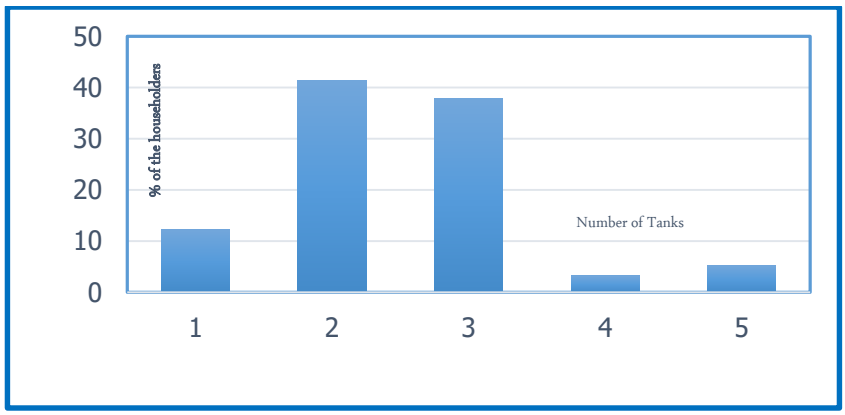

Fig. 2. Number of tanks used

3.1.5. Tank Location

The majority of people (95.7%) placed their house tanks on their roofs, but a small percentage (4.3%) placed tanks in their backyard for agricultural use, in addition to having a rooftop tank. Placing tanks on the rooftop has several advantages: firstly, it provides the necessary water pressure for various uses without the use of pumps, secondly, it offers a practical utilization of space, as rooftops are typically unused areas that can be effectively utilized for tank placement. Overall, rooftop tanks are a convenient and space-saving solution for water storage and distribution in residences.

3.1.6. Impact of the Residential Location

Analysis of questionnaire findings and householder responses revealed that residential location significantly impacts water supply frequency. For example, in some rural locations, water is only supplied once a week, whereas in cities, water is pumped three times or more. However, the average water supply in the study area was twice per week. Several factors influence how frequently water is delivered to the area, including the efficiency of water networks, the availability of water resources, the significance of investment in the area, and the cost of power.

3.1.7. The Tank Cover

The presence of a cover for water tanks is critical because it acts as a barrier against potential contamination. Without a cover, water is more likely to be exposed to contamination such as sand during dusty weather conditions, as well as access by animals, birds, and air pollutants. These sources can introduce biological contaminants that are harmful to human health. Therefore, it is crucial to cover the tanks to avoid the accumulation of impurities and pollutants within.

According to the field study, all householders had covers on their water tanks, however, 12% of the covers were left open owing to wind or other factors. However, only 35% of them utilized a lock to secure the tank cover. To protect the integrity of the water supply and reduce the possibility of contamination, owners should use both a cover and a lock to secure the tank cover. This increases protection against external pollutants and unauthorized entry, enhancing the safety and purity of stored water.

3.2. Water Practices and Uses

This section of the questionnaire is designed to know how people handle their household water tanks, including how they are committed to cleaning and disinfection of tanks.

3.2.1. Tank Cleaning and Water Uses

Only 0.9% of households reported using tank water for drinking purposes. This is because most of the householders are dissatisfied with the water quality from the source. In contrast, the majority uses water for a variety of other purposes, including cooking, washing, and irrigation. When it comes to cooking, it is worth noting that water is often purified using membrane filtering.

In terms of tank cleaning practices, 25% of the households reported performing a cleaning process once a year, while 26% cleaned their tanks twice a year. On the other hand, 49% of respondents claimed that they did not use any tank cleaning methods.

Tank cleaning improves water quality and prevents pollution. Tank cleaning practices are determined by public awareness, education level, and purpose of water use. People who are concerned about tank cleanliness, often rely on expert cleaning and disinfection services. It was found that a significant negative correlation (R2=0.86) between impurities observed and tank cleaning.

According to Schafer and Mihelcic (2012), tanks that receive more than twice-yearly cleanings have reduced turbidity in comparison to those that do not receive cleanings. Likewise, tanks that receive a lot of cleaning time have lower E.coli counts. As a result, there is a need for continuous community awareness programs about the importance of storage tank maintenance and cleaning.

In terms of tank disinfection, just 17.3% of householders disinfect their water tanks, with 8.5% doing so once and 7.8% twice a year. Chlorine and hypochlorite are the most utilized tank disinfectants.

3.2.2. Householders' Opinion About Water Quality

The questionnaire's last component measured participants' impressions of water quality in their tanks, as well as their level of satisfaction. Approximately 6.03% rated the water quality as excellent, 21.55% as very good, 41.36% as good, 19.83% as acceptable, and 11.21% as poor. Despite these scores, the majority of owners (65%) stated that water quality is variable and susceptible to contamination sources, resulting in a lack of confidence in its overall quality. This poor attitude may be due to previous occurrences of pollution and insufficient management in the water sector. These findings emphasize the necessity of addressing water quality concerns, fostering transparency, and implementing effective water management measures to restore public trust and provide a consistent and safe water supply.

3.2.3. Color and taste

About 30% of tank owners reported having taste and color concerns with their water. The presence of color and taste in the water is most likely due to internal corrosion, particularly in iron tanks. Furthermore, 27% of owners reported noticing the odor of chlorine in their water. This can be ascribed to the high chlorine concentration in the sources.

It is important to address these issues to ensure that the water provided from the tanks has no undesirable taste, color, or odor. Proper maintenance and treatment protocols should be implemented to mitigate such concerns and give users a satisfactory water experience.

3.3. Human health

Regarding the impact of water quality on human health, only 7.8% reported being affected by a specific disease/sickness owing to water quality, whereas 92.2% reported not becoming ill as a result of water quality. The most commonly reported symptoms are stomach pain (88% of cases), vomiting (44%), and fatigue (22%). The reported illnesses could be ascribed to a variety of causes, including water contamination, tank cleanliness, and poor personal hygiene practices. It is critical to address these issues to maintain effective water quality management and avoid potential health hazards related to water quality.

3.4. The Best Practices

The initial step in water management is a routine inspection to look for signs of leakage, damage, corrosion, or fracture in the tank's material. Every year, the tank should be cleaned and disinfected. Cleaning entails vacuuming the walls and floors as well as removing any internal scaling, dirt, and debris. Water quality samples should be taken from the tank and examined for hardness, pH, chlorine concentration, and bacterial growth. In the event of biological contamination, immediate response is required. Although each tank should have adequate ventilation to prevent the growth of bacteria and algae, excessive airflow and dirty vents can harm water quality. Insulation of the tank with suitable material can reduce the effect of ambient temperature, and reduce the risk of freezing, and heat loss. Maintaining the tank's water level is important since low water levels can damage the pumps and valves, while high water levels cause overflow and waste. A qualified team with experience in this field should plan and carry out periodic maintenance. Tank material, repair, cleaning, fittings replacement, tank cover, pipes, and power supply are all examples of maintenance. The maintenance crew ought to be certified and outfitted with the appropriate PPE.
The field survey's findings demonstrated that Jordan's water tank management does not adhere to worldwide best practices; typically, there is no routine tank maintenance, no periodic water monitoring, and no cleaning or disinfection procedures.

Conclusions

In rural areas and places with intermittent municipal water supplies, water storage tanks are frequently used. This paper aims to investigate the management of water tanks in Irbid governorate. The field survey includes the distribution of a questionnaire to the local community. The questionnaire consists of questions about the tank, water management, owners' opinions, and water quality indicators. It was found that only a few people clean and disinfect their tanks regularly. Most tanks were made of plastic (67.2%), and 32.8% were made of galvanized iron.
The results of the questionnaire analysis showed that the majority of householders use water tanks for cooking, showering, and irrigation, while less than 1% use it for drinking. Most owners (65%) thought that water quality is variable and susceptible to contamination sources, so it is critical to determine why and work to improve people's satisfaction. Poor management of water inside the tank highlights the importance of cleaning and maintenance. The study's findings highlight the importance of enhancing public awareness about water quality, cleaning tanks, regular disinfecting, and protecting tanks from contaminants.

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