



Faculty of Graduate Studies

Master Program in Water and Environmental Engineering

MSc. Thesis

**Developing a model for estimating the water rights of Palestinian
refugees in the West Bank and Gaza strip camps**

Submitted By

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This Thesis was submitted in partial fulfillment of the requirements for the Master's Degree in Water and Environmental Engineering from the Faculty of Graduate Studies at Birzeit University, Palestine.

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The findings, interpretations and the conclusions expressed in this study do not necessarily express the views of Birzeit University, the views of the individual members of the MSc. Committee or the views of their respective employers

Date of Defense: 03-02-2022

Dedication

I dedicate this thesis to my amazing parents, who always encouraged me to succeed,

To my lovely sisters and dear brothers,

To my supervisor, family, friends, and to everyone, who gave me a hand,

I wish a better future for all,

I dedicate my work

Acknowledgment

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List of Abbreviations

ARIJ	Applied Research Institute of Jerusalem
AWC	Actual Water Consumption
CSCE	Conference on Security and Cooperation in Europe
DWC	Deserved Water Consumption
IDPs	Internally displaced persons
IHRL	International Human Rights Law
JWC	Joint Water Committee
MCM	Million Cubic Meters
MOPIC	Ministry Of Planning and International Cooperation
OAU	Organization of African Unity
OHCHR	Office of the High Commissioner for Human Rights
OPT	Occupied Palestine Territory
PCBS	Palestinian Central Bureau of Statistics
PWA	Palestinian Water Authority
UFW	Unaccounted For Water
UNHCR	United Nations High Commissioner for Refugees
UNPO	Unrepresented Nations and Peoples Organization
UNRWA	United Nations Relief and Works Agency for Palestine Refugees in the Near East
WB and GS	West Bank and Gaza Strip
WEF	World Economic Forum
WRAP	Water Research Action Program
WHO	World Health Organization

Abstract

Occupied Palestine (OP) is a clear example of the relationship between political conflict and environmental degradation. The Israeli occupation has contributed to the negative impact on the status of the environment in OP through various factors:

- Israeli military control and confiscation of Palestinian lands to implement the policy of colonialism.
- Control on natural and water resources and exploiting them for the benefit of the Israeli side.

Despite the depletion of Palestinian water resources because of arbitrary Israeli measures, many natural and mandatory factors have influenced the required quantities of water, including variations in rainfall from year to year, huge development in agricultural and industrial fields, excessive water consumption by Israelis, increasing the population growth rate in occupied Palestine territories, and population growth in the number of Palestinian refugees in the host countries.

The water crisis is one of the most important challenges facing the Palestinians, which confirms the need to search for ways to restore the refugees' water rights and to demand compensation for the losses incurred by the Israeli occupation in the water and environmental sector. This can be considered the only option for the Palestinian political leadership to solve the problem of water scarcity and develop water infrastructure in the occupied Palestinian territories.

This research focuses on the water status of Palestinian refugees in the West Bank and Gaza Strip camps, since it is the most critical category in Palestine. It presents a study on Palestinian refugee water consumption (actual and deserved) from the Arab-Israeli conflict in 1948 to the present, based on the mathematical equation to estimate the quantities of water consumed by refugees in camps.

The research shows that the total quantities of domestic water that are entitled to be consumed by Palestinian refugees in the camps, and which must be claimed through negotiations with Israeli side through international courts, are approximately 447,345,438 m³. While the second part of the research presents a questionnaire to measure the opinions of policymakers and experts on the issue of recovering the refugees' water rights.

الخلاصة

فلسطين المحتلة هي مثال واضح للعلاقة بين الصراع السياسي والتدهور البيئي، حيث ساهم الاحتلال الإسرائيلي في التأثير السلبي على حالة البيئة في فلسطين المحتلة من خلال عوامل مختلفة:

- السيطرة على الأراضي الفلسطينية ومصادرتها؛ لتنفيذ سياسة الاستعمار.
- السيطرة على الموارد الطبيعية والمائية واستغلالها لصالح الجانب الإسرائيلي.

على الرغم من استنزاف موارد المياه الفلسطينية نتيجة الإجراءات الإسرائيلية التعسفية، فقد أثرت العديد من العوامل الطبيعية والإلزامية على كميات المياه المطلوبة، بما في ذلك التغيرات في هطول الأمطار من سنة إلى أخرى، والتطور الهائل في المجالات الزراعية والصناعية، والاستهلاك المفرط للمياه من قبل الإسرائيليين، وزيادة معدل النمو السكاني في فلسطين المحتلة، والنمو السكاني في عدد اللاجئين الفلسطينيين في الدول المضيفة.

أزمة المياه من أهم التحديات التي تواجه الدولة الفلسطينية، مما يؤكد ضرورة البحث عن سبل لإعادة الحقوق المائية للاجئين والمطالبة بالتعويض عن الخسائر التي تكبدها الاحتلال الإسرائيلي في قطاع المياه والبيئة. يمكن اعتبار هذا الخيار الوحيد للقيادة السياسية الفلسطينية لحل مشكلة ندرة المياه وتطوير البنية التحتية للمياه في الأراضي الفلسطينية المحتلة.

يركّز هذا البحث على الوضع المائي للاجئين الفلسطينيين في مخيمات الضفة الغربية وقطاع غزة، باعتبارها الفئة الحرجة في المجتمع الفلسطيني. يُقدّم هذا البحث دراسة حول الاستهلاك المائي للاجئين الفلسطينيين (الفعلي والمستحق) منذ بداية الصراع العربي الإسرائيلي عام 1948 وحتى الوقت الحاضر، بناءً على النموذج الرياضي المستخدم لتقدير كميات المياه التي يستهلكها اللاجئون في المخيمات.

يظهر البحث أن إجمالي كميات المياه المنزلية التي يحق للاجئين الفلسطينيين استهلاكها في المخيمات، والتي يجب المطالبة بها من خلال المفاوضات مع الجانب الإسرائيلي عبر المحاكم الدولية، حوالي 438,447,345 م³، ويقدم الجزء الثاني من البحث استبانة لقياس آراء صنّاع القرار وخبراء في موضوع استرداد الحقوق المائية للاجئين.

Chapter One

Introduction

1.1 General Background

Millions of people in various parts of the world forcibly migrate from their countries, because of political conflicts, wars, famines, dangerous diseases that lead to death and other tragic circumstances. These are the so-called refugees according to UNHCR, United Nations High Commissioner for Refugees ([UNHCR, 2011](#)).

Palestinian refugees are defined as “persons who lost their homes and livelihoods between June 1, 1946 and May 15, 1948 and beyond, as a result of the 1948 Arab Israeli conflict” ([Saleh, 2019](#)). Palestinian refugees fall, into three categories: First category represents the Palestinians who were expelled from their lands and homes because of the 1948 war. Second represents those who were displaced for the first time because of the 1967 war. Moreover, the last category represents the Palestinians who reside outside their original homes in Palestine and cannot return due to the persecution practiced against them ([Khalil, 2009](#)). More than 1.5 million Palestinian refugees live in 58 official camps in the host countries, distributed over Lebanon, Syria, Jordan, the Gaza Strip and the West Bank, including East Jerusalem ([UNRWA, 2020](#)).

The Palestinian refugees have suffered many disturbances and persecutions, which prevent them from their most basic rights. Therefore, the United Nations relief and work agency for Palestine refugees in the near east (UNRWA), on behalf of the international community, protects them from violence and enforced persecution, providing necessities for the life and safety of refugees, providing food security and responding to the emergency call, and health care, including their natural right to access water to ensure the survival and health of the Palestinian refugee ([Shrestha, 2006](#)). In this thesis, the focus will be on how to restore the Palestinian refugees’ water right in enough quantities as per world health organization (WHO) standards.

Before the Palestinian-Israeli conflict, Palestine was characterized by a rare position in terms of hydrology, rich in groundwater resources, as the northern half is characterized by the western, eastern and northeastern basins, while the southern is characterized by the coastal basin. In addition to the surface resources represented by the Jordan River, the Sea of Galilee, and many seasonal valleys and water springs in Palestine, which

helped the Palestinians to maintain the permanence of their survival, the increase in environmental and natural diversity.

Since the occupation of the West Bank and Gaza Strip, Israel has begun to control the water resources crossing the Palestinian borders, including the mountainous aquifer basins and the Jordan River. It issued a number of military orders indicating the transfer of full authority over the shared resources of the Israeli army and prohibited the Palestinians from undertaking water infrastructure projects without the approval of the Israeli occupation (PWA, 2013).

Today, the Israeli occupation controls surface and groundwater resources, which continue to drain for the benefit of Israel as a whole, in contrast to the provisions of customary international water law that all transboundary and shared water resources must be shared in a fair and acceptable manner. However, since 1967 it became clear to what extent the water supply to Palestine has decreased, while the balance of water supply and its consumption for Israel has been very high. Whereas, the Palestinian Water Authority (PWA) estimated that Israel exploits more than 90% of the shared freshwater resources, while restricting the amount of water used by the Palestinians to less than 10% of these resources (PWA, 2013).

Israeli restrictions limit Palestinian domestic water consumption to 70 l/c/d (PWA, 2009). This is less than the minimum recommended by the WHO of 100 l/c/d and well below the average of 300 l/c/d that Israelis consume (World Bank, 2009).

Water is a fundamental issue at the heart of the Arab-Israeli conflict, for its effective role in preserving the resilience and sustainability of countries. However, the Palestinian issue is a particularly concerning one and alternative solutions must be explored to obtain water in the quantity and quality required according to WHO.

1.2 Statement of the Problem

The Arab-Israeli conflict caused an influx of large numbers of refugees to neighboring host countries, as the total number of Palestinian refugees registered with the UNRWA in the world at the end of 2018 reached nearly 6 million Palestinian refugees at least. In particular, the percentage of Palestinian refugees in the West Bank reached 17% of the total Palestinian refugees, while the percentage of Palestinian refugees in Gaza strip is equal to 25% (PCBS, 2018).

This human mass flow (refugees) had a negative impact on the environment in general. Because of the increase in the population, there was an increase in the demand for water, an increase in the production of wastewater that must be treated or disposed of. On the other hand, Israel's domination of water resources and the transfer of management authority to them, depriving Palestinians of the right to dispose of the water resources that feed their lands and prevents them from developing infrastructure and designing water distribution networks and treatment networks. In addition to the Israeli water policies that limited the daily Palestinian consumption.

Refugees, water, borders and settlements are concerns that Palestinians face in general, and alternative solutions must be considered to recover their stolen rights as stipulated in the Universal Declaration of Human Rights in Article 25: "Everyone has the right to a standard of living adequate for the health and well-being of himself and his family" ([Universal Declaration of Human Rights, 1948](#)). The right to water was recognized and became an international priority when the Economic and Social Council (ECOSOC) adopted, in late 2002, that "the human right to drinking water is fundamental to life and health".

1.3 Aim and Objectives

The main goal of this research is to develop a mathematical formula to estimate the Palestinian refugees' water rights in camps in the West Bank and Gaza Strip, by calculating the quantities of water consumed by the Palestinian refugees from 1948 to the present day. In order to reach a scientific conclusion and truth to claim the refugees' water rights based on international agreements and laws. The specific objectives are:

1. To study the international laws and national strategies on refugee water rights.
2. To study the environmental impacts of refugees on host countries.
3. To study the differences between the quantities of water currently supplied to the Palestinians and the quantities imposed.
4. To study and analyze the views of policymakers and experts on reclaiming the refugees' water rights.

1.4 Research Questions

Some of the questions that this research aim to answer are:

1. What are the environmental impacts of refugees on host countries?

2. What are the differences between the quantities of water currently supplied to the Palestinians and the quantities imposed?
3. Have the refugees water rights been recognized by international laws?
4. What are the views of policymakers and experts on reclaiming the refugees' water rights?

1.5 Research Outline

This thesis is composed of six chapters. Chapter (1) "Introduction" describes the contents and the structure of this research, including research objectives research questions ...etc. Chapter (2) "Study Area" describes the nature of the West Bank and Gaza strip, with a brief about water and wastewater services. Chapter (3) "Literature Review" this chapter introduces the definition of the Palestinian refugees and their impacts on their host countries. In addition, the water status in the West Bank and Gaza strip is presented. Finally, the laws and strategies in water rights for Palestinian refugees is discussed. Chapter (4) "Approach and Methodology" this chapter presents the method followed in this research including the development of the questionnaire used in this study. The results and discussion are presented in Chapter 5. Excel program was used for data and statistical analysis. Chapter (6) introduces the "Conclusions & Recommendations" based on the result obtained.

Chapter Two

The Study Area: West Bank and Gaza Strip

2.1 Physical Characteristics

2.1.1 Location and Population

The major political events in historical Palestine were the 1948 conflict, which forced the foundation of the State of Israel on Palestinian territory, and the 1967 Six-Day War, which culminated in Israeli sovereignty and occupation of Palestinian areas. Palestine was divided into two geographical blocs under the current situation: the West Bank and the Gaza Strip (UNEP, 2003).

The West Bank covers 5,660 km² (PCBS, 2017), extending from 31° 30' N to 32° 30' N and from 35° E to 35° 30' E (Siam, 2013). It is bounded on the east by the Jordan River and on the north, west, and south by the 1948 cease-fire line, as shown in the figure below. The West Bank consists of 19 official camps distributed over governorates of Jericho, Ramallah, Bethlehem, Hebron, Jerusalem, Nablus, Tulkarm, Jenin and Tubas (Issac, 2007). According to recent statistics, the Palestinian registered refugee population in the West Bank at the end year 2019 is equal to 858,758 person (PCBS, 2021).

The second part of the case study in this research is Gaza Strip, which is surrounded on the west by the Mediterranean Sea, on the south by the Arab Republic of Egypt, and on the north and east by the 1948 cease-fire line, i.e. what is known as Israel (Wafa, 2021), has a total area of 365 km² (PCBS, 2017). North Gaza, Gaza, Deir al-Balah, Khanyounis, and Rafah are the five governorates that compose the Gaza Strip and contain eight official camps distributed over these governorates. According to the most recent statistics, the Palestinian registered refugee population in Gaza Strip at the end year 2019 is equal to 1,460,315 person (PCBS, 2021).

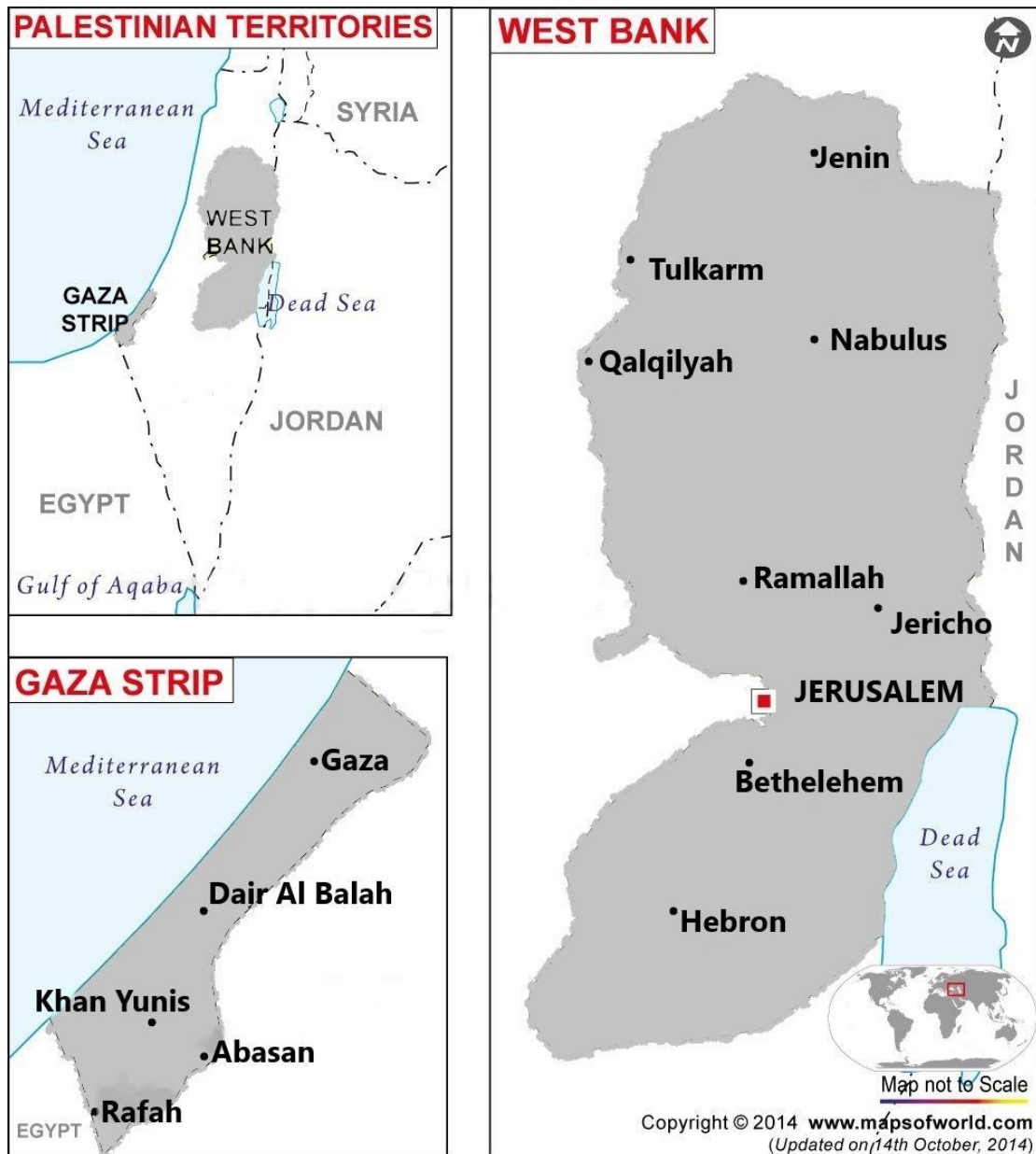


Figure 1: West Bank and Gaza Strip in the Current Regional Context

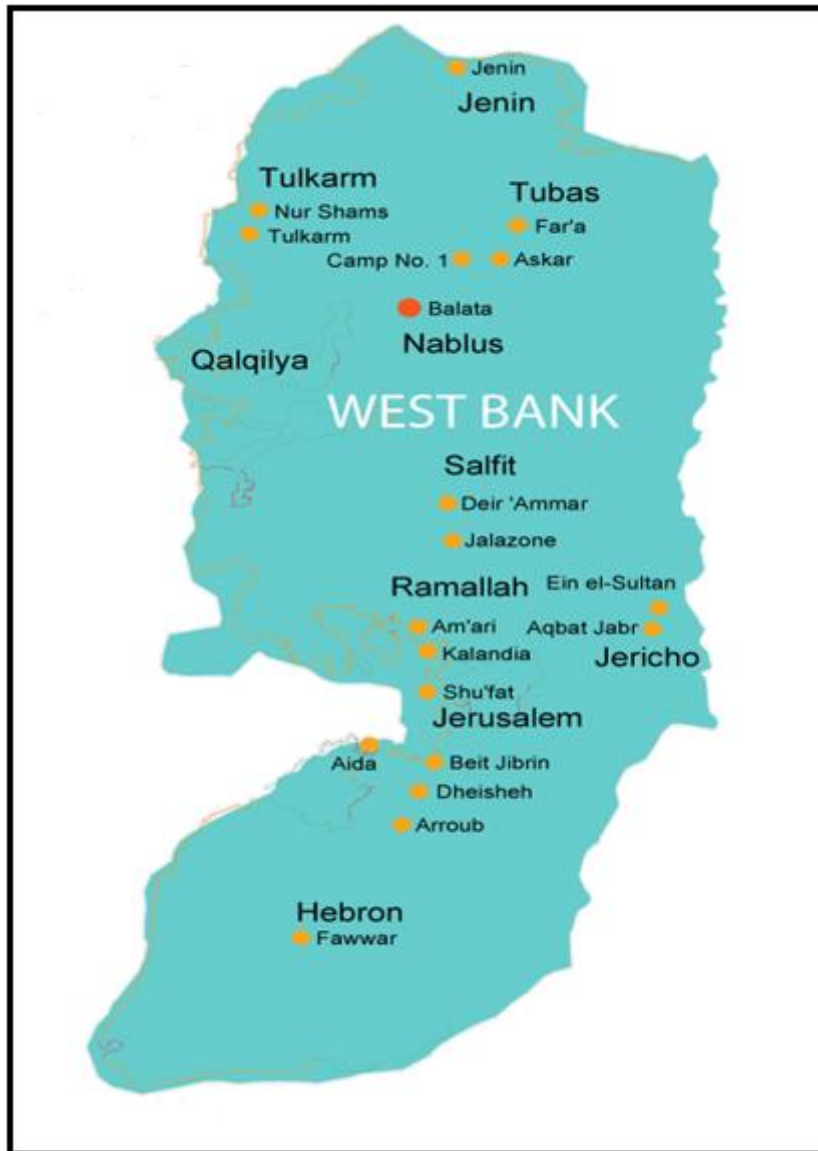


Figure 2: Official Camps in West Bank

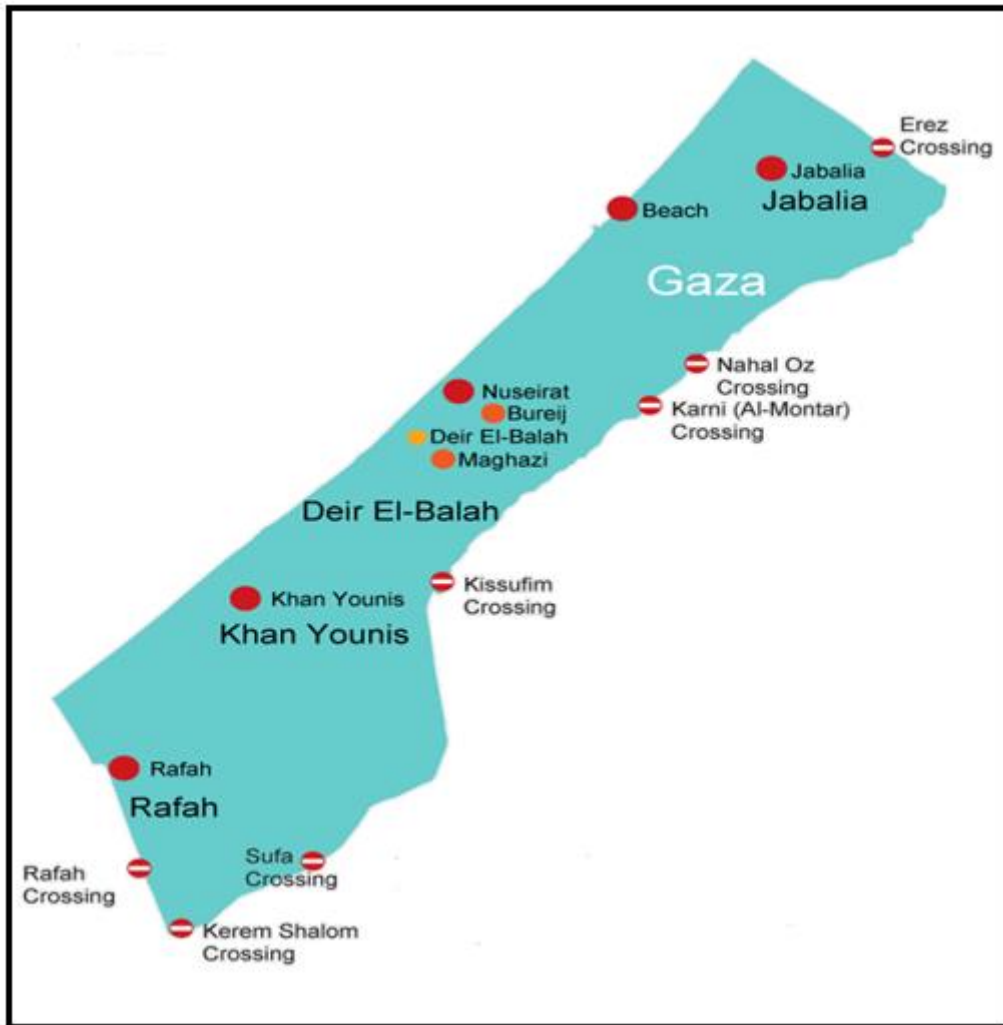


Figure 3: Official Camps in Gaza Strip

2.1.2 Topography

Despite its limited area, Occupied Palestine has a diversified terrain that affects climate, ecosystems, and biodiversity, as well as a variety of agricultural patterns ranging from rainfed agriculture in the highlands to irrigated agriculture in the Jordan Valley (Issac, 2007).

Based on geomorphology, the West Bank is divided into four regions: the central highlands, the semi-coastal region, the eastern slopes and the Jordan Valley. The central highlands region is considered a recreation area, where most of the population lives, and it nourishes the aquifers (UNEP, 2020). The height of the hills in the West Bank ranges between 700-900 meters, noting that the lowest point in the West Bank is the Dead Sea 410 m below sea level and the highest point is Tal Asur 1,022 m above sea level. Tal Asur is surrounded by the Palestinian villages of Silwad, Al- Taybeh, Kofr-

Malik Al-Mazraa' Al-Sharqia and the Israeli settlement of Ofra (UNEP, 2003). Most of the hills consist of limestone, there is fertile soil in the plains, and the soil cover is thin (UNEP, 2020).

As for the Gaza Strip, it is a coastal plain from the western side, while from the northern side; the sector is characterized by the presence of four hills, with altitudes ranging from 20 to 90 meters above sea level, the coastal hills series, the Mintar mountain range, the Gaza hills series and the Beit Hanoun mountain range (Issac, 2007).

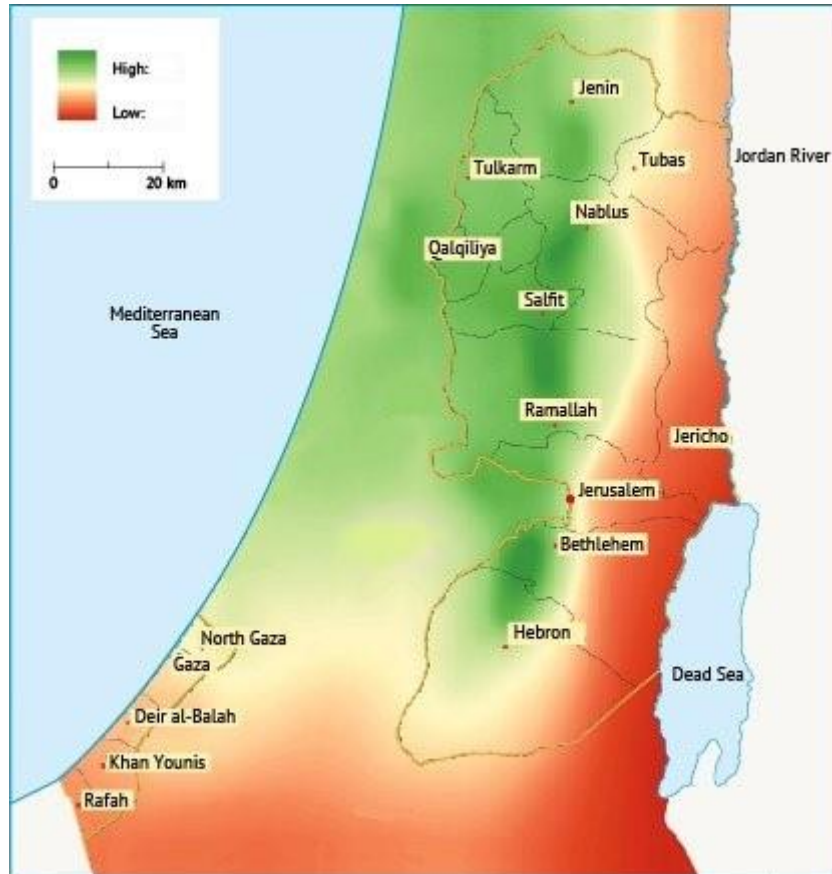


Figure 4: West Bank and Gaza Strip Topography Map

2.1.3 Climate

OP is characterized by the diversity of its climate due to its unique geographical location, between 31°13' and 32°33' latitude, and between 34°13' and 35°34' longitude (Issac, 2007). Which divided it into five climatic zones: the Jordan Valley, which suffers from saline soil, the eastern slopes, the central highlands whose altitude ranges between 400-1000 meters above sea level, the semi-coastal region, and the coastal plain of Gaza (FAO, 2008; ICRC, 2021).

2.1.3.1 Rainfall

The average annual rainfall varies according to the geographical and spatial location of each region in occupied Palestine. The average rainfall in the West Bank ranges from 700 mm/year in the northern part to 80 mm/year in the southern part. In the Gaza Strip, the coastal climate prevails, with rainfall ranging between 200-400 mm/year (ICRC, 2021).

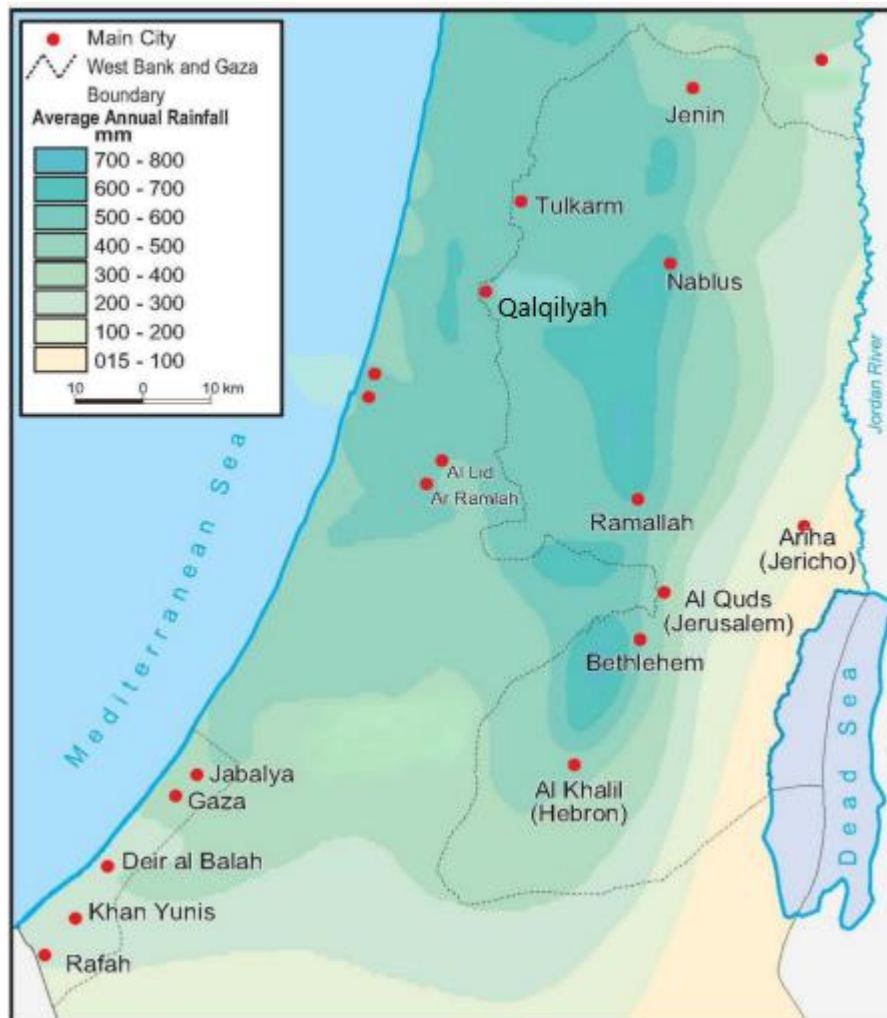


Figure 5: Average Annual Rainfall in West Bank and Gaza Strip.

2.1.3.2 Temperature

Temperatures differ depending on location, height, and exposure to marine effects (Issac, 2007). In general, the West Bank is characterized by relatively high temperatures. The average summer temperature in the West Bank is between 20.8°C and 30°C. While the average temperature in the winter ranges from 8.7°C to 14.7°C. As for the Gaza Strip is influenced by the Sinai Peninsula's arid desert environment as well as the moderate

and semi-humid Mediterranean climate. As a result, from summer to winter, the average temperature swings between 25 and 13 degrees Celsius (ARIJ, 2015).

2.1.3.3 Precipitation

The winter rainy season begins between October and May. Rain and snowfall are concentrated on the mountainous heights. The West Bank receives roughly 535 mm of yearly rainfall, whereas Gaza receives nearly 359 mm (ARIJ, 2015; MoA, 2013).

2.1.3.4 Evaporation

Because of the intense sun radiation, the West Bank has a high rate of evaporation and a low level of humidity. The Jordan Valley and the Dead Sea have the highest rates of evaporation, which are estimated to be around 2600-2100 mm. Due to constant exposure to moist sea breezes, the rate of evaporation lowers in coastal plain areas. Because of the high relative humidity, evaporation is lowest in the Gaza Strip than anywhere else in the Palestinian territory (Issac, 2007).

2.1.4 Land Use

Israel practices systematic policies to seize Palestinian land on the one hand, and impose restrictions on the Palestinians to prevent them from accessing their land and exercising their right to use it. One of the policies followed is the classification of land in the West Bank into three areas “A”, “B” and “C”, which define different levels of control (Issac, 2007).

In Areas “A” and “B”, the Palestinians have limited control over the land and its resources, but they have no control in Area “C”, which constitutes 60% of the occupied Palestinian land and is completely under Israeli control (Judeh, 2017).

Despite all the Israeli obstacles in the Occupied Palestinian Territories, The West Bank and the Gaza Strip, with their lands and diversity, constitute a mosaic, as the nature of land uses varies between build up areas, agricultural areas of different types, permanent, seasonal, rainfed and irrigated, in addition to that part of the land is designated for industrial uses.

Land uses in the West Bank were determined and divided into nine groups in varying proportions based on an analysis conducted by the Applied Research Institute - Jerusalem (ARIJ). As shown in Figure 6: agricultural land (37.98%), forestland (1.38%), shrubs and herbs (4.94%), Open spaces (31.85%), Palestinian artificial surfaces (6.24%), Israeli artifacts (4.15%), inland waters (0.02). %), the wall area

(0.21%) and finally the pastures (13.23%). In addition, as it is clear from the percentages that agricultural lands occupied the highest percentage of land uses in the West Bank (Isacc, 2011).

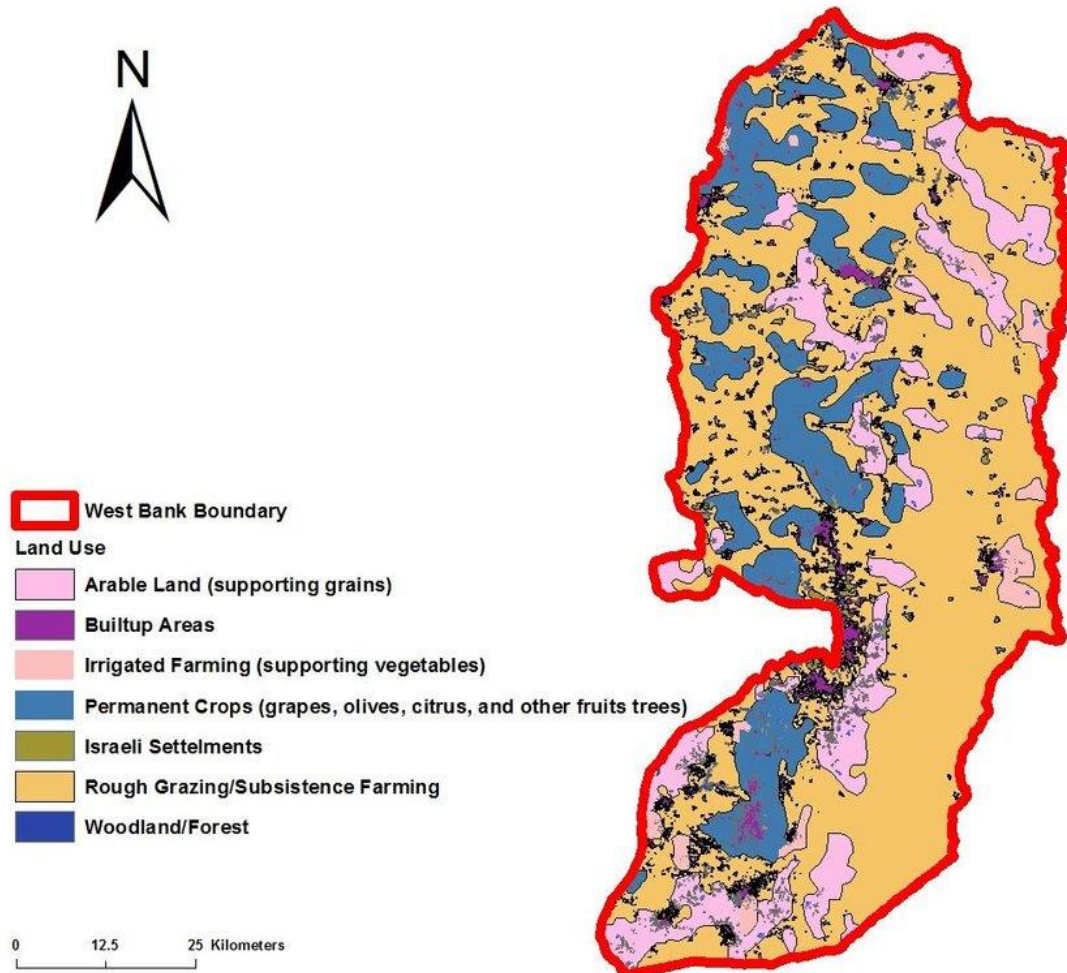


Figure 6: Distribution of Land use in West Bank

According to the Figure 7, buildings and roads encompass roughly 45% of the Gaza Strip, while agricultural land accounts for 42%. The access-restricted area near the border is home to the majority of bare land 12% (UN-Habitat, 2014).

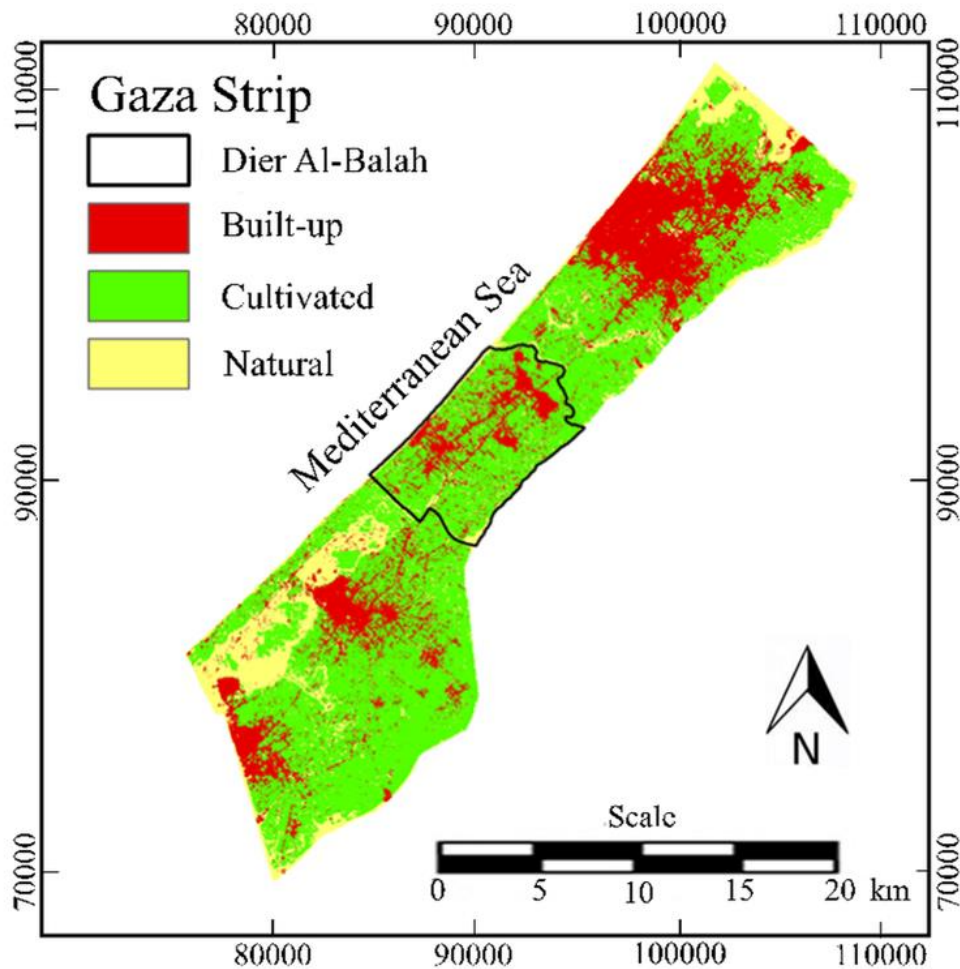


Figure 7: Distribution of Land use in Gaza Strip.

2.2 Environmental Challenges

2.2.1 Water Resources

2.2.1.1 Introduction

Water security in Palestine is worrying. In the aftermath of the 1967 war, Israel took control of all the water resources available in the OPT, restricted the use of water by Palestinians, and developed all wells in the OPT. In addition to the water supply network that was connected to the previously established Mekorot network that secures the transfer of water from its current sources to demand centers for agricultural, industrial and municipal customers. In addition to it, mainly and illegally serve the settlements, the amount of water supplied by Mekorot is estimated at 75 million cubic meter (MCM), and it is produced from Israeli-controlled wells in the West Bank (World Bank, 2009).

The political situation in Palestine in general, made the water problem a major issue. Not only did Israel control the water resources in the OPT, but it also canceled the water rights of the Palestinians, such as their right to the waters of the Jordan River, in addition to their displacement from their lands and homes in the 1948 war and in the 1967 war. Moreover, there is an unfair distribution of water between Palestinians and Israelis, as the quantity of water obtained by the Israeli is six times the quantity obtained by the Palestinian (Nazer, 2009; 2010).

In short, the OPT suffers from water scarcity for mostly political reasons, in addition to the method of disposal of water used in the West Bank and Gaza strip with negative returns. Where wastewater is disposed of in valleys without any kind of treatment and this negatively affects the water quality, which reduces the quantities of good water available (Nazer, 2009; 2010). Based on the Palestinian water situation, there is an urgent need to negotiate with Israel regarding Palestinian water rights (Issac, 2007).

After the Palestinian people have obtained all their lost water rights here and there, they can think of other solutions such as using unconventional sources, such as desalination of seawater, wastewater treatment and reuse, and rainwater harvesting in order to meet the increasing demand for water that will be the result of population growth (Issac, 2007).

2.2.1.2 Water Resources in West Bank and Gaza Strip

The main water resources available in Palestinian territories (WB and GS) including Jerusalem East include rainwater, surface water resources, and groundwater resources (PWA, 2012; Judeh, 2017). Rainwater is a volatile water resource, which varies from place to place and from time to time, as the annual average rainfall was 450 mm/year in the West Bank, while the annual average rainfall in the Gaza strip was 327 mm/year (Judeh, 2017).

Israel and neighboring countries share all surface and groundwater resources in occupied Palestine (Attili, 2021). Following the 1967 occupation, Israel gained control of all shared water resources, both surface and groundwater, and consumes over 85% of them, leaving only 15% for Palestinian usage (PWA, 2013).

The surface water in the OPT is represented by several seasonal valleys, in addition to the Jordan River, which is the only water source that can be used as a surface water resource; unfortunately, it is currently controlled and used exclusively by the Israelis (PWA, 2013). Therefore, groundwater can be considered as the main source of water

supply for Palestinians, as there are four aquifers located partially or completely in the West Bank and Gaza Strip (Attili, 2021; PWA, 2013). Note that, The Coastal Aquifer is Gaza's only source of freshwater.

- Surface Water

Surface water resources in Palestine OPT are extremely limited, as there are few surface water resources in the West Bank and none left in the Gaza Strip, as the existing valleys have dried up due to Israel's excessive exploitation (PWA, 2013b).

The main surface water resources in the West Bank are the Jordan River, the valleys that drain into the Mediterranean Sea, the Dead Sea, and the Jordan Valley. The Jordan River is the only permanent source of surface water in Palestine, extending from north to south to drain into the Dead Sea. Historically, the quantities of water flowing into the Jordan River and draining into the Dead Sea were at least 1400 million cubic meters (MCM)/year, and these quantities continued to decline gradually until they became no more than 30 MCM/year (PWA, 2013). This decline is due to many reasons, the most important of which is Israel's diversion of water through the Mekorot network to serve the settlements, the construction of dams on the tributaries of the river, in addition to environmental influences and factors, however. Israel had the biggest role in reaching this situation and depriving the Palestinians and other riparian countries of the Jordan River of benefiting from this water resource. The water security in the Jordan River is also threatened due to the discharge of untreated wastewater from settlements on it (Judeh, 2017). In the current situation, Palestinian access to the waters of the Jordan River is prevented due to the imposed Israeli rules and regulations that are under the total control of the Israelis (Nazer, 2008; WRAP, 1994; MOPIC, 1998; ARIJ, 1998).



Figure 8: Current Utilization of Jordan River Water

Although the quantity of surface water in the valleys varies from year to year, it is an essential supply of water. The average annual flow of floodwater through the valleys of the West Bank is about 165 MCM/yr. In general, the valleys of the West Bank are classified according to the direction of flow into eastern valleys (toward the Jordan Valley and the Dead Sea) and western valleys (toward the Mediterranean) (PWA, 2013b).

In the Gaza Strip, valleys arise east of the border where Israel prevents the natural flow of these valleys, which leads to their drying up. The average annual flow of floodwater through Wadi Gaza is about 20 MCM/yr (PWA, 2013b).

- Ground Water

According to the Israeli obstacles imposed on surface water resources, which deprived the Palestinians of their right to water, the groundwater resources represented by the mountain aquifer, wells and springs are the main sources of water that serves the Palestinians in the West Bank and Gaza strip. It provides more than 90% of the fresh water supplies needed by the Palestinians (Judeh, 2017; PWA, 2013).

The water flows in the mountain aquifer basin in three main directions in the West Bank, and accordingly it can be divided into three basins for the drainage of groundwater, the western, northeastern and eastern basins. Water is shared in the western and northeastern basins with Israel, while the eastern basin falls entirely within West Bank (Nazer, 2008; Judeh, 2017; Hassan, 2010). Geologically, these basins are similar in their rocky nature and consist mainly of limestone and karst, which distinguishes them with a high storage capacity (Hassan, 2010).

In Gaza, the coastal Aquifer is the only source of groundwater; its average recharge is estimated at up to 450 MCM/yr in Israel and 55-60 MCM/yr in Gaza (Attili, 2021; PWA, 2014). Sand, sandstone, and pebbles make up the coastal aquifer. The aquifer is shallow, with water table depths ranging from 70 meters in high mountainous areas to less than 5 meters along the coast. The aquifer is porous and very permeable. Near the seashore, the aquifer thickness might reach 160 meters (Jayyousi, 2009).

The annual recharge rate that flows into each of these three west bank basins is a thorny and controversial topic, and the reason for this is due to the different rates of rainfall each year, and the amount of water infiltrating the ground. The researcher Fisher and Huber Lee (2005) estimated that the annual average recharge for all three west bank aquifers ranges between 590 and 690 MCM/yr (Hassan, 2010), while another study by the researcher (Judeh, 2017) estimated that the annual recharge rate The conservation of all three west bank aquifers ranges between 578 and 814 MCM/yr. As for the water expert, Dr. Shaddad Attili, indicated that the annual recharge rate ranges from 679-734 MCM/yr. Meanwhile, the annual recharge rate that flows into the Gaza coastal aquifer was estimated at 69 MCM/yr (PWA, 2013). According to the Ministry of Planning and International Cooperation (MOPIC, 1996), recharge percentages in sandy regions may exceed 60%, whereas recharge percentages in clay areas range from 15% to 40% (Jayyousi, 2009).

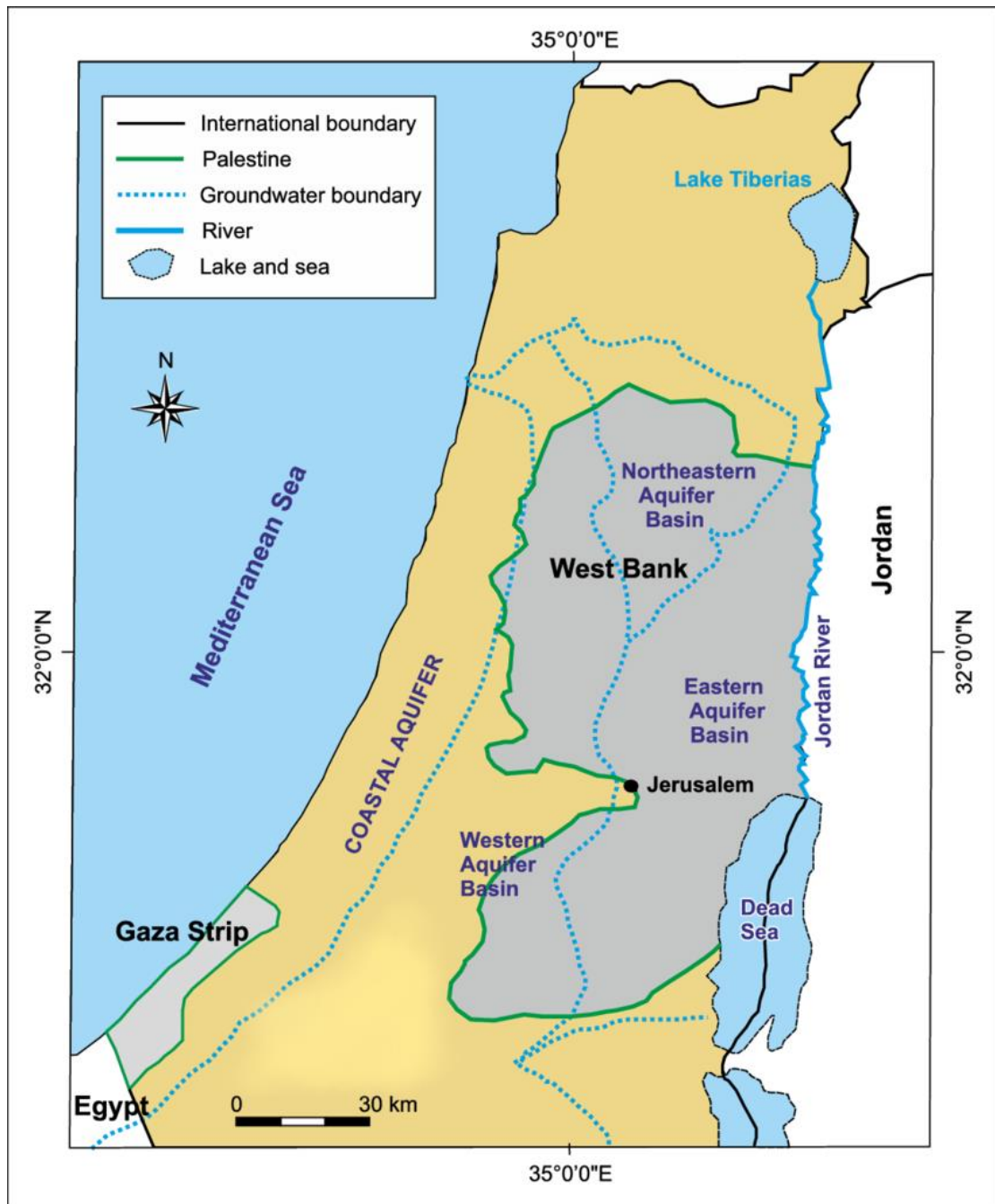


Figure 9: Mountain Aquifer

The recharge estimate for the ground water aquifers in the west bank and Gaza is shown in Table 1 (PWA, 2013).

Table 1: Recharge Estimate for the ground water aquifer at years 2011/2012 (PWA, 2013).

Aquifer – Basin	Area Within West Bank (Km²)	Average rainfall 2011/2012 (mm)	Recharge Volume 2011/2012 (MCM)	Long- term Average Recharge (MCM)
Western Aquifer	1,767	581	359	318-430
North – eastern Aquifer	981	517	152	135-187
Eastern Aquifer	2,896	483	210	125-197
West Bank Total	5,644	519	721	578-814
Gaza Coastal Aquifer	365	372	64	55-60
Palestine Total	6,009		785	633-874

2.2.1.3 Water Quality in West Bank and Gaza Strip

Degradation of water quality in OPT is a major environmental concern and a barrier to achieving sustainable development goals such as improving access to clean drinking water (Attili, 2021). Water quality is threatened not only by sewage leakage, but also by a lack of proper management of solid waste and solid waste sites, excessive use of chemical fertilizers, and a lack of a system for regulating and controlling the environment, all of which have harmed water quality (Jaradat, 2016).

In the West Bank, the water quality is regarded to be acceptable, although the situation is deteriorating due to uncontrolled sewage discharge into rural areas and Jewish settlements. Noting that the West Bank's water and sanitation infrastructure is in poor condition, with just 41% of Palestinians connected to a sewage network, while the others depend on sewage tanks, cesspits, and pit latrines, and that the percentage of those connected varies depending on where they reside (refugee camp, city, and a rural region) (Attili, 2021).

According to PWA studies, most Jordan Valley wells have a high chloride content of more than 250 mg/L despite having a low nitrate concentration (PWA, 2014).

As mentioned earlier, groundwater is the main source of water consumption in Gaza, and therefore the excessive pumping of water from the coastal basin has led to the influx of saline water due to seawater intrusion and lateral flow from Israel. As a result, the water quality is well below the accepted international guidelines for potable water resources (Attili, 2021).

Gaza suffers from many problems caused by sewage, as the levels of salinity in groundwater are much higher than the recommendations of the World Health Organization (WHO), which is 250 mg /L. It is also characterized by high levels of nitrate and chloride in the water, which results in less than 5% of the water that comply with the prevailing drinking water standards (PWA, 2013).

2.2.2 Wastewater Infrastructure in West Bank and Gaza Strip

The occupied Palestinian territories (West Bank and Gaza Strip) are considered the most water-poor, because of natural and political pressures. Currently, due to the increase in the population of the Palestinians along with the issue of refugees and forced displacement, the gap between water supply and water needs is increasing, meaning that the demand for water has exceeded the limit of supply. Therefore, it was considered that treated sewage water could help reduce the gap of the increasing water needs, even in part, for the purposes of industry and agriculture (Samhan, 2010).

Sewage networks are limited to the main cities in the West Bank and Gaza Strip. According to a PWA survey, conventional sewage networks served roughly 46% of the total population of the occupied Palestinian State (31 percent of the West Bank population and 72 percent of the population in the Gaza Strip) (PWA, 2013b).

Despite this, the efficiency of the available sewage networks is low, especially those that were built in the seventies, as they suffer from leakage, and are characterized by small diameter pipes that contrast with the quantity of input from wastewater, which leads to clogging and frequent floods. Therefore, it is necessary to work on developing the existing systems and improving the treatment process to reach water with acceptable characteristics purposes (Isaac, 2007).

As for the Palestinian refugee camps, UNRWA has built sewage networks in most of the West Bank camps, such as: Jenin camp, Askar, Balata, Dheisheh and others, while the camps of Jericho Governorate (Ain al-Sultan and Aqabat Jaber) are still not served by sanitation services. Whereas, all camps in the Gaza Strip are served by sewage

networks. In general, 85% of the Palestinian refugee camps were provided with sewage network services ([PWA, 2013b](#)).

Chapter Three

Literature Review

3.1 Refugees around the World

The refugee issue is one of the most important long-term issues of concern to the whole world, given the great importance that refugees occupy and their influence on the host countries. Many specialized institutions consider the refugee issue a supreme goal and are looking at opportunities for refugees to obtain a decent standard of living. However, who are the refugees?

The institutions differed in trying to define the concept of refugees, and despite the differences, the main goal revolves around providing assistance, facilitating their lives and protecting them.

The United Nations High Commissioner for Refugees (UNHCR) described a ‘**refugee**’ as anyone who: “Owing to well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion, is outside the country of his nationality and is unable or, owing to such fear, unwilling to avail himself of the protection of that country; or who, not having a nationality and being outside the country of his former habitual residence as a result of such event, is unable or, owing to such fear, is unwilling to return to it ”. This approach only covers people who fear persecution, and in general, it does not spare a large number of those in need of help who suffer from poverty, natural disasters and wars. Therefore, it is necessary to look at the concept of refugee from another point of view. The Organization of African Unity 1969 Convention (OAU) described a refugee as “every person who, owing to external aggression, occupation, foreign domination or events seriously disturbing public order in either part of the whole of his country of origin or nationality, is compelled to leave his place of habitual residence in order to seek refuge in another place outside his country of origin or nationality” (Lister, 2012).

Millions of people migrate because of wars, conflicts, natural disasters, violence and persecution. The United Nations High Commissioner for Refugees (UNHCR) estimates that the number of migrants is approximately 80 million around the world by mid-2020, 26.3 million refugees, and 45.7 million internally displaced persons (IDPs) who have all the characteristics of a refugee but have not crossed international borders, 4.2 million

asylum seekers who suffer from Persecution and rights violations. In addition, 3.6 million Venezuelan refugees ([UNHCR, 2021](#)).

Developing countries host 86% of the world's refugees and internally displaced persons. The countries hosting the greatest number of refugees globally are Turkey, Colombia, Pakistan, Uganda and Germany. Which is host 39% of the world's refugees and IDPs ([UNHCR, 2021](#)). Refugee constitute a heavy burden on the host country, as this population jump affects the infrastructure and environment, economic, social, and political of the host. Therefore, refugees compete with local citizens for available scarce resources such as water, food, housing, and health services. This overpopulation caused by refugees leads to an increase in the demand for infrastructure services, water supply and sanitation, and for natural resources ([Barman, 2020](#)). Thus creating a state of stress between the population increase and the scarcity of available resources.

This increase in refugee numbers has created great interest at the global and local levels. As a result, UNHCR has established almost massive relief programs and campaigns to meet the needs of refugees. This is in addition to the effort made by the local hosts (host countries). But at the time, the study of the effects of population growth in the host countries was marginalized, that is, the impact of this situation on the host countries in many ways such as the environment, the economy, politics, participation in available resources, infrastructure, development resources, in addition to the security situation in general. This sudden increase in the population caused by the presence of refugees led to a radical and major conflict in all areas of life in the host countries. As this issue raises increasing concern from the international community and host governments. Which indicated the need for scientific research on the impact of refugees on the host countries and the search for strategies that link the means between refugee relief and sustainable development in the host countries. This was confirmed at the Second International Conference on Assistance to Refugees in Africa (ICARA II) in 1984 ([Whitaker, 1999](#)). However, the host countries must create a state of balance in order to maintain their security and general stability as a country, and to protect their refugees ([Atim, 2013](#)).

As we live in a time that showed the highest rate of refugees worldwide, The World Economic Forum (WEF) highlighted water crises in its Global Risks Report 2016 as one of the most important issues of global concern ([WEF, 2016](#)). Which emphasizes the need to understand the reasons behind this, and to see the possible links between

refugees and water scarcity. This is so that we can develop policies that address the causes of the current refugee situation (Jägerskog, 2016). This increase in refugees is putting pressure on both the host community and its scarce natural resources.

The environmental impact of refugees should be seen as a process that depends on many factors, the most important of which are: the length of time during which refugees have been displaced, the size of the refugee population, the ratio of the refugee population to the original population, and the adequacy and appropriateness of international assistance provided to refugees, local populations and host governments. In general, the environmental impact of refugees' studies changes in land, water, soil, roads, green areas, and other resources available in the host country. Often this study has a negative outcome, because this huge influx in the number of refugees reduces the area of green land to build their own housing, which in turn negatively affects the soil, reduces groundwater recharge, and depletes surface water sources because of increased demand and pollution at another time. All of which is considered a dangerous deterioration of the ecosystem in the host country, which is severe in the early stages of the arrival of refugee flows (Jacobsen, 1997).

Due to the importance of the Refugees issue, there are a good number of previous studies that concern and study the issue of refugees and their impact on the host countries in the world. The results of some studies suggest negativity, while others indicate the positive impact that the refugee creates on the host community, and another part results in a mixture of pros and cons that the refugee affects in the host country.

Hadi (2019) referred to the effects created by the Syrian crisis in Lebanon and the consequent hosting of huge numbers of Syrian refugees.

The researcher focused on the principle of comparing the water situation in Lebanon before and after the Syrian crisis and studying the sample community by analyzing the spatial variation for different domestic, industrial and agricultural water uses. The research results indicated that there is a 20% increase in water demand because of the Syrian refugee crisis.

Hadi insisted that the issue of water stress is very important at the level of the Middle East in particular and at the level of the world as a whole, and therefore recommended a number of approaches to reduce water stress in Lebanon.

[Taleb \(2020\)](#) studied the water situation in the countries of the arid regions, Jordan in particular, and the results of the increasing population census due to the refugees. He pointed out that Jordan was classified as the third poorest water resource in the world based on the scarcity of available water resources. Hence, the necessity of establishing water resource projects such as dams, rainwater harvesting, and desalination of saline water. GIS has been adopted as an improved tool for spatial analysis in order to create projects to be implemented.

To solve the water crisis in Jordan and to move towards providing sustainable water resources to meet the growing population in all. A number of projects has been implemented, taking into account the environmental and economic conditions, including ([Taleb, 2020](#)):

1. Red Sea-Dead Sea Canal Project: It will be connected in the Gulf of Aqaba, and water will be produced using the energy of the height difference between the Dead Sea and the Red Sea.
2. Disi Water Conveyance Project: This project aims to generate groundwater in the Disi aquifer that has been confined for a long time. It is a regional aquifer between Jordan and Saudi Arabia
3. Water Desalination and Nuclear Plant Project: The energy produced in the nuclear plant will be used to desalinate sea water in the Gulf of Aqaba
4. Rainwater Harvesting Projects: a project that has been implemented for a long time, but its results are low. However, there is still a long way to go for a sustainable management of water resources in Jordan, which is considered one of the most important refugee-hosting countries despite its water scarcity.

On the other hand, the World Development Report ([World Bank, 2010](#)) emphasized the strong links between refugee flows and their long-term presence linked to environmental impacts on sustainable development resources such as land, water, and natural resources. It was pointed out that an environmental impact assessment study was conducted in Sudan and Kenya to link refugee flows and environmental impacts, stressing that these environmental impacts are closely related to the place of residence of refugees in the host countries, so-called refugee camps and settlements. Environmental impacts include deforestation, water depletion Groundwater pollution, surface water pollution, air pollution resulting from fuel wood and the degradation of

land and infrastructure of the host country. Hence, the matter can be resolved with the importance of this issue and moving towards a sustainable solution. The refugee issue is an ongoing issue, the war continues, violence and forced displacement still exist, displacement, and all that requires asylum, or it can be shortened and said, all the causes of refuge are still strong.

3.2 Palestinian Refugees

Palestine is distinguished by its strategic geographical location, its natural diversity, its historical and archaeological nature, which made it an inspiration for the great powers, and the focus of the attention of the competing countries. From here began the story of the Arab conflict. Beginning with the British Mandate, which facilitated the arrival of the Israeli delegation to the Palestinian land, then the Israelis' control over parts of the Palestinian land with the 1948 war, then the 1967 war, and other violations and uprisings carried out against the Palestinians. Therefore, it is difficult to resolve the issue of the conflict Arab-Israeli in the long-term without addressing the issue of Palestinian refugees, and finding a just solution to this issue.

A Palestinian refugee according to UNRWA is every person who was residing in Palestine during the period from June 1, 1946 to May 15, 1948, and who lost his home and his right to live in his homeland because of the 1948 Arab-Israeli war. Later, the concept of the Palestinian refugee expanded to include, in addition to those who were expelled from their true neighbors because of the 1948 war. Those who were displaced from their homes because of the 1967 war, and those who were expelled from their homes from Palestine and cannot return to it because of persecution and the ills they are exposed to. Each of them has the right to register with the United Nations Relief and Works Agency for Palestine Refugees to guarantee all their human rights (UNRWA, 2007).

The Palestinian refugee issue is one of the most important and complex issues, as it is a historical issue for the Palestinian society. The Palestinian refugee segment is the second highest numerically compared to the segments of refugees from other countries such as Syrian and Iraqi refugees and others (Ogg, 2020). According to the Palestinian Central Bureau of Statistics (PCBS), the percentage of the refugee population in the State of Palestine reached 42.2% of the total Palestinian population residing in the State of Palestine in 2017. 26.3% of the population in the West Bank

are refugees, while the percentage of refugees in the Gaza Strip is 66.1% (PCBS, 2020).

The Palestinian society is the society that suffers the most from the obliteration of identity, the deprivation of freedom and the deprivation of nationality on the world level (Shiblak, 2006; Khalil, 2009). In 1948, more than 800,000 Palestinians were displaced from their villages and cities, out of the 1.4 million Palestinians who resided in historic Palestine. Most of them were displaced to a number of neighboring Arab countries such as Jordan, Lebanon, Syria, in addition to the West Bank and Gaza Strip. Year after year, the number of Palestinian refugees is increasing. Consequently, at December 2019, the number of Palestinian refugees worldwide reached about 6.3 million (PCBS, 2020). Note that two third of the refugees reside in the 58 refugee camps, 27 of them are in Palestine (Rempel, 2000). While the other part of the refugees reside in urban areas and surrounding areas.

Table 2: Number of Registered Palestinian Refugees by Country, End Year 2019 (PCBS, 2021).

Country	عدد المخيمات Number of Camps	أشخاص مسجلون آخرون* Other Registered Persons *	اللاجئون المسجلون Registered Refugees	المجموع Total	الدولة
Total	58	663,561	5,629,829	6,293,390	المجموع
Jordan	10	147,251	2,272,411	2,419,662	الأردن
Lebanon	12	62,659	476,033	538,692	لبنان
Syria	9	84,831	562,312	647,143	سوريا
Palestine	27	368,820	2,319,073	2,687,893	فلسطين
West Bank	19	207,014	858,758	1,065,772	الضفة الغربية
Gaza Strip	8	161,806	1,460,315	1,622,121	قطاع غزة

* : Other Registered Persons include those eligible to receive services.

*: أشخاص مسجلون آخرون يشملون أولئك المؤهلين لتلقي الخدمات.

At the beginning of the Arab-Israeli conflict and its negative consequences for the Palestinians in particular, the world took an interest in this issue as a temporary issue, so it embraced the refugees, provided them with living services, and contributed to the realization of part of their rights. However, the environmental aspect left by the conflict was very little or not taken into account at the time, so the Palestinian environment was the first victim of this conflict. On the other hand, this conflict negatively affected the environment of the country hosting the refugees.

During this period and afterwards, the occupation authorities focused on creating an adequate standard of living for the Israeli army and settlers, by imposing a systematic and arbitrary policy against Palestinian citizens, not only expelling a large part of them from their lands and homes, but placing restrictions on those steadfast Palestinians on their lands, by controlling the Palestinian natural resources, such as controlling the natural water resources, by calculating the bulk of the water for the benefit of the settlers to an unfair and unacceptable extent. It also limited the Palestinians' use of water resources, preventing them from digging new wells, or pumping from existing wells in a number of areas. It imposed an unfair regime on the Palestinians to obtain their water rights in exchange for sums of money to be paid to them.

On the other hand, the policies of the occupation affected the Palestinian lands, through the implementation of the Israeli Separation Plans and the construction of the racist separation wall, in order to seize the largest possible amount of Palestinian lands. It also worked to close part of the Palestinian territories for military purposes. And not only that, but it also worked to create a visual distortion of the landscape in Palestine, which hindered the management of solid waste, ignored the discharge of sewage into the valleys, which led to the deterioration of biodiversity, and restricted the construction of purification and treatment plants, which helped in the depletion and use of available water resources. For all human purposes, industry and agriculture, it affected the water quality, and accordingly the long years of the Israeli occupation turned vast areas of Palestinian land into deserts ([Isaac, 2011](#)).

As mentioned previously, following the catastrophe of the 1948 war, hundreds of thousands of Palestinians were forced to seek refuge in the camps scattered in the cities of the West Bank and Gaza Strip in Palestine, in Lebanon, Syria, Jordan and Egypt. These Palestinian families initially migrated to tents and then expanded to camps where they built houses ([Al- Khatib, 2003](#)).

UNRWA manages these camps, and camp lands are provided by the host countries, which are responsible for providing infrastructure services such as sewage disposal, providing roads serving the camp, providing them with water and electricity, education, health, providing job opportunities for refugees in order to reduce Unemployment and other necessities of life ([Chen, 2009](#)). On the other hand, all this

is another additional burden on the host countries. It is necessary to work to draw attention to this issue and to find effective solutions for the two parties (host country and refugees) that guarantee each of them their rights.

3.2.1 Palestinian Refugees in Syria

One of the countries hosting Palestinian refugees, which has a history that supports the Palestinian cause, is Syria. It was not satisfied with Palestinian refugees only, but was a host for Jordanian refugees as a result of the September war, and for Lebanese refugees as a result of the Israeli conflict on Lebanon in 1978 (Valentine, 2011).

In 1947, Syria hosted 70,000 Palestinian refugees, because of the continuation of the Arab-Israeli conflict (Valentine, 2011), and generation after generation, the number of Palestinian refugees registered with UNRWA at the end of 2019 nearly about 562,312 (BADIL Recourse Center, 2018).

About 27% of the Palestinian refugees reside in the Syrian camps, as there are fourteen camps, ten of which are officially recognized and managed by UNRWA. The Syrian government encouraged the hosting of Palestinian refugees through the establishment of the General Authority for Palestinian Refugees (JABAR), which manages the camps together with UNRWA by providing basic services to the refugees.

Despite the efforts made by the Syrian government in providing basic services to Palestinian refugees, there is a shortage and weakness in the water supply, sewage systems may be very old or unavailable, and the streets are unpaved. Unlike other host countries, it can be said that The Syrian community is one of the best host communities for Palestinian refugees based on the services provided to them and their equal rights to the Syrian citizen after the Syrian government signed the Casablanca Protocol to the League of Arab States in 1965 (Al- Mawed, 1999). This is another indication of the need to draw attention to the issue of refugees and their water rights that must be restored to ensure a decent life and livelihood for them in whatever land they are.

3.2.2 Palestinian Refugees in Lebanon

The presence of Palestinians in Lebanon dates back to the Arab-Israeli conflict in 1948, when about 100,000-130,000 Palestinians were forced to seek refuge in

Lebanon (Valentine, 2011; BADIL Recourse Center, 2018) as a result of oppression, torture and displacement practiced by the occupier against the Palestinians. These arbitrary measures did not stop at the time, but they continued to arbitrarily over many years and still are. At the end of 2019, the number of Palestinian refugees registered with UNRWA was about 562,312 (BADIL Resource Center, 2018).

At the end of 2018, the number of official Lebanese camps reached 16, in which about 270,614 Palestinian refugees reside, in addition to 6 unofficial Lebanese camps that are not recognized by UNRWA, comprising about 22,685 (BADIL Resource Center, 2018). However, UNRWA provides all educational, health and social services to both registered and unregistered refugees living in these gatherings (Shafie, 2006).

Many studies, the most important of which is the researcher's (Shafie, 2006), indicated that there is no major infrastructure in the areas of Palestinian refugee gathering, as it lacks natural resources, a water supply network and sewage lines, a transportation network and paved roads, the lands on As they have been since 1948, they are not allowed to be developed. Residential buildings are in violation of public safety requirements. In short, Palestinian refugees in Lebanon suffer from difficult life, social and economic conditions. As indicated by the United Nations High Commissioner for Refugees in 2016, Palestine refugees in Lebanon have been marginalized and excluded from the main aspects of social, political and economic life for many years, with no right to access any services other than those provided by UNRWA (UNHCR, 2016).

According to the researcher (Suleiman, 2006), Lebanon is the most cruel and deprived host country towards Palestinian refugees. It practices violence and marginalization policies against them.

3.2.3 Palestinian Refugees in Jordan

Because of the Arab-Israeli wars of 1948 and 1967, hundreds of thousands of Palestinians fled to Jordan, due to its geographical and political location that is important to Palestine. In 1952, the number of Palestinian refugees reached about 470,000, then it increased until the number of Palestinian refugees registered with UNRWA in 2019 reached about 2,272,411 (BADIL Resource Center, 2018).

To accommodate this huge influx of Palestinian refugees in Jordan in a humane manner, 10 official camps were established as temporary housing for refugees, in

addition to three unofficial camps. At the end of 2018, the number of Palestinian refugees residing in Jordanian camps amounted to about 442,143. They depend mainly on the services provided by UNRWA (Alnsour, 2014). As for the refugees who reside outside the Jordanian camps, they are treated like a Jordanian citizen (Valentine, 2011).

Jordan is a safe host country for those fleeing political and humanitarian crises. The Syrian political crisis created a new crisis in Jordan, as it was not satisfied with hosting Palestinian refugees only and providing them with services. Rather, it was a refuge for those Syrians (Farishta, 2014). Since 2011, Jordan has absorbed at least 600,000 Syrian refugees (UNHCR, 2013).

UNRWA provides the basic services to Palestinian refugees and the UNHCR for non-Palestinian refugees, in cooperation with the Jordanian government. However, it must be noted that Jordan is a country that suffers from a scarcity of available resources, and the depletion of these resources due to the massive influx of refugees raises the concern of the Jordanian government, which prompted it to reduce the services provided to refugees, and to focus only on the humanitarian sector (BADIL Resource Center, 2018). Accordingly, the situation of refugees in Jordan is difficult and needs to be studied and evaluated. To find sustainable development solutions, it is clear that the refugee issue is a long-term issue.

3.2.4 Palestinian Refugees in West Bank

In the aftermath of the Arab-Israeli conflict in 1948 and 1967, hundreds of thousands of Palestinians fled to the West Bank, where the number of registered refugees in 1999 reached about 576,160 (BADIL Resource Center, 2000), according to recent statistics, the number of registered refugees in the West Bank reached 858,758 at the end of 2019 . That is, 15% of the total Palestinian refugees residing in Lebanon, Syria, Jordan, the West Bank and the Gaza Strip (BADIL Resource Center, 2018).

At the end of 2018, the number of refugees living in camps reached 256,758, as there are 19 official refugee camps in the West Bank, distributed throughout the West Bank. While there are a number of other informal camps (BADIL Resource Center, 2018).

In general, despite the efforts made by UNRWA to provide basic services to Palestinian refugees, but they suffer from difficult living conditions, they suffer from poor access to the basic requirements for a decent life, including: health care, healthy

nutrition, water supply, and sanitation, social, health and educational services (Husseini, 1996).

3.2.5 Palestinian Refugees in Gaza Strip

One of the countries hosting Palestinian refugees because of the Arab-Israeli conflict is the Gaza Strip. Thousands of refugees sought refuge in it, ranging between 83,000 - 250,000 in 1948 (Cheal, 1988), year after year, and with the continuation of displacement and the systematic policies of the Israeli occupation against the Palestinians, the number of Palestinian refugees registered with UNRWA in 2019 reached 1,460,315. Where about 593,990 Palestinian refugees live in eight camps recognized by UNRWA (BADIL Resource Center, 2018).

UNRWA was the pillar of stability for the Palestinian refugees in Gaza, and it made efforts to provide all services to the refugees in the fields of education, health care, and the social and economic field. However, due to the hostile actions of the Israeli occupation against Gaza and its control over most of the available resources in Gaza, access to clean water, electricity and energy sources remains extremely difficult and complex. This negatively affects the various aspects of life for all Gazans, including the refugees.

A product of the Arab-Israeli conflict, in addition to the refugee issue, is Jewish immigration. Where the first Jewish colony was established in Palestine in 1837, and its population at that time was 1500 Jews, then the number of Jewish immigrants began to increase at the beginning of the twentieth century, especially in the period from 1911-1914 (Wafa, 2021).

The Palestinian territories were subjected to five successive waves of Jewish immigration from the late nineteenth century until World War II in the areas where Jews were present, as follows (Wafa, 2021):

1. The first emigration, 1882-1903: It took place in two batches, during which about 25,000 Jews came to Palestine, most of whom were from Romania and Russia.
2. The second emigration 1904-1918: This emigration took place after the establishment of the Zionist movement, and the number of immigrants reached about 40,000, most of whom came from Russia and Romania. With the end of the second wave of immigration and due to the outbreak of the

First World War in 1914, the number of Jews in Palestine reached about 85,000.

3. The Third Emigration 1919-1923: The number of immigrants reached about 35 thousand Jewish immigrants, an average of eight thousand immigrants annually, most of whom came from Russia, Romania and Poland, in addition to small numbers that came from Germany and America.
4. The Fourth Migration 1924-1932: It began during the time of the British Mandate, when about 89 thousand Jewish immigrants flocked to Palestine in this wave, most of them from the middle class, especially from Poland.
5. The Fifth Emigration 1933-1939: The number of Jewish immigrants who came in this emigration to Palestine reached about 215,000, most of whom came from central European countries.

In short, the Jewish immigration to Palestine had a negative impact, as it led to the displacement of Palestinians from their lands and their real homes (refugees), not only that but also depriving the Palestinians of their most basic human and natural rights.

As mentioned earlier, Palestinian refugees suffered from difficult living conditions in the various host countries, despite the efforts made by the competent authorities to provide them with a decent life. On the other hand, refugees have had a negative and possibly positive impact on the host countries. Share land, infrastructure, power and water supplies, job opportunities and competition. This resulted in a shortage of resources available in the host countries because of the population increase caused by the increasing number of refugees year after year.

One of the most important resources that suffer from scarcity in the host countries because of the increase in population numbers is water resources, especially in Palestine. Since the early days of the Israeli occupation in 1967, Israel has controlled all the water resources available in the occupied Palestinian territory, and continues its control until today, imposing strict restrictions on the quantities of water it provides to the Palestinians, while exploiting large quantities for the benefit of Israeli use. It also imposed futile policies on the development of Palestinian infrastructure in addition to the deliberate destruction of the existing Palestinian water infrastructure. All this has led to an exacerbation of water scarcity, especially in the

West Bank and Gaza Strip. In addition to the huge numbers of Palestinian refugees in their lands, there are systematic policies practiced against them and restrict them from using their available water resources in the best way, so the water crisis facing the Palestinians has become more severe than before (PWA, 2013).

Based on previous studies that focused on linking the relationship between the scarcity of water resources and refugees, it is expected that the issue of water security will be a major issue due to the increasing water scarcity due to population growth and the increasing number of refugees, and the volatile political situation (Jägerskog, 2016). Hence, the importance of this research, which aims to assess the existing water situation in the West Bank and find practical solutions to restore the rights of Palestinian refugees.

3.3 Control of the Water Sector in West Bank and Gaza Strip

Since the Ottoman rule, many administrations have succeeded in administering the water sector in Palestine, including the British Mandate, the Jordanian Administration (1948-1967), and the Israeli occupation in 1967. The political situation in Palestine and Palestinian water security are strongly linked.

The Water Sector Before 1967

Before the 1967 war, the water situation in Palestine was stable and locally managed, according to historians who recorded the historic water infrastructure, which included a canal connecting Hebron's springs to Jerusalem (Trottier, 2019).

The Jordan River, springs and wells were the major sources of water for Palestinians until the early 1960s.

The springs in the West Bank had a large flow and provided enough water for agricultural and residential purposes. Palestinian farmers to serve their interests and lands created them, and they are still utilized today despite the occupation's difficulties. Ain Sultan spring near Jericho and Ain Miska spring in Wadi Al-Far'ah are two of the most notable springs (Trottier, 2019).

Wells were originally created in the Gaza Strip owing to the simplicity of drilling in sandy soil, whereas drilling in rocky soil in the West Bank began in the mid-fifties on the northern border (Trottier, 2019).

Until 1967, Palestinian farmers were able to irrigate the lands near the Jordan River by pumping enough water from it. The Jordanian administration, located in Ramallah, launched the Jerusalem Water Project with the goal of bringing tap water to Ramallah, East Jerusalem, and Bethlehem. It extended to Bait Hanina. Then obstructed by the occupation and ordered to stop it in the south (Trottier, 2019).

The Water Sector from (1967-1994)

Since the 1920s, Palestinian demand for water has increased in both the West Bank and Gaza Strip. The main reason for this, in addition to the natural population growth and the increase in the number of Palestinian refugees, is the increase in the number of communities connected to the central water network (B'Tselem, 2000).

Despite the increased demand for water in the Palestinian territories, Israel has practiced policies that prevented the Palestinians from achieving the minimum rights to obtain the amount of water approved by the WHO.

Israel has benefited from its water strategy in the OPTs in two ways (B'Tselem, 2000):

1. Maintaining the uneven distribution of the shared groundwater in the western and northern aquifers of the West Bank.
2. The use of new water sources, such as the eastern aquifer and the Gaza aquifer, to which Israel had no access prior to 1967, mainly for the benefit of the established Israeli settlements.

To support this policy, Israel changed the legal and administrative framework for the water sector in the occupied territories (West Bank and Gaza Strip), which existed before the occupation. This modification was developed in stages (B'Tselem, 2000):

- In 1953, Israel began building the national water carrier extending from Lake Tiberius to the Negev, which diverts 75% of the Jordan River water to Israel. Syria and Jordan are allowed to use specific quantities estimated by Israel, and Palestinians are prohibited from obtaining any water from this source. The work was completed in 1964 (CESR, 2002).
- In June 1967, the Israeli military authorities imposed full control over all water resources and water infrastructure in the Occupied Palestinian Territories according to military order No. 2 (Amnesty International, 2017).

- In November 1967, the Israeli authorities issued Military Order No. 158, which states that Palestinians may not build any new water facilities without prior permission from the Israeli army ([Amnesty International, 2017](#)).
- A number of military directives have also been issued with the same purpose. That is, controlling water supplies and denying Palestinians access to them. The 1970 order, as well as orders 450 and 451 for 1971, order 457 for 1973, and order 498 for 1974, are among them. Israel used a variety of techniques and policies in carrying out these orders, including ([Wafa, 2021](#)):
 - Limiting the quantity of water that wells owners are allowed in the West Bank and Gaza Strip. Which does not exceed 100 m³/hr.
 - Preventing the digging of new wells for agricultural purposes, and confiscating Palestinian farmers' wells for the benefit of the Israeli settlements.
 - Small dams are being built to block the surface waters of valleys and prevent them from reaching Palestinian lands, as is the situation in Gaza.
 - Transfer of high-quality water from Israeli settlements in the Palestinian territories, to Israeli cities inside Israel.
 - Meanwhile, Israel developed its own water infrastructure and established a Mekorot Company for the use of its citizens in Israel and the settlements, by drawing water from wells and springs in the West Bank. Simultaneously, Israel is selling water through the Mekorot Company to the Palestinians at exorbitant amounts.
- Mekorot, Israel's national water authority, gained control of Palestinian water in 1982. While many existing Palestinian wells were destroyed, drilling and pumping for deeper Israeli wells proceeded, essentially drying out older Palestinian wells ([CESR, 2002](#)).
- Israel reduced Palestinians' well-water pumping quotas by 10% in 1986, resulting in significant water shortages ([CESR, 2002](#)).

The Israeli water company Mekorot, which is the principle water provider to both Palestinians and Israelis, continued to violate water security in the Occupied Palestinian Territories. The situation did not end with the violation of Palestinian water security; but it also followed a discriminatory strategy in the prices of water provided to both

sides, selling a cubic meter of water to Israelis for 1.8 \$ while selling it to Palestinians for 2.5 \$ (Al-Rabi, 2021).

The Water Sector from (1994 - Present)

Israeli control of water resources continued in the West Bank and Gaza Strip, and Palestinian-Israeli negotiations were launched, resulting in the signing of the Declaration of Principles (Oslo 1) agreement in September 1993, which provided for the establishment of a self-governing authority for a transitional period, and the Palestinian National Authority was established (Al-Tamimi, 2021).

With the establishment of the Palestinian Authority, Presidential Resolution No. 90 of 1995 was issued regarding the establishment of the Palestinian Water Authority (PWA), in order to ensure the most efficient management of the available water resources in the occupied Palestinian territories in order to achieve a balance between the quantities of available water and the needs of the Palestinians (Wafa, 2021b), although From this, the PWA was given only household water management (Trottier, 2019).

When Israel signed the Interim Agreement (Oslo 2) in Taba in 1995, it acknowledged the Palestinian water rights, but it postponed the description of these rights to final negotiations. Water was one of the key issues that were put off, also borders, refugees, Jerusalem and settlements issues (Al-Tamimi, 2021; Attali, 2021).

The issue of water and sanitation was addressed in Article 40 of Annex III of the Oslo Accords, which is titled "Water and Sewage." The following items were included (Al-Tamimi, 2021; Attali, 2021):

- Israel's acknowledgment of Palestinians water rights in the West Bank.
- As noted in the table below, specific amounts of water have been assigned to both parties from aquifers situated solely in the West Bank.

Table 3: Allocation of water according to 1995 Oslo agreement

Aquifer	Israel (MCM)	OPT (MCM)
Western Aquifer	340	22
Eastern Aquifer	40	54 + 78 to be developed
Northeastern Aquifer	103	42

- The agreement did not address water in the Jordan River Basin or the Gaza Strip's coastal basin, but Gaza's rights were addressed in Annex VIII of Article 40, which states that five MCM of water will be transferred to Gaza. This quantity will be increased while using desalination in the future.
- Israeli pledges to provide 28.6 MCM as urgent needs for the Palestinians after the signing of the agreement.

Under this agreement and Article 40, the Joint Water Committee (JWC) was established as a framework through which water and sanitation projects in the West Bank or projects related to settlements are approved. This committee is composed of an equal number of representatives from the Palestinian Authority and Israel. Since its inception, it has agreed to drill seventeen new wells, while others have refused (B'Tselem, 2000), provided that the approval of the Joint Water Committee is followed with the approval of the Civil Administration, according to the drilling site in the political division of the occupied Palestinian territories A, B, and C (Tamimi, 2021). This agreement ensured that Israel would maintain control over 85% of the Palestinian water resources (Al-Rabi, 2021).

Furthermore, in order to consent to the development of water and sewage systems, Israel began putting limitations on the Palestinians. It required that Israeli settlements be linked to any sewage treatment project for Palestinian cities and towns in the West Bank, which the Palestinians rejected, causing numerous projects to be delayed or abandoned, such as the purification plant projects in Salfit and Nablus. The Palestinians suffered substantial losses as a result of this strategy, since Israel regarded untreated sewage pouring into the Green Line as a source of pollution, and the Palestinian side was forced to bear the expense of treating it (Al-Rabi, 2021).

The water situation in the West Bank and Gaza Strip camps differs from that in other places of the world, despite the fact that the term is the same. The Israeli occupation

and policies against Palestinians are the reason for this difference, with Israel aiming to dominate the completely Palestinian area and its natural resources.

The results of the fieldwork on the quantities of water consumed and deserved in the West Bank and Gaza Strip camps will be provided in an analytical and detailed manner that is easy to follow, support, and improve, in accordance with the study's objectives.

3.4 International Laws about Palestinian Water Rights and Negotiations

Water security in the West Bank and Gaza Strip is vulnerable and unstable. Therefore, in order to obtain the water rights of the Palestinians, considering that water is a landmark of civilization and development, it is necessary to adhere to international law to restore those rights and ensure easy access to water in the required quantity and quality.

3.4.1 Self-determination in international law

The principle of self-determination is stated in Article 1 of the United Nations Charter, and its inclusion in this Charter represents a universal recognition of all peoples' right to self-determination. All peoples have the right to self-determination, according to Article 1. All People can freely determine their political status and freely pursue their economic, social, and cultural development as a result of this right (UNPO, 2017).

Many international instruments acknowledge the right to self-determination, including (UNPO, 2017):

- The United Nations General Assembly approved the Declaration of Principles of International Law Concerning Friendly Relations and Cooperation among States in 1970, which refers to the right to self-determination.
- The Final Document of Helsinki In 1975, the Conference on Security and Cooperation in Europe (CSCE) adopted it.
- The African Charter on Human and Peoples' Rights, which was adopted in 1981.
- The Paris Pact for a New Europe, which was signed in 1990.
- The United Nations Commission on Human Rights and the Committee on the Elimination of Racial Discrimination determined the extent and content of the right to self-determination.

The recognition of this right by international instruments “self-determination” confirms that this right is universally applied and is a prerequisite for the enjoyment of human

rights. In this regard, the Palestinian Authority must focus its efforts on protecting this right and asserting its right to freedom of action in ways that benefit economic, social, and cultural development, as well as taking into account international law. One of the sustainable development goals is the right to water. In the final discussions, this right must be fully requested, including the water rights of refugees and citizens in OPT, as well as the water utilized by Israeli settlements in the West Bank and Gaza Strip.

In its decision on the wall in 2004, the International Court of Justice affirmed the Palestinian people's right to self-determination, which is included in the principle of permanent sovereignty over natural resources (including water resources), which was referred to in General Assembly Resolution 1803 in 1962. This ruling is based on a well-established customary basis, and anybody who breaches it is violating the international legal system's foundations. As a result, the Palestinian leadership must appeal to the International Court of Justice through the General Assembly to seek these rights before Israel takes any action on territorial annexation, which would jeopardize Palestinian water security (Al Tamimi, 2021).

3.4.2 International human rights law (IHRL)

Access to water and sanitation is one of the basic human rights, to ensure a decent and healthy life, to eradicate poverty, to build a prosperous society and to achieve sustainable development goals.

Therefore, international human rights law (IHRL) obliges nations to work to achieve universal access to water and sanitation services for all people without discrimination, with a focus on those who need it most, taking into consideration availability, access to sources, affordability, quality, safety, and acceptability (OHCHR ·2021).

Based on this law, and recognizing that water is a human right for all equally and that priority should be given to those who need it most, the Palestinian Authority must demand the rights of Palestinians in Area C, in refugee camps, and in village communities. As these particular areas, suffer from very few quantities of water now. It is also worth noting that Palestinians in Area C pay three times as much as settlers for water, which is illegal under IHRL (Assi, 2021)

Ratification of international human rights treaties means if any domestic legal procedures fail to address human rights violations, complaints mechanisms and procedures are available at the regional and international levels to help ensure respect

for international human rights standards and implementation at the local level (OHCHR, 2021b). Because of the failure, in other words, the Israeli violation in the occupied Palestinian territories, the Palestinian Authority can go directly to this regard to demand the Palestinian water rights!

3.4.3 International law of transboundary waters

In view of the living developments, the increasing needs of countries for water and the multiplicity of purposes of use, the need to formulate the rules that govern shared running water in a clear and accurate manner has emerged. In 1910, this topic was included in the schedule of the International Law Institute (Al- Radayda, 2015).

The Madrid Declaration was issued in 1901, where it included its first article, that no state participating in the river basin has the right to make a change in the flow of the river or to consume its water in any way that might hurt the other participating states without their approval (Al- Radayda, 2015).

With the rise and development of international water conflicts, the International Law Commission continued to work to establish a legal basis and rules governing the use of shared water resources. Until the committee accepted the regulations, it proposed at the Helsinki Conference in its final report in 1966, known as the Helsinki Rules, which define how international seas should be used. Based on the principle of fair and equitable distribution among all the participating countries (Al- Radayda, 2015).

The Helsinki rules were based on the principle of "reasonable and equitable use" of shared waters. These rules set out a set of factors that must be taken into account when determining the quantities of use for each shared country, including: the geography of the basin, the extent of the drainage area in the territory of each country, the hydrology of the basin, the climate in which it is located. Affects the basin, the economic and social needs of each shared state, the population dependent on the basin's water in each state, the availability of other resources and the degree to which the basin's needs can be met without causing significant damage to the state of the shared basin (Salman, 2007).

Initially, just surface shared water attracted people's interest. However, the water condition of groundwater was reviewed in 1982, and the International Law Commission enacted the Seoul Laws related to international groundwater in 1986 (Al- Radayda, 2015).

The Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki Convention) was established in 1992. This agreement is based on the Helsinki rules of 1966 in general, but it was updated to increase collaboration between the participating countries under the idea of fair and equitable distribution (Al-Radayda, 2015).

The United Nations Convention on Watercourses for Non-Navigational Purposes was adopted in 1997, and it defined a watercourse as the surface water network and groundwater in this context. This convention includes 37 articles distributed in seven chapters, including Article No. 5 in Chapter Two, which states the principle of equitable utilization and participation, which requires that the participating states benefit from a watercourse in an equitable manner, taking into account all relevant factors and circumstances referred to in Article 6 of the same chapter, and Article 7 affirms the obligation not to cause significant harm to any states (McCaffrey, 2010).

The agreement's third chapter addresses the idea of prior notice in relation to the actions to be implemented. If one of the participating countries wishes to carry out a project that may harm another, it must notify the other participating countries of the plans and measures to be taken, and in the event of a breach of clauses 5, 6, and 7, the matter is negotiated between the participating countries to reach an equitable solution (McCaffrey, 2010).

In short, this agreement is based on three fundamental concepts, all of which should be followed (McCaffrey, 2010):

- Equitable and reasonable benefit
- Prevent serious harm
- Advance notification of the measures will to be implemented

Based on the foregoing, the Palestinian Authority has the right to negotiate in order to claim its water rights from the aquifers and the Jordan River, in order to achieve the principle of "fair and equitable distribution", and to abide by the principle of no harm.

3.4.4 The Hague Convention 1907

The most important principles enshrined in the laws of war are that occupation is a temporary, realistic situation in which the occupier does not have the right to sovereignty over the occupied land; this means that occupation does not imply

ownership of the territory controlled or the transfer of sovereignty to the occupation authorities in any way (Al- Radayda, 2015).

In 1907, the Hague Regulations dealt with the Law of Property Rights in Occupied Territories, imposing limits on the enemy's ownership and use of the occupied territories' property. The third part of the rules, headed "Military authority on the territory of the enemy state," was one of the articles that regulated public property:

1. According to Article 43 of the Hague Regulations of 1907, "If the legitimate force's authority is effectively transferred to the hands of the occupying power, the latter shall, as far as possible, achieve and guarantee security and public order while respecting the laws in force in the country, except in cases of extreme necessity." This indicates that Israel has no authority to alter the existing public order in the occupied Palestinian territory (Al- Radayda, 2015).
2. Article 46 of the Hague Regulations specifies that private property must be protected and not confiscated territory (Al- Radayda, 2015), implying that Israel has no legal authority to issue military orders prohibiting the owners of water wells from drilling additional wells or confiscating them.

The Hague Regulations confirmed the concept of the inadmissibility of capturing occupied territory by force, which has since been applicable in all international treaties and with which the international court has worked, and was founded on basic principles: in international relations, the principle banning the use of force and The principle of the right to self-determination (Al- Radayda, 2015).

3.4.5 The 1949 Fourth Geneva Convention

The Fourth Geneva Convention of 1949 did not include any provisions relating to natural and water resources, but it did deal with the protection of public and private property in Article 53, and decided to protect property from destruction and attacks by imposing Article No. 147 on serious violations of natural resources (Al- Radayda, 2015).

The Israeli occupation, on the other hand, has broken this agreement by committing acts of burning and destroying water facilities in the occupied Palestinian lands, as well as issuing military orders giving the military ruler complete control over water resources. The demolition of water wells surrounding the Western Basin, the control of a number of wells, and the transportation of toxic waste from within the Green Line to

Palestinian towns in the West Bank, which pollutes water and water wells, are all acts performed by Israel in violation of this agreement (Al- Radayda, 2015).

The occupying state is prohibited from differentiating between the people of the occupied areas under Article 27 of the Convention. In reality, due to its recognition of the strategic value of water, Israel discriminates between settlers and Palestinians at its water policy, even if this is at the risk of Palestinian water security, especially in a time of water shortage. Many experts predicted that water, not oil, is the basis for the coming wars in the Middle East (Al Rabi, 2021).

Palestine adhered to the Geneva Convention, recognizing its rules that the occupation is a temporary force, but Israel's position is different. It did not implement these rules on the pretext that it was not incorporated into national law by a legislative text, and these arguments are internationally rejected, as the United Nations General Assembly stressed the idea that Israel is a temporary force that does not have the right to sovereignty over natural and water resources (Al- Radayda, 2015).

According to the law of “military occupation” found in the Hague Regulations of 1907, and the Fourth Geneva Convention of 1949, they affirm that Israel is a temporary occupying power in the Palestinian territories and does not have the right to control the natural and water resources in the occupied territories. It is necessary to note that Israel recognized the right of the Palestinians to water in Article 40 of the Second Oslo Agreement, and therefore Israel must restore the Palestinian water rights and compensate and repair the damage for all the violations it caused (Attili, 2021).

3.4.6 United Nations General Assembly Resolutions on Palestinian Water

The United Nations has passed several resolutions dealing with the Palestinian problem in all of its forms. It has paid special attention to Palestine's water resources (Al- Radayda, 2015):

- General Assembly resolution 1803 (XVII) of 14 December 1962, "Permanent sovereignty over natural resources", which affirmed the right of the Palestinian leadership to full sovereignty over all its natural resources, including water resources.
- In 1970, Resolution No. 2727 was published based on the Special Political Committee for Palestine recommendations. This resolution addressed the subject of Palestinian permanent sovereignty over natural resources, especially

surface and groundwater. According to this viewpoint, the Palestinians have control over water resources, and Israel has no right to do anything that might damage this natural resource.

- In 1972, the United Nations General Assembly passed Resolution 3005, confirming the Palestinians' right to control over their natural resources, including water.
- Resolution No. 186 of 1976 dealt with the occupied lands' permanent sovereignty over their natural resources, as well as their right to fully and truly restore their natural resources, including water resources, and to receive full compensation for the loss, depletion, and damage.
- The United Nations General Assembly passed Resolution No. 3175 in 1973, titled "Permanent Control over National Resources in Occupied Territories."
- The International Law Society's Doctrinal Resolution No. (75) on the protection of water resources and facilities, which stated in its third paragraph "it is not permissible to divert water sources for military ends, especially when this causes suffering to civilians or serious damage to the ecological balance." The sixth paragraph addressed the seized regions specifically, stating, "Actions of expropriation and sabotage of water facilities that are important for the health and survival of the civilian population must be avoided."
- Resolution No. (10) Was adopted at the United Nations Conference on Water in 1977, and it deals with the Palestinian territories' water management. It voiced great concern among the world community over the illicit exploitation of water resources possessed by peoples and countries under colonialism and foreign domination, particularly Israel's actions in the occupied Palestinian territories.
- The United Nations General Assembly recognized the human right to water and sanitation on July 28, 2010, with Resolution 64/292. The Resolution urges states and international organizations to provide financial resources, capacity-building assistance, and technology transfer to assist nations, particularly developing countries, in providing safe, clean, accessible, and affordable drinking water and sanitation to everyone ([UNDESA, 2014](#)).

The UN resolutions, in their entirety, affirmed permanent sovereignty over natural resources in the occupied Palestinian territories and Arab territories in general, and

condemned Israel for its illegal exploitation of natural and human resources, while also emphasizing that the Hague Convention of 1907 and the Fourth Geneva Convention of 1949 apply to Palestinian and Arab territories. These recognize the Palestinian right to complete sovereignty over all natural and water resources (Attili, 2021).

Despite the fact that the General Assembly of the United Nations has passed resolutions prohibiting Israel from exercising arbitrary control over Palestinian natural resources as an occupying power, and that the Palestinians must be granted sovereignty over these resources, Israel has violated the resolutions and is thus in violation of the United Nations Charter and international conventions that stipulate the principle of non-expansion and acquisitiveness (Al-Radayda, 2015).

The beginning of Palestinian water rights negotiations must be directly related to the concerns of the ultimate settlement, according to international law and UN General Assembly resolutions. This implies that the issues of refugees and displaced individuals, water, borders, Jerusalem, and settlements are all intertwined. The Palestinian side must highlight that these discussions are founded on the idea of complete sovereignty over water and natural resources, in order to safeguard the right of access to resources and their management in order to accomplish sustainable development goals (Al-Tamimi, 2021).

The issue is not about finding a solution to the existing and future water situation; rather, it is also about seeking recompense for the harm that Israel has caused to Palestinians in exchange for denying them of their rights and the bad consequences that have resulted.

The Israeli negotiator relies in negotiations over water on two principles (Attili, 2021):

First: All water sources are depleted, and the Palestinian side must go to options to develop non-conventional sources such as desalination

Second: Israel was concerned with water needs, not rights, and the Palestinian negotiator rejected this.

Therefore, the Palestinian negotiator must demand the following (Attili, 2021):

- Compensation for Israel's exploitation of the Palestinian share of water in the Jordan River and its basins, as well as the Palestinians' deprivation of it.

- Compensation for the Palestinians' prohibition from the use of natural resources on land, sea, and air, particularly the Dead Sea salts.
- Palestinian water rights should include the water share of Palestinian refugees in the homeland and in the diaspora.

Chapter Four

Approach and Methodology

This chapter discusses the methodology used in the research, for achieving the objectives of the study and answering the research questions. The methodology explains the data collection phase and data analysis techniques, based on the study's goal and research questions presented in chapter one.

4.1 Research Approach

This research adopted the quantitative and analytical research methodology in a sequential manner to reach the mathematical result that achieves the goal of this research. On the other hand, a questionnaire was developed to measure the opinions of water experts and decision-makers, as well as their attitudes on water refugees' rights and recovery of these rights from their home countries.

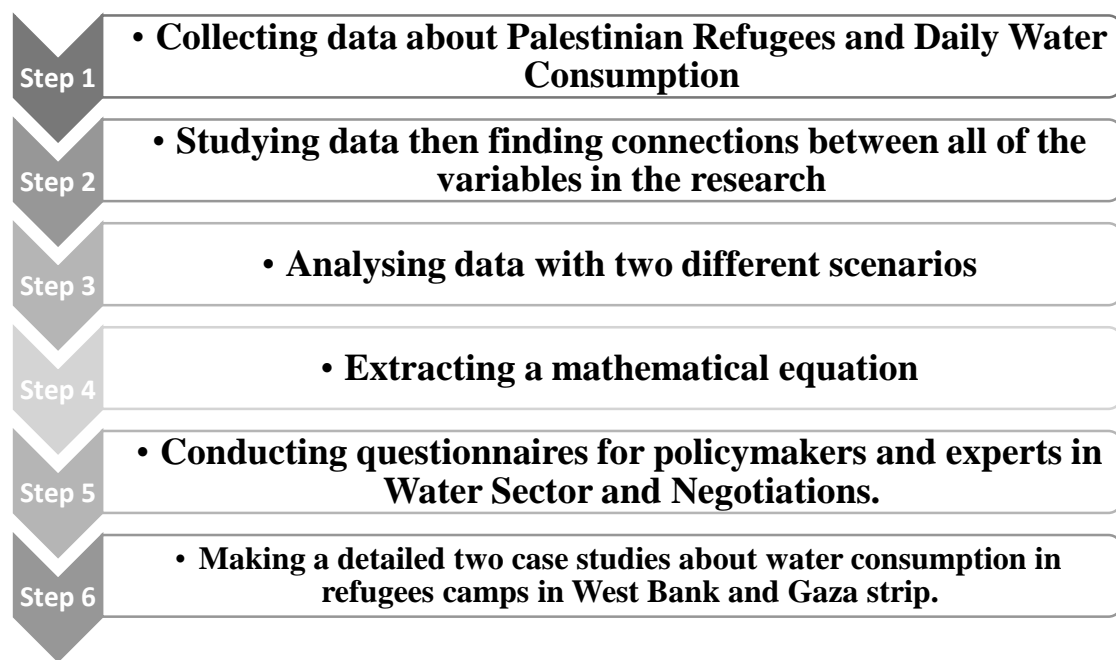


Figure 10: Key steps in the research approach process

4.2 Data Collection and Analysis

A review of academic articles and scientific books was conducted to study the water situation in the West Bank and Gaza Strip, the refugee camps in particular. In addition to studying laws and international relations that discuss human rights and refugees first.

This study aims to develop a model for calculating the quantities of domestic water that the Palestinian refugees deserve, based on the standards of the World Health Organization (WHO), also for calculating the actual domestic water consumption for refugees from the beginning of the Arab-Israeli conflict to the present day. At this stage and because of the limited availability of data and information in the relevant government institutions and their official websites. The Palestinian Central Bureau of Statistics (PCBS) has been adopted as the main source of information related to the population numbers of Palestinian refugees in the official camps. While the Palestinian Water Authority (PWA) was adopted as the main source of information and data related to water consumption quantities.

This study involves several variables, the most important of which is the population census of Palestinian refugees, in addition to the Quantities of water consumption. This is in order to achieve the study objective by calculating the quantities of water that the Palestinian refugees deserve and actual quantities of water consumption by refugees during the years of the Arab-Israeli conflict.

The 2021 surveys were adopted to enumerate Palestinian refugees in the official camps in the West Bank and Gaza Strip, because of the availability of statistical data for the years between 2017 and 2021. Then, by studying the growth rate in these years, the population census of refugees in all years of study was extracted; from the beginning of the Arab-Israeli conflict in 1948 to the present day. Based on the following equation:

$$P_f = P_0 \times \left(1 + \frac{r}{100}\right)^n \quad \text{Eq. 4.1}$$

Where;

P_f = Final Number of Palestinian Refugees Population ($P_{2021} = 420,565$).

P_0 = Initial Number of Palestinian Refugees Population (P_{1948}).

n = Number of Study Years ($2021 - 1948 = 73$ yrs).

r = Population growth rate in Percent (2.68% in this study).

From recent statistics, the number of Palestinian refugees in official camps in the west bank and Gaza Strip in year 2021 is equal 420,565. Then, by applying Eq. 4.1, the number of Palestinian refugees in 1948 was calculated as shown:

$$P_{1948} = P_{2021} \times \left(1 + \frac{2.68}{100}\right)^{-73} = 61,005$$

Then, the population of Palestinian refugees was calculated for all the years between 1948 and 2021, For example:

$$P_{1949} = P_{1948} \times \left(1 + \frac{2.68}{100}\right)^1 = 62,640 \text{ and so on.}$$

One of the most important variable in this study is water consumption. It has been studied in two scenarios. **The first scenario** used Eq. 4.2 to calculate the actual water consumption quantity (AWC) by Palestinian refugees in camps, whereas **the second scenario** used Eq. 4.3 to calculate the deserved water consumption quantity (DWC) from the beginning of the Arab-Israeli war until now.

The actual water consumption (AWC) quantities were collected from municipalities, the Water Authority, and the Water Sector Regulatory Council. By applying Eq. 4.2, the actual water consumption of the study area was calculated over the years of the Arab-Israeli conflict (Scenario No. 1 – Actual Water Consumption).

$$AWC_n = AWC_0 \times \left(1 + \frac{wcr}{100}\right)^n \quad \text{Eq. 4.2}$$

Where;

AWC_n = Yearly Actual Water Consumption at year n (AWC_{2021}).

AWC_0 = Yearly Actual Initial Water Consumption (AWC_{1948}).

n = Number of Study Years (2021 – 1948 = 73 yrs).

wcr = Water Consumption rate in Percent (differ from region to other).

Then, calculated daily actual water consumption per capita by divided equation Eq. 4.2 to Eq. 4.1 at the same year:

$$DAWC_n = \frac{AWC_n}{P_n} \times \left(\frac{1}{365}\right) \quad \text{Eq. 4.3}$$

Where:

$DAWC_n$ = Daily Actual Water Consumption per capita at year n.

AWC_n = Yearly Actual Water Consumption at year n.

P_n = Palestinian Refugees Population at year n.

(1/365) to convert from year to day.

Another important component in this study is deserved daily water consumption. In March 2021, the World Health Organization (WHO) reported that the daily deserved water consumption per capita is 100 L/c/d. The following equation Eq. 4.4 was used to compute the deserved water consumption quantity in each camp since the beginning of the Arab-Israeli conflict, based on this statement. It should be noted that the rate of rise in water consumption was determined by analyzing the reality of water consumption in the study area (Scenario No. 2 – Deserved Water Consumption).

$$DDWC_n = DDWC_0 \times \left(1 + \frac{i}{100}\right)^n \quad \text{Eq. 4.4}$$

Where;

$DDWC_n$ = Deserved Daily Water Consumption per Capita at year n ($DDWC_{2021} = 100$ l/c/d).

$DDWC_0$ = Deserved Initial Daily Water Consumption per Capita ($DDWC_{1948}$).

n = Number of Study Years (2021 – 1948 = 73 yrs).

i = Water Consumption rate in Percent (0.5% in this study).

Then, by applying Eq. 4.4, Deserved daily water consumption per capita in 1948 was calculated as shown:

$$DDWC_{1948} = 100 \times \left(1 + \frac{0.5}{100}\right)^{-73} = 69.4 \text{ l/c/d.}$$

Then, the deserved daily water consumption was calculated for all the years between 1948 and 2021, For example:

$$DDWC_{1949} = DDWC_{1948} \times \left(1 + \frac{0.5}{100}\right)^1 = 69.7 \text{ l/c/d.}$$

The Palestinian refugee population in all official camps in the West Bank and Gaza Strip, as well as the deserved daily water consumption per capita for each year, were determined using equations Eq. 4.1 and Eq. 4.4. The yearly-deserved water consumption for each camp was then computed using the equation below Eq. 4.5.

$$TDWC_n = DDWC_n \times P_n \quad \text{Eq. 4.5}$$

Where;

$TDWC_n$ = Total Deserved Water Consumption at year n

$DDWC_n$ = Deserved Daily Water Consumption per Capita at year n

P_n = Palestinian Refugees Population at year n.

For example, the total deserved water consumption of the Palestinian refugee camps in 1948 amounted to 1,545,318 m³/yr.

$$TDWC_{1948} = DDWC_{1948} \times P_{1948}$$

$$TDWC_{1948} = 69.4 \frac{1}{c.day} \times 61,005 c \times \frac{1 m^3}{1000 l} \times \frac{365 day}{1 yr} = 1,545,318 m^3/yr.$$

4.3 Questionnaire Surveys Targeting Policymakers and Experts

In order to understand the aspirations of relevant opinion holders, policy makers and experts, a questionnaire was designed and developed, as follows:

The questionnaire was intended for policy makers and experts. The questionnaire aims to measure the opinions of decision makers and experts in the water sector and their attitudes regarding the rights of water refugees and their recovery from their countries of origin. In order to examine the effectiveness of international laws and national strategies and their role in claiming the rights of water refugees. Finally, the recommendations made by the experts to make this idea a success and putting it into action in the future.

The sample size was 36, 11.1 % of whom had a Bachelor's degree, 55.6 % of whom had a master's degree and 33.3% of whom had a PhD, from a variety of institutions, including the Investment Promotion and Industrial Cities Authority, Palestinian Water Authority, Palestinian Hydrology Group, Palestinian standard institution, Ministry of

The questionnaire was sent by E-mail to policy makers directly, and posted on the Environmental and Hydrological pages. Then a detailed analysis by statistical analysis methods in the Excel program of the results was carried out.

4.4 Water Consumption of Palestinian Refugees in the Case Camps

Data collection stage was divided into two parts: the first concerned the number of Palestinian refugees in the camps, while the second related to the actual consumption rates of Palestinian refugees in the camps. Despite the fact that there were several challenges on the way to this point. Nonetheless, we were able to collect enough data to meet the research's aims.

First: Given the difficulties the Palestinian people faced that prevented the documentation of all issues at the time, it has been difficult to find the numbers of Palestinian refugees in official camps since the beginning of the Palestinian refugee issue, which is a historical issue that began 73 years ago and is still ongoing. However, the Palestinian Central Bureau of Statistics provided part of the essential data. As a result, the rate of increase of Palestinian refugees was measured, and all refugee numbers in all official camps in the West Bank and Gaza Strip were calculated.

Second: The difficulty of obtaining data related to the actual water consumption rate of the camps due to the reservations of some governorates, where they had some concerns.

Two case studies for research were chosen expressly to clarify all of the stages involved in this research, one in the West Bank and the other in the Gaza Strip, where we were able to collect data for the majority of the camps with the help of:

- The Department of Refugee Affairs in the West Bank and Gaza Strip
- Palestinian Central Bureau of Statistics
- Palestinian Water Authority (PWA).
- Water Sector Regulatory Council.
- Coastal Municipalities Water Utility.
- Jerusalem District Water Authority.
- Water and Sewage Authority Bethlehem - Beit Jala - Beit Sahour.
- Municipalities of all governorates.
- The popular committees responsible for the camps.

After presenting all officials a brief summary of the thesis's subject, the replies ranged from favorable to disagreement to reservation, and it was clear that there were many anxieties and apprehensions, considering that the thesis deals with a sensitive historical issues for Palestinians.

Chapter Five

Result and Discussion

5.1 Palestinian Refugees in Official Camps

By analyzing the data on Palestinian refugee camps in the West Bank and Gaza Strip, from the Palestinian Central Bureau of Statistics in the years 2017-2021, and extracting the population count for the years 1948-2016 (see annex A). Results show a clear increase in the population numbers of refugees in the camps as shown in Figure 11.

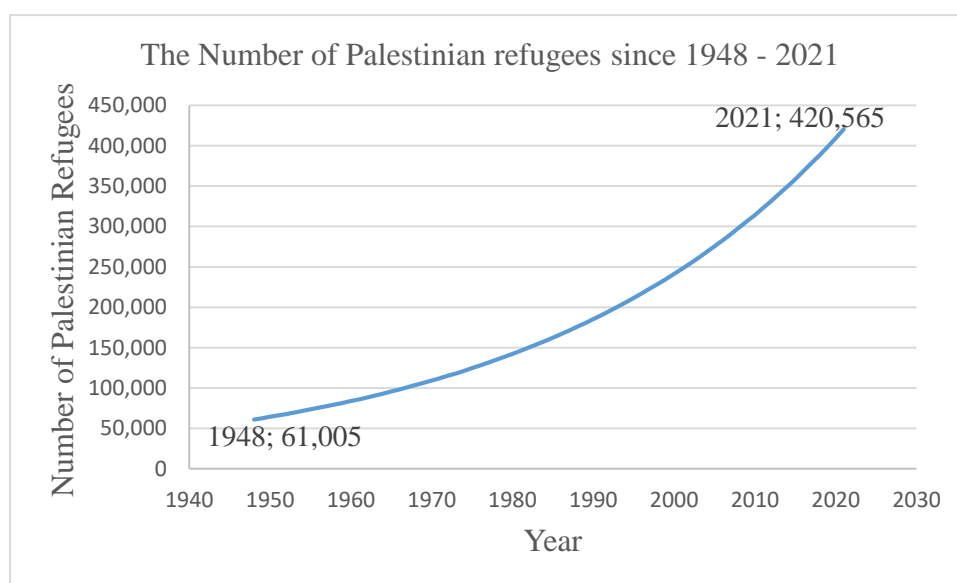


Figure 11: The Number of Palestinian Refugees since 1948 to 2021

The number of Palestinian refugees in 2021 was 420,565, while it was 61,005 in 1948, with an annual growth rate of 2.68%. It is worth emphasizing that this study focused on Palestinian refugees in camps as a case study, despite the fact that two-thirds of the refugees live in other host countries and villages, some of which are close to their homeland. Knowing that the circumstance that applies to camp refugees also applies to all refugees, regardless of where they are. All refugees have rights that must be claimed and recovered.

Refugees have the right to an adequate standard of living under international law, which includes housing, health, education, job opportunities, protection, and infrastructure development, such as water and sanitation facilities, water wells, and wastewater treatment in refugee camps and surrounding areas.

Based on the reality that the Palestinian refugees simulate in the camps, and the obstacles they suffer from that negatively affect their living, such as electricity cuts, lack quantities of water supplied, low quality of water supplied, and poor infrastructure. Here, it was necessary and urgent need to study the water reality in the refugee camps to search for ways to find solutions and restore rights to their owners.

5.2 Actual and Deserved Water Consumption for Palestinian Refugees in Camps

Actual water consumption (AWC) data for Palestinian refugees were collected in the camps for some governorates, while others were reluctant to provide the necessary data due to their concerns about the sensitivity of the issue as a political issue.

The archived data of the municipalities and the relevant authorities were in the majority for the years 2000-2021. The nature of water consumption for each camp was studied through the data available to us, and on the basis of which the rate of increase in water consumption was determined, taking into account the increase in the population of each camp along with the life development since 1948 and still going .

The actual water consumption quantities of the refugee camps were calculated and tabulated on the Excel program (see annex B) using Equation 4.2, in order to derive a mathematical equation based on calculating the total quantities of water consumed from the start of the Arab-Israeli conflict until the present day.

The initial plan was to calculate the quantities of water actually consumed in Palestinian camps, but due to difficulties encountered during the data collection stage, a different scenario was investigated, based on the quantities of water that deserved to be consumed by Palestinian refugees in the camps according to World Health Organization standards.

The global standards approved by the WHO and the PWA were reviewed, and by applying equations Eq. 4.4 and Eq. 4.5, the quantities of deserved water consumption were calculated. Then, all data extracted were tabulated using the Excel program. Which found that Palestinian refugees in the camps of the West Bank and Gaza Strip in the year 2021 have the deserved Water consumption is estimated at 15,350,623 m³/year, at a rate of 100 L/c/d.

The following table shows the quantities of water consumption that Palestinian refugees have had the right to consume since the beginning of the Arab-Israeli conflict.

Table 4: Deserved Water Consumption 1948 – 2021.

Deserved Water Consumption (1948-2021)				
Year	Population	DWC (l/c/d)	DWC (l/c/yr)	TDWC (m³/yr)
1948	61,005	69.4	25,331	1,545,318
1949	62,640	69.7	25,441	1,593,624
1950	64,319	70.1	25,587	1,645,730
1951	66,042	70.4	25,696	1,697,015
1952	67,812	70.8	25,842	1,752,398
1953	69,630	71.1	25,952	1,807,038
1954	71,496	71.5	26,098	1,865,903
1955	73,412	71.8	26,207	1,923,908
1956	75,379	72.2	26,353	1,986,463
1957	77,400	72.6	26,499	2,051,023
1958	79,474	72.9	26,609	2,114,724
1959	81,604	73.3	26,755	2,183,315
1960	83,791	73.7	26,901	2,254,062
1961	86,036	74	27,010	2,323,832
1962	88,342	74.4	27,156	2,399,015
1963	90,710	74.8	27,302	2,476,564
1964	93,141	75.1	27,412	2,553,181
1965	95,637	75.5	27,558	2,635,564
1966	98,200	75.9	27,704	2,720,533
1967	100,832	76.3	27,850	2,808,171
1968	103,534	76.7	27,996	2,898,538
1969	106,309	77.1	28,142	2,991,748
1970	109,158	77.4	28,251	3,083,823
1971	112,083	77.8	28,397	3,182,821
1972	115,087	78.2	28,543	3,284,928
1973	118,171	78.6	28,689	3,390,208
1974	121,338	79.0	28,835	3,498,781
1975	124,590	79.4	28,981	3,610,743
1976	127,929	79.8	29,127	3,726,188
1977	131,358	80.2	29,273	3,845,243
1978	134,878	80.6	29,419	3,967,976
1979	138,493	81.0	29,565	4,094,546
1980	142,204	81.4	29,711	4,225,023

(Cont'd)Table 4: Deserved Water Consumption 1948 – 2021.

Deserved Water Consumption (1948-2021)				
Year	Population	DWC (l/c/d)	DWC (l/c/yr)	TDWC (m³/yr)
1981	146,015	81.8	29,857	4,359,570
1982	149,929	82.2	30,003	4,498,320
1983	153,947	82.7	30,186	4,647,044
1984	158,073	83.1	30,332	4,794,670
1985	162,309	83.5	30,478	4,946,854
1986	166,659	83.9	30,624	5,103,765
1987	171,125	84.3	30,770	5,265,516
1988	175,711	84.8	30,952	5,438,607
1989	180,420	85.2	31,098	5,610,701
1990	185,256	85.6	31,244	5,788,138
1991	190,221	86.0	31,390	5,971,037
1992	195,318	86.5	31,573	6,166,775
1993	200,553	86.9	31,719	6,361,341
1994	205,928	87.3	31,865	6,561,896
1995	211,447	87.8	32,047	6,776,242
1996	217,113	88.2	32,193	6,989,519
1997	222,932	88.7	32,376	7,217,646
1998	228,907	89.1	32,522	7,444,513
1999	235,041	89.6	32,704	7,686,781
2000	241,340	90.0	32,850	7,928,019
2001	247,808	90.5	33,033	8,185,842
2002	254,450	90.9	33,179	8,442,397
2003	261,269	91.4	33,361	8,716,195
2004	268,271	91.8	33,507	8,988,956
2005	275,461	92.3	33,690	9,280,281
2006	282,843	92.8	33,872	9,580,458
2007	290,423	93.2	34,018	9,879,610
2008	298,206	93.7	34,201	10,198,943
2009	306,198	94.2	34,383	10,528,006
2010	314,404	94.6	34,529	10,856,056
2011	322,831	95.1	34,712	11,206,110
2012	331,482	95.6	34,894	11,566,733
2013	340,366	96.1	35,077	11,939,018
2014	349,488	96.6	35,259	12,322,597
2015	358,854	97.0	35,405	12,705,226
2016	368,472	97.5	35,588	13,113,182
2017	378,347	98.0	35,770	13,533,472
2018	388,486	98.5	35,953	13,967,237

(Cont'd)Table 4: Deserved Water Consumption 1948 – 2021.

Deserved Water Consumption (1948-2021)				
Year	Population	DWC (l/c/d)	DWC (l/c/yr)	TDWC (m³/yr)
2019	398,898	99.0	36,135	14,414,179
2020	409,588	99.5	36,318	14,875,417
2021	420,565	100	36,500	15,350,623
				447,345,438

Palestinian refugees are entitled to a water claim or compensation equivalent to 447,345,438 m³ since the beginning of the Arab-Israeli conflict, as indicated in the table above. Note that, the quantities are calculated only for domestic use.

On the other hand, while the Palestinian refugee was sharing the water resources available in the host country with Palestinian citizens, a settler or occupier was consuming at least the quantity of water that the Palestinian refugee was entitled to. Israel not only controlled Palestinian territory but also aimed to utilize all available resources in a planned manner that limited the lives of Palestinians. It is time to reclaim all rights!

As mentioned earlier in the literature review, international law and United Nations General Assembly resolutions have all stated the rights of Palestinians to sovereignty over natural resources, including water, and emphasized the principle of equitable distribution with regard to shared waters. From this standpoint, the Palestinian negotiator must adhere to international law and demand the right of the Palestinians to control all Palestinian water resources, and demand financial compensation for the losses caused by Israel previously, and to exploit this in order to develop the Palestinian infrastructure.

The occupied Palestinian territories are mostly agricultural lands that require water supplies for irrigation, and they must be taken into account, noting that this study was limited to the amounts of domestic water due and actually consumed. However, given the negotiations and the recovery of rights, we find it necessary to demand the quantities of water needed for agricultural purposes.

According to the latest data, there are 745,000 dunums of agricultural land in Palestine (82% in the West Bank and 17.9% in the Gaza Strip). The amount of water required varies from place to place and depends on the rate of rainfall, temperature, soil quality, the type of crops grown and the irrigation technology used. Therefore, the Ministry of Agriculture recommends the use of an average amount of water of 600 m³/dunum/year in the occupied Palestinian territories, and indicated that the current use is at an average of 75% (nearly 450 m³/ dunum/yr) of the recommended amount (PWA, 2013).

From another point of view, when negotiating the recovery of Palestinian water rights, the quantities of water needed for agricultural purposes must be considered based on the recommendations of the Ministry of Agriculture during the years of conflict.

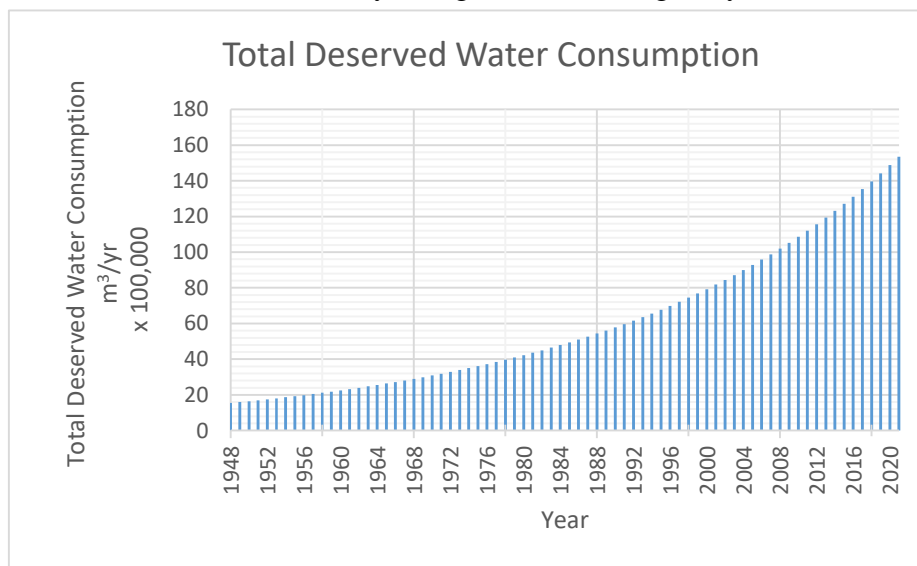


Figure 12: Total deserved water consumption at the end of each year

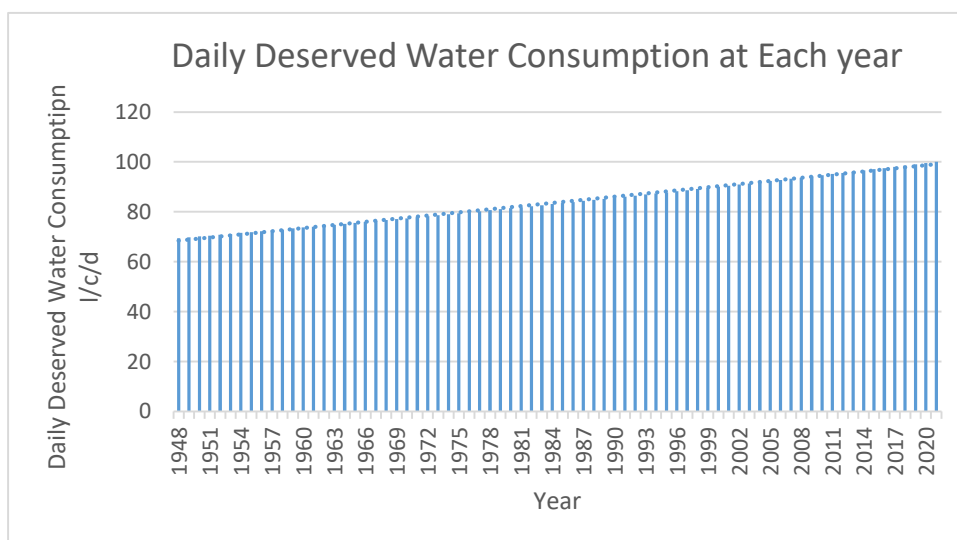


Figure 13: Total daily deserved water consumption due to each year

All research axes were studied, with its different scenarios (actual water consumption quantities and deserved water consumption quantities), passing through all the difficulties of; data collection, analysis, and calculating the missing ones on a scientific basis, despite the long time period included in the research, which is still ongoing (73 years). The researcher succeeded in Connecting all the variables and arriving at a mathematical equation that facilitates calculating the total quantities of (water actually consumed/deserved) since the beginning of the Arab-Israeli conflict until today, which can be applied anywhere, and for any category of consumers.

The mathematical formula in its content is based on a rate (increase / decrease) that depends on population growth and the rate of water consumption, in addition to the value of the initial water consumption as shown:

$$TWC = WC_0 \times \frac{1-(1+X)^{n+1}}{1-(1+X)}, \text{ while } X = \sqrt[n]{\frac{WC_n \times P_n}{WC_0 \times P_0}} - 1 \quad \text{E.q. 5.1}$$

Where;

TWC = Total Water Consumption During all Study Period.

WC₀ = Initial Water Consumption (WC₁₉₄₈), Water consumption may be actual or deserved.

WC_n = Water Consumption at year n (WC₂₀₂₁), Water consumption may be actual or deserved.

P_n = Palestinian Refugees Population at year n (P₂₀₂₁= 420,565).

P₀ = Initial Palestinian Refugees Population (P₁₉₄₈).

n = Number of Study Years (2021 – 1948 = 73 yrs.).

X = Increase/Decrease Rate.

Data about the year 2021 are available and easily obtained. While the data related to the beginning of the 1948 Arab-Israeli conflict were calculated, as the Number of Palestinian refugee's population was calculated by applying equation 4.1, and the deserved water consumption rate was calculated by applying equation 4.4. Thus, we met all the necessary variables to calculate the total quantities of deserved water

consumption for a period of 73 years, which is a right for all Palestinian refugees in the camps of the West Bank and Gaza Strip, and they have the right to claim it.

Table 5: Data required to calculate the total quantity of deserved water consumption at years 1948-2021 by a mathematical formula.

Data / Year	2021	1948
Population (P, capita)	420,565 (PCBS)	61,005 (Eq. 4.1)
Daily Water Consumption (DWC, l/c/d), (Deserved)	100 (WHO, PWA)	69.4 (Eq. 4.4)
$P \times DWC$ (m ³ /yr)	$WC_f = 15,350,623$	$WC_0 = 1,545,318$

Then, by applying E.q. 5.1 can be calculated the total quantity of deserved water consumption as shown below:

$$X = \sqrt[n]{\frac{WC_n \times P_n}{WC_0 \times P_0}} - 1 = \sqrt[73]{\frac{WC_{2021} \times P_{2021}}{WC_{1948} \times P_{1948}}} - 1 = \sqrt[73]{\frac{15,350,623}{1,545,318}} - 1 = 0.03195$$

$$TWC = WC_0 \times \frac{1-(1+X)^{n+1}}{1-(1+X)} = 1,545,318 \times \frac{1-(1+0.03195)^{73+1}}{1-(1+0.03195)} =$$

$$\mathbf{447,411,522.5 \text{ m}^3}$$

As shown by the result of the mathematical equation, the total quantities of deserved water consumption that must be claimed are **447,411,522.5 m³**, while the quantity resulting from data collection and analysis for all years of study was equivalent to **447,345,438 m³**, with an error rate of 0.015% that is scientifically acceptable, as shown:

$$\% \text{ Error} = \frac{|Value \text{ from Excel} - Value \text{ from Formula}|}{Value \text{ from Excel}} \times 100\%$$

$$\% \text{ Error} = \frac{|447,345,438 - 447,411,522.5|}{447,345,438} \times 100\% = 0.015\%$$

Therefore, the mathematical equation can be adopted to calculate the quantities of water actually consumed/deserved, for any category of consumers, at any time, and in any place. In a scientific and effective way, that saves time and effort in the stage of data collection and analysis.

5.3 A Case Study

Case Study 1: Jenin Camp in West Bank

In 1953, the Jenin camp was established. It covers 0.42 km² within the Jenin municipality. Residents of the camp are originally from Haifa's Carmel neighborhood and the Carmel Mountains, where the camp is located near their original villages (UNRWA, 2015).

1. Data on the number of Palestinian refugees in Jenin camp was collected through the Palestinian Central Bureau of Statistics, which found data for the years 2017 – 2021.

Table 6: Refugees Population in Jenin Camp (PCBS, 2021)

Year	Refugees Population	Year	Refugees Population
2017	10,327	2020	10,986
2018	10,541	2021	11,213
2019	10,761		

2. The number of Palestinian refugees in 1953 was calculated using equation Eq. 4.1, while growth rate is equal 2.1% according the available data as shown in table 6.

$$P_f = P_0 \times \left(1 + \frac{r}{100}\right)^n$$

$$P_{2017} = P_{1953} \times \left(1 + \frac{2.1}{100}\right)^{64}$$

$P_{1953} = 2,731$ *capita*, and then the population at year 1954 calculated as:

$$P_{1954} = P_{1953} \times \left(1 + \frac{2.1}{100}\right)^1 = 2,788 \text{ capita and so on.}$$

3. The camp's yearly actual water consumption for the years 2011- 2020 was obtained through communication with the Jenin municipality. Then, It was used to evaluate the rate of rise or reduction in water consumption, and then to determine yearly actual water consumption for the years 1953 to 2012 using equation Eq. 4.2 (**Scenario No. 1, Actual Water Consumption**)

Table 7: Annual actual water consumption for Palestinian refugees in Jenin Camp

Year	Actual Water Consumption m ³ /yr
2011	194,129
2012	208,147
2013	214,035
2014	220,141
2015	221,052
2016	231,838
2017	227,155
2018	219,827
2019	225,466
2020	236,875

According to the above data, yearly actual water consumption is increasing at a rate of 2.3%. Then, by applying equation Eq. 4.2, actual water consumption in 1953 was calculated.

$$AWC_n = AWC_0 \times \left(1 + \frac{wcr}{100}\right)^n$$

$$AWC_{2011} = AWC_{1953} \times \left(1 + \frac{2.3}{100}\right)^{58}$$

$AWC_{1953} = 51,916 \text{ m}^3/\text{yr} = 142,236 \text{ l/d}$. and then, the actual water consumption at year 1954 calculated as:

$$AWC_{1954} = AWC_{1953} \times \left(1 + \frac{2.3}{100}\right)^1 = 53,110 \text{ m}^3/\text{yr} = 145,508 \text{ l/d}$$
 and so on.

In addition, daily actual water consumption per capita was calculated by equation Eq. 4.3 as shown below:

$$DAWC_{1953} = \frac{AWC_{1953}}{P_{1953}} = \frac{142,236 \text{ (l/d)}}{2,731 \text{ (capita)}} = \mathbf{52.1 \text{ l/c/d.}}$$

4. Because of the reservations of some governorates and the difficulties in getting yearly actual water consumption data for some camps, another scenario was studied for each camp, which is based on the World Health Organization's water consumption standards for each individual.

The deserved water consumption was calculated between 1953 and 2021 by adopting a standard of 100 l/c/d in 2021 and evaluating the annual increase rate (0.5%) (**Scenario No. 2, Deserved Water Consumption**)

$$DDWC_{2021} = 100 \text{ l/c/d}$$

$$DDWC_n = DDWC_0 \times \left(1 + \frac{i}{100}\right)^n$$

$DDWC_{1953} = DDWC_{2021} \times \left(1 + \frac{0.5}{100}\right)^{-68} = 71.12$ l/c/d. and then the deserved daily water consumption at year 1954 calculated as:

$$DDWC_{1954} = DDWC_{1953} \times \left(1 + \frac{0.5}{100}\right)^1 = 71.47 \text{ l/c/d. and so on.}$$

5. The total quantity of deserved water consumption was calculated by applying Eq. 4.5.

$$TDWC_{1953} = DDWC_{1953} \times P_{1953} = 71.12 \times 2,731 = 194,229 \text{ l/d.}$$

Table 8: Actual and Deserved Water Consumption for Jenin Refugees Camp since 1953 to 2021.

Jenin Camp Water Consumption					
Year	Population	Actual Water Consumption		Deserved Water Consumption	
		AWC m ³ /yr	AWC (L/c/d)	DWC (L/c/d)	DWC (m ³ /yr)
1953	2,731	51,916	52.1	71.12	70893
1954	2,788	53,110	52.2	71.47	72,729
1955	2,847	54,332	52.3	71.83	74,643
1956	2,907	55,582	52.4	72.19	76,598
1957	2,968	56,860	52.5	72.56	78,606
1958	3,030	58,168	52.6	72.92	80,646
1959	3,094	59,506	52.7	73.29	82,767
1960	3,159	60,874	52.8	73.66	84,933
1961	3,225	62,274	52.9	74.03	87,143
1962	3,293	63,707	53.0	74.40	89,425
1963	3,362	65,172	53.1	74.77	91,753
1964	3,432	66,671	53.2	75.15	94,139
1965	3,505	68,204	53.3	75.53	96,627
1966	3,578	69,773	53.4	75.90	99,123
1967	3,653	71,378	53.5	76.29	101,721
1968	3,730	73,019	53.6	76.67	104,382
1969	3,808	74,699	53.7	77.05	107,093
1970	3,888	76,417	53.8	77.44	109,897
1971	3,970	78,174	53.9	77.83	112,780
1972	4,053	79,973	54.1	78.22	115,714
1973	4,138	81,812	54.2	78.62	118,745
1974	4,225	83,694	54.3	79.01	121,843
1975	4,314	85,618	54.4	79.41	125,040
1976	4,405	87,588	54.5	79.81	128,321
1977	4,497	89,602	54.6	80.21	131,657
1978	4,592	91,663	54.7	80.61	135,109
1979	4,688	93,771	54.8	81.02	138,635

(Cont'd) Table 8: Actual and Deserved Water Consumption for Jenin Refugees Camp since 1953 to 2021.

Jenin Camp Water Consumption					
Year	Population	Actual Water Consumption		Deserved Water Consumption	
		AWC m³/yr	AWC (L/c/d)	DWC (L/c/d)	DWC (m³/yr)
1980	4,787	95,928	54.9	81.42	142,262
1981	4,887	98,134	55.0	81.83	145,965
1982	4,990	100,392	55.1	82.24	149,788
1983	5,094	102,701	55.2	82.66	153,691
1984	5,201	105,063	55.3	83.07	157,697
1985	5,311	107,479	55.4	83.49	161,847
1986	5,422	109,951	55.6	83.91	166,060
1987	5,536	112,480	55.7	84.33	170,401
1988	5,652	115,067	55.8	84.75	174,838
1989	5,771	117,714	55.9	85.18	179,424
1990	5,892	120,421	56.0	85.61	184,111
1991	6,016	123,191	56.1	86.04	188,930
1992	6,142	126,024	56.2	86.47	193,851
1993	6,271	128,923	56.3	86.91	198,930
1994	6,403	131,888	56.4	87.34	204,122
1995	6,537	134,921	56.5	87.78	209,444
1996	6,675	138,024	56.7	88.22	216,033
1997	6,815	141,199	56.8	88.67	220,564
1998	6,958	144,447	56.9	89.11	226,310
1999	7,104	147,769	57.0	89.56	232,225
2000	7,253	151,168	57.1	90.01	238,288
2001	7,406	154,644	57.2	90.46	244,531
2002	7,561	158,201	57.3	90.92	250,918
2003	7,720	161,840	57.4	91.37	257,462
2004	7,882	165,562	57.5	91.83	264,188
2005	8,048	169,370	57.7	92.29	271,104
2006	8,217	173,266	57.8	92.76	278,206
2007	8,389	177,251	57.9	93.22	285,438
2008	8,565	181,327	58.0	93.69	292,896
2009	8,745	185,498	58.1	94.16	300,552
2010	8,929	189,764	58.2	94.64	308,440
2011	9,116	194,129	58.3	95.11	316,463
2012	9,308	208,147	61.3	95.59	324,759
2013	9,503	214,035	61.7	96.07	333,228
2014	9,703	220,141	62.2	96.55	341,941
2015	9,907	221,052	61.1	97.04	350,902
2016	10,115	231,838	62.8	97.52	360,041
2017	10,327	227,155	60.3	98.01	369,434
2018	10,541	219,827	57.1	98.51	380,168

(Cont'd) Table 8: Actual and Deserved Water Consumption for Jenin Refugees Camp since 1953 to 2021.

Jenin Camp Water Consumption					
Year	Population	Actual Water Consumption		Deserved Water Consumption	
		AWC m ³ /yr	AWC (L/c/d)	DWC (L/c/d)	DWC (m ³ /yr)
2019	10,761	225,466	57.4	99.00	388,849
2020	10,986	236,875	59.1	99.50	398,984
2021	11,213	242,323	59.2	100	409,275
		∑= 8,624,149			∑= 13,373,519

The above table shows the actual and deserved water consumption quantities by the refugees in Jenin camp, which refers to several things:

- ✓ The Palestinian refugee shared with the host country about 8,624,149 m³ of its water resources, which in turn led to a reduction in the individual's right to daily water use
- ✓ A Palestinian refugee is entitled to consume about 13,373,519 m³ of water during the past 68 years, based on the standards of the WHO.
- ✓ While the Palestinian refugee was sharing water resources with the host country, with a daily water consumption rate of nearly half the rate approved by the World Health Organization, there was a settler consuming six to eight times the water right of the Palestinian refugees.

The figure below shows the differences between actual and deserved water consumption for some years in the Jenin camp

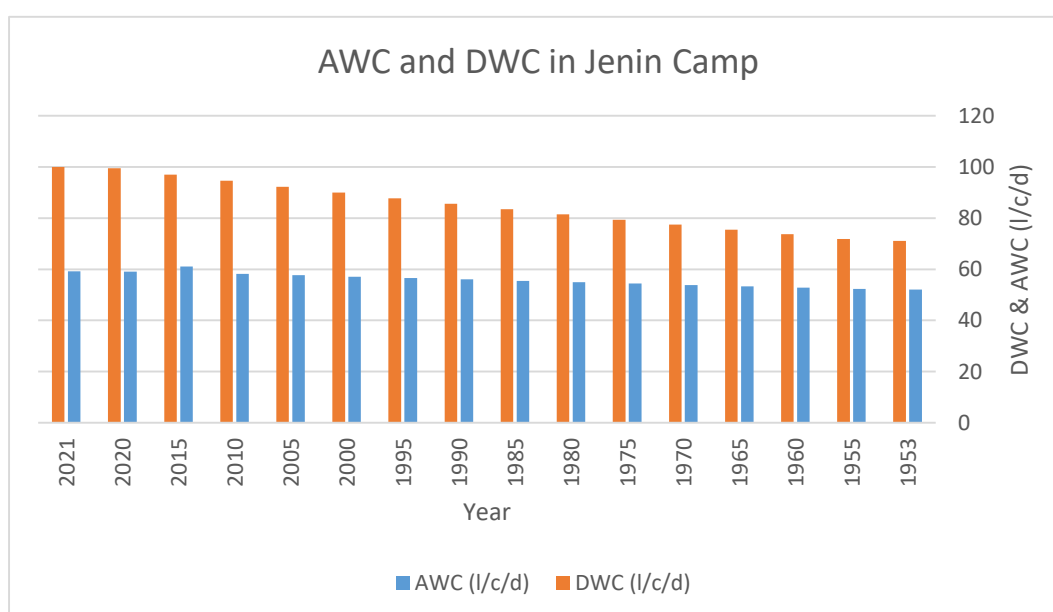


Figure 14: AWC and DWC in some years in Jenin Camp.

6. By applying Equation 5.1, the total quantity of deserved water consumption in Jenin camp since the beginning of the Arab-Israeli conflict was calculated as shown:

Table 9: Data required to calculate the total quantity of deserved water consumption at years 1953-2021 by a mathematical formula.

Data / Year	2021	1953
Population (P, capita)	11,213 (PCBS)	2,731 (Eq. 4.1)
Daily Water Consumption (DWC, l/c/d), (Deserved)	100 (WHO, PWA)	71.12 (Eq. 4.4)
$P \times DWC$ (m ³ /yr)	$WC_f = 409,275$	$WC_0 = 70,893$

The total quantity of deserved water consumption:

$$X = \sqrt[n]{\frac{WC_n \times P_n}{WC_0 \times P_0}} - 1 = \sqrt[68]{\frac{WC_{2021} \times P_{2021}}{WC_{1953} \times P_{1953}}} - 1 = \sqrt[68]{\frac{409,275}{70,893}} - 1 = 0.02612$$

$$TWC = WC_0 \times \frac{1-(1+X)^{n+1}}{1-(1+X)} = 70,893 \times \frac{1-(1+0.02612)^{68+1}}{1-(1+0.02612)} = \mathbf{13,366,489 \text{ m}^3}$$

As shown by the result of the mathematical equation, the total quantities of deserved water consumption that must be claimed are **13,366,489 m³**, while the quantity resulting from data collection and analysis for all years of study was equivalent to **13,373,519 m³**, with an error rate of 0.053% that is scientifically acceptable, as shown:

$$\% \text{ Error} = \frac{|Value \text{ from Excel} - Value \text{ from Formula}|}{Value \text{ from Excel}} \times 100\%$$

$$\% \text{ Error} = \frac{|13,373,519.36 - 13,366,489.72|}{13,373,519.36} \times 100\% = 0.053\%$$

7. Also, by applying Equation 5.1, the total quantity of Actual water consumption in Jenin camp since the beginning of the Arab-Israeli conflict was calculated as shown

Table 10: Data required to calculate the total quantity of Actual water consumption at years 1953-2021 by a mathematical formula.

Data / Year	2021	1953
Population (P, capita)	11,213 (PCBS)	2,731 (Eq. 4.1)
Daily Water Consumption (AWC, l/c/d), (Actual)	59.2 (Municipality)	52.1 (Eq. 4.2)
$P \times AWC$ (m ³ /yr)	$WC_f = 242,323$	$WC_0 = 51,916$

The total quantity of actual water consumption:

$$X = \sqrt[n]{\frac{WC_n \times P_n}{WC_0 \times P_0}} - 1 = \sqrt[68]{\frac{WC_{2021} \times P_{2021}}{WC_{1953} \times P_{1953}}} - 1 = \sqrt[68]{\frac{242,323}{51,916}} - 1 = 0.02291$$

$$TWC = WC_0 \times \frac{1-(1+X)^{n+1}}{1-(1+X)} = 51,916 \times \frac{1-(1+0.02291)^{68+1}}{1-(1+0.02291)} = \mathbf{8,549,709 \text{ m}^3}$$

As shown by the result of the mathematical equation, the total quantities of actual water consumption that must be claimed are **8,549,709 m³**, while the quantity resulting from data collection and analysis for all years of study was equivalent to **8,624,149 m³**, with an error rate of 0.86% that is scientifically acceptable, as shown:

$$\% \text{ Error} = \frac{|Value \text{ from Excel} - Value \text{ from Formula}|}{Value \text{ from Excel}} \times 100\%$$

$$\% \text{ Error} = \frac{|8,624,149.36 - 8,549,709.437|}{8,624,149.36} \times 100\% = 0.86\%$$

Case Study 2: Khanyounis Camp in Gaza Strip

In 1948, the Khanyounis camp was established. It covers 0.549 km² within the Khanyounis municipality (UNRWA, 2015).

1. Data on the number of Palestinian refugees in Khanyounis camp was collected through the Palestinian Central Bureau of Statistics, which found data for the years 2017 – 2021.

Table 11: Refugees Population in Khanyounis Camp (PCBS, 2021)

Year	Refugees Population	Year	Refugees Population
2017	40,691	2020	44,620
2018	41,980	2021	45,970
2019	43,289		

2. The number of Palestinian refugees in 1948 was calculated using equation Eq. 4.1, while growth rate is equal 3.2 % according the available data as shown in table 11.

$$P_f = P_0 \times \left(1 + \frac{r}{100}\right)^n$$

$$P_{2017} = P_{1948} \times \left(1 + \frac{3.2}{100}\right)^{69}$$

$P_{1948} = 4,630$ capita, and then the population at year 1954 calculated as:

$$P_{1949} = P_{1948} \times \left(1 + \frac{3.2}{100}\right)^1 = 4,778 \text{ capita and so on.}$$

3. The camp's yearly actual water consumption for the years 2001- 2021 was obtained through communication with the Khanyounis municipality. Then, It was used to evaluate the rate of rise or reduction in water consumption, and then to determine yearly actual water consumption for the years 1953 to 2012 using equation Eq. 4.2. **(Scenario No. 1, Actual Water Consumption)**

Table 12: Annual actual water consumption for Palestinian refugees in Khanyounis Camp

Year	Actual Water Consumption m ³ /yr)
2001	606,367
2002	606,367
2003	657,813
2004	686,406
2005	714,481
2006	844,792
2007	753,041
2008	906,482
2009	925,497
2010	1,101,480
2011	1,094,698
2012	1,161,294
2013	1,228,992
2014	1,137,975
2015	1,112,568
2016	1,194,364
2017	1,305,368
2018	1,366,423
2019	1,338,340
2020	1,393,000
2021	1,187,968

According to the above data, yearly actual water consumption is increasing at a rate of 4.0%. Then, by applying equation Eq. 4.2, water consumption in 1948 was calculated.

$$AWC_n = AWC_0 \times \left(1 + \frac{wcr}{100}\right)^n$$

$$AWC_{2001} = AWC_{1948} \times \left(1 + \frac{4.0}{100}\right)^{53}$$

$AWC_{1948} = 75,852 \text{ m}^3/\text{yr} = 207,814 \text{ l/day}$. and then, the actual water consumption at year 1949 calculated as:

$$AWC_{1949} = AWC_{1948} \times \left(1 + \frac{4.0}{100}\right)^1 = 78,886 \text{ m}^3/\text{yr} = 216,127 \text{ l/day}$$
 and so on.

In addition, daily actual water consumption was calculated by equation Eq. 4.3 as shown below:

$$DAWC_{1948} = \frac{AWC_{1948}}{P_{1948}} = \frac{207,814}{4,630} = 44.9 \text{ l/c/d.}$$

4. Because of the reservations of some governorates and the difficulties in getting yearly actual water consumption data for some camps, another scenario was studied for each camp, which is based on the World Health Organization's water consumption standards for each individual.

The deserved yearly water consumption was calculated between 1948 and 2021 by adopting a standard of 100 l/c/d in 2021 and evaluating the annual increase rate (0.5%) according to PWA recommendation. **(Scenario No. 2, Deserved Water Consumption)**

$$DDWC_{2021} = 100 \text{ l/c/d}$$

$$DDWC_n = DDWC_0 \times \left(1 + \frac{i}{100}\right)^n$$

$DDWC_{1948} = DDWC_{2021} \times \left(1 + \frac{0.5}{100}\right)^{-73} = 69.4 \text{ l/c/d}$. and then the deserved daily water consumption at year 1949 calculated as:

$$DDWC_{1949} = DDWC_{1948} \times \left(1 + \frac{0.5}{100}\right)^1 = 69.7 \text{ l/c/d.}$$
 and so on.

5. The total quantity of deserved water consumption was calculated by applying Eq. 4.5.

$$TDWC_n = DDWC_{1948} \times P_{1948} = 69.4 \times 4,630 = 321,322 \text{ l/d.}$$

Table 13: Actual and Deserved Water Consumption for Khanyounis Refugees Camp since 1948 to 2021.

Khanyounis Camp					
Year	Population	Actual Water Consumption		Deserved Water consumption	
		AWC (m³/yr)	AWC(L/c/d)	DWC (L/c/d)	DWC (m³/yr)
1948	4,630	75,852	44.9	69.4	117,213
1949	4,778	78,886	45.2	69.7	121,572
1950	4,931	82,042	45.6	70.1	126,093
1951	5,089	85,323	45.9	70.4	130,782
1952	5,252	88,736	46.3	70.8	135,645
1953	5,420	92,286	46.6	71.1	140,689
1954	5,593	95,977	47.0	71.5	145,921
1955	5,772	99,816	47.4	71.8	151,347
1956	5,957	103,809	47.7	72.2	156,975
1957	6,148	107,961	48.1	72.6	162,812
1958	6,344	112,280	48.5	72.9	168,866
1959	6,548	116,771	48.9	73.3	175,146
1960	6,757	121,442	49.2	73.7	181,659
1961	6,973	126,300	49.6	74.0	188,414
1962	7,196	131,352	50.0	74.4	195,420
1963	7,427	136,606	50.4	74.8	202,687
1964	7,664	142,070	50.8	75.1	210,224
1965	7,910	147,753	51.2	75.5	218,042
1966	8,163	153,663	51.6	75.9	226,150
1967	8,424	159,809	52.0	76.3	234,559
1968	8,693	166,202	52.4	76.7	243,282
1969	8,972	172,850	52.8	77.1	252,328
1970	9,259	179,764	53.2	77.4	261,711
1971	9,555	186,954	53.6	77.8	271,443
1972	9,861	194,432	54.0	78.2	281,537
1973	10,176	202,210	54.4	78.6	292,006
1974	10,502	210,298	54.9	79.0	302,865
1975	10,838	218,710	55.3	79.4	314,127
1976	11,185	227,458	55.7	79.8	325,808
1977	11,543	236,557	56.1	80.2	337,924
1978	11,912	246,019	56.6	80.6	350,490
1979	12,293	255,860	57.0	81.0	363,523
1980	12,687	266,094	57.5	81.4	377,041
1981	13,093	276,738	57.9	81.8	391,062
1982	13,512	287,808	58.4	82.2	405,604
1983	13,944	299,320	58.8	82.7	420,687

(Cont'd) Table 13: Actual and Deserved Water Consumption for Khanyounis Refugees Camp since 1948 to 2021.

Khanyounis Camp					
Year	Population	Actual Water Consumption		Deserved Water consumption	
		AWC (m ³ /yr)	AWC(L/c/d)	DWC (L/c/d)	DWC (m ³ /yr)
1984	14,390	311,293	59.3	83.1	436,330
1985	14,851	323,744	59.7	83.5	452,555
1986	15,326	336,694	60.2	83.9	469,384
1987	15,816	350,162	60.7	84.3	486,839
1988	16,323	364,168	61.1	84.8	504,942
1989	16,845	378,735	61.6	85.2	523,719
1990	17,384	393,884	62.1	85.6	543,194
1991	17,940	409,640	62.6	86.0	563,393
1992	18,514	426,025	63.0	86.5	584,343
1993	19,107	443,066	63.5	86.9	606,073
1994	19,718	460,789	64.0	87.3	628,610
1995	20,349	479,221	64.5	87.8	651,986
1996	21,000	498,389	65.0	88.2	676,230
1997	21,672	518,325	65.5	88.7	701,377
1998	22,366	539,058	66.0	89.1	727,458
1999	23,081	560,620	66.5	89.6	754,509
2000	23,820	583,045	67.1	90.0	782,566
2001	24,582	606,367	67.6	90.5	811,667
2002	25,369	630,622	68.1	90.9	841,849
2003	26,181	655,847	68.6	91.4	873,154
2004	27,019	682,080	69.2	91.8	905,623
2005	27,883	709,364	69.7	92.3	939,300
2006	28,775	737,738	70.2	92.8	974,228
2007	29,696	767,248	70.8	93.2	1,010,456
2008	30,647	797,938	71.3	93.7	1,048,031
2009	31,627	829,855	71.9	94.2	1,087,003
2010	32,639	863,049	72.4	94.6	1,127,424
2011	33,684	897,571	73.0	95.1	1,169,348
2012	34,762	933,474	73.6	95.6	1,212,831
2013	35,874	970,813	74.1	96.1	1,257,932
2014	37,022	1,009,646	74.7	96.6	1,304,709
2015	38,207	1,050,031	75.3	97.0	1,353,226
2016	39,429	1,092,033	75.9	97.5	1,403,547
2017	40,691	1,135,714	76.5	98.0	1,455,739
2018	41,980	1,181,143	77.1	98.5	1,509,401
2019	43,289	1,228,388	77.7	99.0	1,564,288
2020	44,620	1,277,524	78.4	99.5	1,620,487
2021	45,970	1,328,625	79.2	100	1,677,905
		Σ= 32,647,937			Σ= 43,823,310

The above table shows the actual and deserved water consumption quantities by the refugees in Khanyounis camp, which refers to several things:

- ✓ The Palestinian refugee shared with the host country about 32,647,937 m³ of its water resources, which in turn led to a reduction in the individual's right to daily water use
- ✓ A Palestinian refugee is deserved to consume about 43,823,310 m³ of water during the past 68 years, based on the standards of the WHO.
- ✓ While the Palestinian refugee was sharing water resources with the host country, with a daily water consumption rate of nearly half the rate approved by the World Health Organization, there was a settler consuming six to eight times the water right of the Palestinian refugee (Nazer, 2009; 2010).

The figure below shows the differences between actual and deserved water consumption for some years in the Khanyounis camp

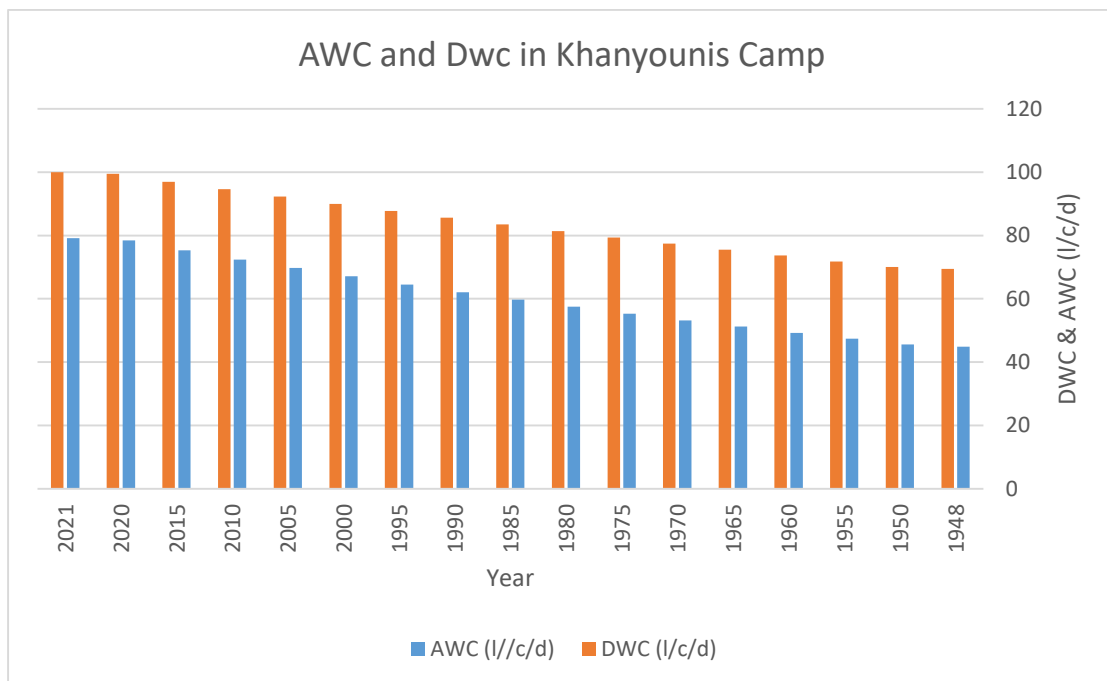


Figure 15: AWC and DWC in Some Years in Khanyounis camp

6. By applying Equation 5.1, the total quantity of deserved water consumption in Khanyounis camp since the beginning of the Arab-Israeli conflict was calculated as shown:

Table 14: Data required calculating the total quantity of deserved water consumption at years 1948-2021 by a mathematical formula.

Data / Year	2021	1948
Population (P, capita)	45,970 (PCBS)	4,630 (Eq. 4.1)
Daily Water Consumption (DWC, l/c/d), (Deserved)	100 (WHO, PWA)	69.4 (Eq. 4.4)
$P \times DWC$ (m ³ /yr)	$WC_T = 1,677,905$	$WC_0 = 117,213$

The total quantity of deserved water consumption:

$$X = \sqrt[n]{\frac{WC_n \times P_n}{WC_0 \times P_0}} - 1 = \sqrt[73]{\frac{WC_{2021} \times P_{2021}}{WC_{1948} \times P_{1948}}} - 1 = \sqrt[73]{\frac{1,677,905}{117,213}} - 1 = 0.03713$$

$$TWC = WC_0 \times \frac{1-(1+X)^{n+1}}{1-(1+X)} = 117,213 \times \frac{1-(1+0.03713)^{73+1}}{1-(1+0.03713)} = \mathbf{43,714,515 \text{ m}^3}$$

As shown by the result of the mathematical equation, the total quantities of deserved water consumption that must be claimed are **43,714,515 m³**, while the quantity resulting from data collection and analysis for all years of study was equivalent to **43,823,310 m³**, with an error rate of 0.25% that is scientifically acceptable, as shown:

$$\% \text{ Error} = \frac{|Value \text{ from Excel} - Value \text{ from Formula}|}{Value \text{ from Excel}} \times 100\%$$

$$\% \text{ Error} = \frac{|43,823,310 - 43,714,515.72|}{43,823,310} \times 100\% = 0.25\%$$

- Also, by applying Equation 5.1, the total quantity of Actual water consumption in Khanyounis camp since the beginning of the Arab-Israeli conflict was calculated as shown

Table 15: Data required to calculate the total quantity of Actual water consumption at years 1948-2021 by a mathematical formula.

Data / Year	2021	1948
Population (P, capita)	45,970 (PCBS)	4,630 (Eq. 4.1)
Daily Water Consumption (AWC, l/c/d), (Actual)	79.2 (Municipality)	44.9 (Eq. 4.2)
$P \times AWC$ (m ³ /yr)	$WC_T = 1,328,625$	$WC_0 = 75,852$

The total quantity of actual water consumption:

$$X = \sqrt[n]{\frac{WC_n \times P_n}{WC_0 \times P_0}} - 1 = \sqrt[73]{\frac{WC_{2021} \times P_{2021}}{WC_{1948} \times P_{1948}}} - 1 = \sqrt[73]{\frac{1,328,625}{75,852}} - 1 = 0.04$$

$$TWC = WC_0 \times \frac{1-(1+X)^{n+1}}{1-(1+X)} = 75,852 \times \frac{1-(1+0.04)^{73+1}}{1-(1+0.04)} = \mathbf{32,647,821 \text{ m}^3}$$

As shown by the result of the mathematical equation, the total quantities of actual water consumption that must be claimed are **32,647,821 m³**, while the quantity resulting from data collection and analysis for all years of study was equivalent to **32,647,937 m³**, with an error rate of 0.00035% that is scientifically acceptable, as shown:

$$\% \text{ Error} = \frac{|\text{Value from Excel} - \text{Value from Formula}|}{\text{Value from Excel}} \times 100\%$$

$$\% \text{ Error} = \frac{|32,647,937 - 32,647,821.55|}{32,647,937} \times 100\% = 0.00035\%$$

5.4 Perceptions of policymakers and experts

Research sample consisted of two categories, experts and policymakers. The sample size was 36, from PWA, Ministry of Health, Palestinian Standard Institution (PSI), Union of Palestinian Water Services Providers, Palestinian Hydrology Group, Universal Institute of Applied and Health Research, Negotiations, Municipalities, Universities, and others. Analysis of the results for the questionnaire directed to the policymakers/experts revealed the following:

- About 91.7% of the respondents believe that there are water rights for Palestinian refugees in camps.
- There are effective laws that require the restoration of Palestinian refugees' water rights, according to 19.4 % of respondents.
- As shown in Figure 16 below, about 94.4% of the respondents believe that there are water rights for all Palestinian refugees now, taking into account the growth rate of the refugee's population. While 2.8% of them believe that there are water rights only for Palestinian refugees who were expelled in 1948 and others believe that there are water rights only for Palestinian refugees in camps.

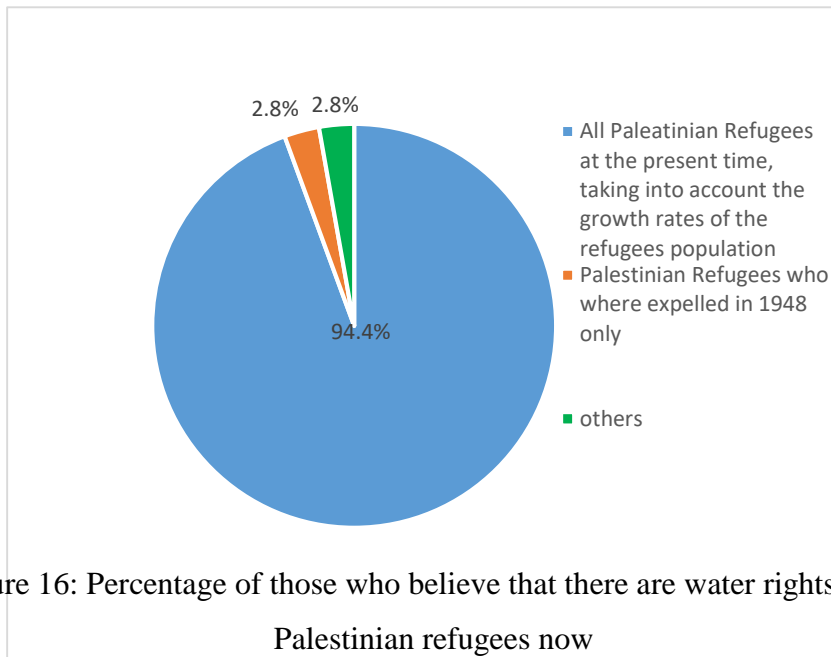


Figure 16: Percentage of those who believe that there are water rights for all Palestinian refugees now

- The ideal basis for demanding the restoration of refugees' water rights is through negotiations and international tribunals, according to 77.8% of respondents, while others highlighted the necessity for an external pressure factor with a strong power to favorably affect.

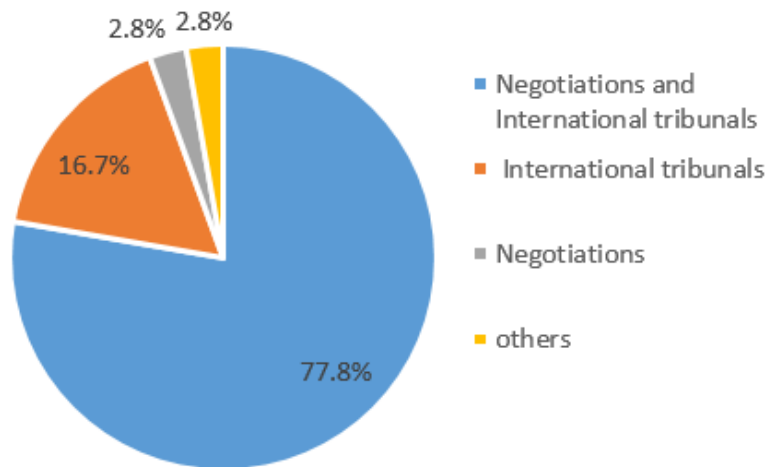


Figure 17: Percentage of those who believe that ideal basis for demanding the restoration of refugees' water rights are negotiations and international tribunals

- 75% of experts and policy makers indicated that the optimal method of compensation that should be claimed in relation to the right of water refugees is to increase the quantities of water currently supplied, while 11.1% of experts demanded financial compensation, and others pointed to other ways represented in:

- Financial compensation but only after getting all rights and control on own resources based on international laws and treaties.
- Improving water quality and quantity and reducing cost.
- Acquiring the fair allocations retrospectively from all shared basin.
- Increasing the amount of water supplied, which was confiscated for many years, in addition to financial compensation in order to establish water collection and treatment facilities as compensation for a lost right.

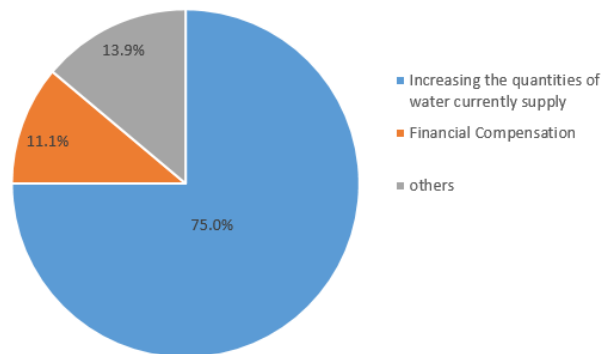


Figure 18: The optimal method of compensation that should be claimed in relation to the right of water refugees

- Despite the importance and sensitivity of the issue "the water rights of Palestinian refugees," 38.9% of the experts said it had never been addressed before, and 44.4 % said they did not know whether it had. 16.7% of experts stated that the issue was covered by the national strategy, which I will describe in more detail later.

5.4.1 National Water Strategy

The National Water and Sanitation Strategy aim to enhance the Palestinian Authority's approach to sustainable management of water resources, in order to ensure the protection, development and management of available water resources in a way that improves water supply and sanitation services in a sustainable manner (PWA, 2013b).

The national strategy emphasized that the Palestinians will continue to demand their water rights, including the equitable right of access, the right to control natural resources, including water, and the right to a fair and equitable use of water resources shared with other countries in accordance with international law. Therefore, the Palestinian National Water Strategy focused on (PWA, 2013b):

1. Demanding the right of every Palestinian to obtain water supplies of the required quality and quality at an affordable cost.
2. A special focus is placed on improving water and sanitation services in marginalized areas, including rural areas, remote villages and refugee camps.

The Palestinian Water Authority concluded a two-stage water strategy in 2013; the short-term (2012-2017) and the long-term (2012-2032) phase (PWA, 2014b).

Short-Term Phase (2014-2016, 2017-2022, 2021-2023):

In view of the restrictions and obstacles that Israel imposes on the Palestinian people, represented by the previously mentioned military orders.

The short-term plan focuses only on investments and management of water resources in light of the existing political situation, and as soon as the military restrictions are removed, the short-term plan will be updated to conform to the long-term strategy (PWA, 2013b).

As a result, the methods adopted by the short-term plan were limited to: programs to reduce unaccounted for water (UFW), issuing permits to dig new wells or rehabilitating existing wells, preserving available water from pollution, adopting non-conventional water sources such as desalinating brackish spring water, collecting water Rainfall and the use of treated wastewater for irrigation (PWA, 2013b).

Among the short-term strategic plans (2017-2021), the following goals were set (PWA, 2016):

1. Increase the quantity and quality of accessible water, as well as the amount of water delivered to Palestinians.
2. Assisting Palestinians in obtaining their water rights through national initiatives.
3. Prevent contamination and depletion of water supplies.
4. Improving and improving all water distribution systems is a top priority.
5. Improving the efficiency of wastewater collection, transportation, treatment, and reuse systems.

Long-Term Phase (2012-2032):

A long-term strategy for the water and sanitation sector under an independent Palestinian state has been developed, based on the following assumptions (PWA, 2013b):

1. In accordance with the 1967 boundaries, including East Jerusalem, the Palestinian people would reclaim their full rights to natural water resources in all forms, surface and underground. As a result, the country's water supply will be substantially larger than it is currently.
2. According to particular objectives and plans, the Palestinian Authority shall have complete control over the planning and implementation of all required water and sanitation infrastructure.
3. The population will grow dramatically because of population growth and the return of many returnees to the nation.
4. There will be no obstructive military directives; hydraulic equipment imports will not be banned, which will boost water supply and sewage network services.
5. The JWC will be disbanded and replaced with other cooperation mechanisms aimed at ensuring Palestine's and neighboring countries' long-term management of transboundary water resources based on a just and equitable distribution of shared water resources in accordance with international law. In other words, the Palestinians will be successful in negotiating reasonable transboundary water-sharing arrangements with neighboring nations (Jordan River, Wadi Gaza and groundwater).

The long-term strategy aimed to improve the water and sanitation services provided to Palestinians over the next twenty years, and was based on the following (PWA, 2012b):

- Increasing the quantity and quality of water supplied to the Palestinians for all purposes.
- Managing water resources in a sustainable and environmental way.
- Protect the available environmental resources
- Providing access for all citizens to a reliable source of water at an affordable cost.
- Improving sanitation to protect natural water resources from pollution.
- Ensuring the financial sustainability of developing water facilities and sewage treatment plants.

If a final deal on water and sanitation cannot be reached with Israel in the final negotiations, there will be no way to execute long-term strategies, which would have a

negative impact on the water situation in the occupied Palestinian territories (PWA, 2013b).

The Palestinian Water Authority has been concerned with restoring Palestinians' water rights in general, in accordance with international law, and has targeted rural areas like villages, refugee camps, and Bedouin communities. It referred to the current water situation.

In terms of the thesis's topic, the strategy can be used to reclaim the rights of Palestinian refugees in particular, as well as Palestinians in general. In addition, it must be connected the water problem to other unresolved issues (refugees, Jerusalem, settlements and borders):

1. Refugees: Palestinian refugees should be included in water rights discussions, both in the country and in the diaspora. Because the number of refugees will have a significant impact on Palestinian water demands, these needs must be satisfied while taking into account the return of refugees from the diaspora to their homelands.

As revealed by the study's findings, Palestinian refugees in the camps have a right to consume 447,345,438 m³ since the start of the Arab-Israeli war. This quantity must be claimed, as well as compensation for any damages caused by Israel to the camps since that time.

2. Jerusalem: There are more than 300,000 Palestinians residing in Jerusalem, and their water needs must be considered
3. Settlements: They are virtually illegal facilities, consuming the available water resources in the West Bank; as a result, they must be isolated from Palestinian water infrastructure, since they represent an added burden, or given to the Palestinian administration.
4. Boundaries: The international law of transit waters must be adhered to based on the principle of equitable and equitable distribution of all countries participating in the basin or watercourse.

Chapter Six

Conclusions and Recommendations

6.1 Conclusions

- In the middle of 2021, there were nearly 420,565 refugees in Palestinian camps, in addition to refugees living in villages and towns near to their real homeland and Palestinian refugees in the diaspora.
- The environmental impact of refugees is clearly shown in the land, surface water, groundwater recharge, soil, roads, green areas, and other resources available in the host country. These impacts are generally negative.
- The issue of refugees' water rights in their home country (country of origin) is totally ignored.
- The average deserved water consumption for domestic use by Palestinian refugees in camps varies between 70 l/c/d – 100 l/c/d over 73 years.
- The total quantity of deserved water consumption in the camps is 447,345,438 m³, which is the total quantity of domestic water that must be negotiated within the refugees' water rights.
- The average actual water consumption for domestic use by Palestinian refugees in camps varies between 50 l/c/d – 80 l/c/d over 73 years.
- The quantities of water supplied are equivalent to at most 70% of the quantities of deserved water for domestic use.
- The study was limited to the quantities of domestic water but took into account the quantities of water for agricultural purposes. Each dunum of agricultural land required 600 m³ of water annually, and the current supplier is only 70% of the deserved value.
- 91.7% of the policymakers and experts note that there are Palestinian refugees' water rights in camps. Nevertheless, there are no laws stated clearly there are refugees water rights.
- 75% of experts and policymakers indicated that the optimal method of compensation that should be claimed in relation to the right of water refugees is to increase the quantities of water currently supplied.

- The issue of Palestinian water resources is an important issue, as it has gained special importance in the international community and the United Nations General Assembly. The results concluded that the Palestinian have a right to permanent sovereignty over natural and water resources. However, these laws did not recognize the refugee's water rights in their country of origin.
- According to the preliminary agreement signed between the two sides (the Palestinians and the Israelis), the Palestinians are able to obtain non-conventional water resources to fulfill their needs. This really has to be avoided. Natural rights must be claimed and restored, and then non-traditional resources must be explored.

6.2 Recommendations

- The research was limited to Palestinian refugees in West Bank and Gaza Strip camps, but it may be applied to all refugees, regardless of location (diaspora refugees).
- In the final negotiations, any temporary arrangements for the water problem or the water of the settlements must be rejected. It is better to have a transitional period in which the control of Palestinian water resources is transferred to the Palestinian leadership and sovereignty over the completely Palestinian land, including its natural resources, is imposed.
- The Palestinian negotiator must adhere to the right of self-determination and international law to obtain Palestinian water rights, from all Palestinian and trans-border water sources, including the Jordan River, as well as the right of Palestinian refugees.
- Claiming the Palestinian water right does not mean increasing the quantities of water supplied to the Palestinians, but rather ensuring the right to access and manage all water resources in a way that achieves the sustainable development of the Palestinian state. In addition to compensating for all the damages caused by Israel because of preventing the Palestinians from using their water resources.
- Preparing the compensation file in a technical and highly professional manner, as Israel has prevented the Palestinian side of water-based growth and development for long period, in addition to the quantities of water that have been completely used.

- Obtaining the appropriate permits and trying to establish a Palestinian corporation with control of all water resources that serve the state's public interest.

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Annax A: Palestinian Refugees Population

No.	Camps Name	1948	1967	2017	2018	2019	2020	2021
1	Aida	624	943	2800	2861	2923	2986	3050
2	AL- Azza	336	509	1510	1543	1576	1610	1645
3	Dheisheh	1945	2940	8729	8919	9114	9311	9510
4	Arroub	1410	2339	8863	9101	9342	9586	9834
5	Fawwar	1205	1999	7575	7778	7984	8192	8404
6	Jenin	2461	3653	10327	10541	10761	10986	11213
7	Ein Sultan	1186	1696	4346	4426	4507	4590	4675
8	Aqabet Jaber	2424	3466	8882	9046	9212	9382	9554
9	Ein Beit AL- Ma'	907	1322	3557	3626	3696	3768	3840
10	Old Askar	1653	2408	6480	6606	6734	6864	6996
11	New Askar	1205	1756	4726	4817	4911	5006	5102
12	Balata	3700	5390	14508	14789	15076	15367	15663
13	Qalandia	1720	2649	8259	8448	8639	8832	9026
14	Deir Ammar	389	599	1868	1909	1951	1993	2035
15	Al - Ama'ri	975	1503	4684	4787	4892	4997	5103
16	Al- Jalazon	1693	2608	8130	8309	8491	8674	8858
17	Silwad	94	145	452	462	472	482	493
18	Qaddoura	191	294	916	936	957	977	998
19	Al - Fara'a	1161	1789	5576	5701	5827	5956	6086
20	Nour Shams	1737	2484	6367	6482	6599	6718	6839
21	Tulkarem	2687	3842	9845	10022	10203	10387	10574
22	Nusierat	4081	7155	31369	32301	33243	34194	35153
23	Bureij	3602	6316	27690	28513	29344	30184	31030
24	Maghazi	2334	4092	17941	18474	19012	19557	20105
25	Deir al- Balah	898	1574	6902	7107	7314	7523	7734
26	Beach (Shati)	6848	11153	40249	41296	42361	43441	44535
27	Khan Younies	4630	8424	40691	41980	43289	44620	45970
28	Jabalia	4552	8751	48873	50575	52313	54084	55887
29	Rafah	4394	7848	36115	37221	38348	39492	40653
	Total Refugees	61042	99648	378230	388576	399091	409759	420565

Annex B: Actual Water Consumption

No. of Camps	Camps Name	1948	1967	2017	2018	2019	2020	2021
1	Aida	48579	51521	60145	60331	60519	60082	60268
2	AL- Azza	84	401	24254	26328	28907	26810	29102
3	Dheisheh	55637	76928	180470	183574	183137	177319	180369
4	Arroub							
5	Fawwar							
6	Jenin	46337	71378	227155	219827	225466	236875	242323
7	Ein Sultan							
8	Aqabet Jaber							
9	Ein Beit AL-Ma'	52587	63530	80608	84106	92884	93231	66124
10	Old Askar	137178	139808	162560	176433	205404	188202	124195
11	New Askar		9392	13238	14501	14538	14019	11296
12	Balata	245810	275399	346739	361078	385167	379617	276015
13	Qalandia	49491	76237	249838	250423	243803	252595	258405
14	Deir Ammar	12070	25429	196476	198880	193449	198585	206528
15	Al - Ama'ri	11237	23674	190525	186852	178361	188632	196177
16	Al- Jalazoon	12903	27185	202426	210908	208537	208537	216878
17	Silwad			11688	14905	13449	14537	15816
18	Qaddoura	17631	18664	21449	20242	19492	20508	20570
19	Al - Fara'a			346410	433610	462430	451620	541944
20	Nour Shams							
21	Tulkarem							
22	Nusierat	534563	778758	2152092	2081305	2286770	2255795	2300911
23	Bureij	16192	48991	881908	966530	1068151	1062214	1125947
24	Maghazi	43072	90746	670048	679636	613885	719176	747943
25	Deir al- Balah	236011	313175	543509	619356	680195	671158	681225
26	Beach (Shati)	1162384	1858246	5270244	5402000	5412683	5548000	5686700
27	Khan Younies	28798.161	60673.38	1305368	1366423	1338340	1393000	1187968
28	Jabalia							
29	Rafah	5398	23297	1283835	1193971	1242788	1587878	1192841

Policy maker/ Expert questionnaire

السادة المحترمين

تحية طيبة وبعد،

تقوم الباحثة بدراسة تهدف إلى تطوير نموذج رياضي لاحتساب كميات المياه التي يستحقها اللاجئ الفلسطيني منذ بداية الصراع العربي الإسرائيلي ليومنا هذا في كل من الضفة الغربية وقطاع غزة، وذلك للمطالبة باسترداد حقوقهم المائية، وتعدّ هذه الدراسة من المتطلبات لاستكمال الحصول على درجة الماجستير في هندسة المياه والبيئة في جامعة بيرزيت، ولتحقيق اهداف الدراسة تم اعداد هذه الاستبانة لقياس آراء صنّاع القرار/ الخبراء في قطاع المياه وتوجهاتهم بخصوص حقوق اللاجئين المائية و استردادها من البلاد المهجرين منها، لذا أعدت هذه الاستبانة والمتعلقة بموضوع البحث، وستستعين الباحثة باستخدام المقابلات للجمع بين الكمي من نتائج الدراسة والنوعي من نتائج المقابلات الفردية.

نرجو تعاونكم ومساعدتكم في تعبئة الاستبانة بدقة وعناية وموضوعية، علماً بأن المعلومات التي نحصل عليها ستعالج بسرية تامة ولن تستخدم إلا لأغراض البحث العلمي.

شاكرين لكم حسن تعاونكم

الباحثة: م. رحمة صالح عطوط

إشراف: د. ماهر أبو ماضي

* Gender / الجنس

Male

Female

* Age Group / الفئة العمرية

30 – 18

45 – 31

60 – 46

60 and Older

* Education Level / مستوى التعليم

Bachelor's Degree

Master Degree

PhD Degree

* Work Institution / مؤسسة العمل

* Job Title / المسمى الوظيفي

Do you believe Palestinian refugees have water rights in the areas where they have been displaced / هل تعتقد بأنّ للاجئين الفلسطينيين حقوق مائية في البلاد التي هجروا منها؟*

Yes

No

Are there any effective laws that require the Palestinians' Refugees water rights be restored, In your opinion? / هل هناك قوانين فعالة تطالب بإعادة حقوق اللاجئين الفلسطينيين المائية، برأيك؟*

Yes

No

Should the amounts of water due only to the Palestinian refugees who were expelled from their lands in 1948, or to all current refugees, in your opinion, be claimed? / هل يجب المطالبة بكميات المياه المستحقة فقط للاجئين الفلسطينيين الذين طردوا من أراضيهم عام 1948 ، أم لجميع اللاجئين الحاليين ، برأيك؟*

Palestinian refugees who were expelled in 1948

All Palestinian refugees at the present time, taking into account the growth rates of the refugee population

Other

إذا كانت اجابتك غير ذلك في السؤال أعلاه، نرجو منك الإجابة على التالي:

Please specify which category of refugees you think is most entitled to seek their water rights / يرجى تحديد فئة اللاجئين التي تعتقد أنها الأكثر استحقاقًا للحصول على حقوق المياه الخاصة بهم*

What are the basis to be followed to claim the restoration of the water rights of Palestinian

refugees? / ما هي الأسس التي يجب اتباعها للمطالبة باسترداد الحقوق المائية للاجئين الفلسطينيين؟*

- Negotiations / المفاوضات
- International tribunals / المحاكم الدولية
- Negotiations and International tribunals / المفاوضات والمحاكم الدولية
- Other

إذا كانت اجابتك غير ذلك في السؤال أعلاه، نرجو منك الإجابة على التالي:

Please specify the appropriate basis in your opinion / يرجى تحديد الأسس المناسبة باعتقادك*

What is the optimal compensation method for Palestinian refugees? / ما هي طريقة التعويض

المُتلى بحقّ اللاجئين الفلسطينيين؟*

- Financial compensation / تعويض مالي
- Increasing the quantities of water currently supplied / زيادة كميات المياه المزودة حالياً
- Other

إذا كانت اجابتك غير ذلك في السؤال أعلاه، نرجو منك الإجابة على التالي:

Please specify the methods of compensation that you deem appropriate for the Palestinian

refugees and their water conflict / يرجى تحديد طرق التعويض التي تراها مناسبة بحق اللاجئين

الفلسطينيين و صراعهم المائي*

Has this topic been discussed previously? / هل تمت مناقشة هذا الموضوع مسبقاً؟*

- Yes
- No
- Don't Know

إذا كانت اجابتك نعم في السؤال أعلاه، نرجو منك الإجابة على التالي:

Please specify the context in which it was discussed, or add a substantive comment on the topic that was previously discussed / يرجى تحديد السياق الذي تمت مناقشته فيه ، أو إضافة تعليق جوهري على الموضوع الذي تمت مناقشته مسبقاً*

Did the national strategies address the water rights of Palestinian refugees? / هل تطرقت الاستراتيجيات الوطنية لحقوق اللاجئين المائية؟ *

Yes

No

Don't Know

إذا كانت اجابتك نعم في السؤال أعلاه، نرجو منك الإجابة على التالي:

Please explain the relevant strategy / يرجى توضيح الاستراتيجية ذات العلاقة*

Do you have advice or guidance you want to give the researcher? / هل لديك نصيحة أو توجيه تريد توجيهه للباحثة؟*

Thank You