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Faculty of Graduate Studies

PALESTINIAN WATER RIGHTS IN THE INTERNATIONAL WATER LAW

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Dedication

إلى أرواح شهداءنا الأبرار وأسرانا الأبطال

إلى معلمتي الأولى ونبراسي المضيء ونبع الحنان، لأمي

إلى رجل الكفاح الذي زرع القيم والمبادئ، لأبي

إلى أقماري الخمسة التي تدور في أفلاك حياتي فتنيرها، لإخوتي

إلى عزوتي وسندي وقوتي، لأصدقائي وأحبابي

إلى علمهم و تعليمهم ودروسهم وعطاءهم لأساتذتي

إلى سنيني بركام ماضيها وثراء حاضرها وطموح مستقبلها ...

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Declaration

I, the undersigned, declare that I submitted the thesis which is titled:

PALESTINIAN WATER RIGHTS IN THE INTERNATIONAL LAW

I declare that the work provided in this thesis, unless otherwise referenced, is the researcher's work, and has not been submitted elsewhere for any other degree or qualification.

Student's name: **Mohammad AL-Alawneh**

Signature: _____

Date: _____

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PALESTINIAN WATER RIGHTS IN THE INTERNATIONAL LAW

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ABSTRACT

Palestine suffered from several occupations because of its lands and location in the middle of the Middle East. where it connects Asia, Europe, and Africa by its lands and it's the Mediterranean Sea. From 1917, Palestine suffered from several wars from the British army, which ended its mandate in 1948 by giving the Israeli Army Belfour declaration.

Water issue between Palestinian and Israeli Occupation was one of the most important issues where conflict exists until these days. After the 1967 war, the Israeli occupation controlled all water resources available in the West Bank and Gaza Strip and start exploiting while preventing Palestinians from developing any additional resources. Article 40 in the Oslo II agreement talks about water share quantities for each country for the interim period of five years. It should be mentioned that the quantities mentioned are not equitable for any time after the year 1999 because it is considered expired accords. So, the Helsinki principles adapted in 1966, mentioned equitable utilization of the waters of an international drainage basin. Article V mentioned eleven factors to be considered while determining the equitable share from shared international watercourses of each riparian state.

Questionnaire distributed to Palestinian water experts to give marks for Helsinki factors according to their importance and multiple criteria decision analysis applied as a tool of Judgment between riparian countries. The final results showed that the percentage of water resources that should be allocated to the State of Palestine is about 56% from groundwater resources which equals 642.31 Mcm/Yr, where the present utilization percentage is less than 15%. For Jordan Rivier Basin the equitable utilization is 20.86% which equals 292.04 Mcm/Yr whereas the Present utilization is 0% from it.

Keywords: Helsinki Rules, riparian countries, international watercourses, groundwater aquifers, Jordan River, equitable share, conflict, and utilization.

Chapter One

Introduction and Literature Review

1.1 Background

The location and lands of Palestine constitute the coveted by the invaders since it is considered a link between three continents. For that, Palestinians faced many wars and occupations all over history causing many cultural and social changes to the population. Assyrians, Babylonians, Persians, Greeks, Romans, Arabs, Fatimids, Seljuk Turks, Crusaders, Egyptians, and Mamelukes ruled Palestine (Editors, 2017).

Until 1917, Palestinian citizens control their land from the Mediterranean Sea to the Jordan River reaching the Dead Sea. When First World War ended, Ottoman Empire rule also ended and the winning countries shared the Empire lands where the British took control of Palestine. After 30 years of the British Mandate, the British gave the Jews living all around the world the Balfour Declaration to establish their national home in Palestine.

In 1948, the United Nations proposed a plan to partition Palestine into two states, an independent Jewish state, and an independent Arab state, and the special international regime for Jerusalem city (SC, 1947). In 1967, only six days were needed to shock the Arabs, change the Middle East and occupy the whole of Palestine from the Israeli army, and beat the Jordanian, Syrian and Egyptian armies (Ropp, 2006). Until this day, all the Palestinian rights on land, Jerusalem, the right to self-determination, and the return of refugees and water were taken away from Palestinians and are kept to be a subject of the final status negotiations between Palestinian and Israeli Occupation.

Conflicts between any parties start with land and existing natural resources. The Israeli Occupation put its hand on water resources to paralyze Palestine from one of its basic life needs. Palestine depends on surface water and groundwater to secure its water supply. Four groundwater aquifer basins and the Jordan river are considered the most important sources of freshwater.

Three groundwater aquifers exist in the West Bank, those are the Eastern Aquifer Basin where the potential abstraction rate is about 203 MCM/Yr, the North-Eastern Aquifer Basin with an annual abstraction rate of 123 MCM and the Western Aquifer Basin with 413 MCM abstraction annually and one in Gaza Coastal Aquifer that contains a highly deteriorate water with the potential abstraction of 195 MCM/Yr. Concerning the surface water resources, the Jordan River is the main surface water resource in historical Palestine. It originates from the Golan Heights and flows into the Dead Sea. Its length is about 251 km long and is shared by five countries which are Palestine, Israel, Jordan, Lebanon, and Syria (PWA, 2012). Palestine before 1967 War rely on Jordan River to provide water mainly for irrigation in the Jordan valley.

Until Oslo Accords 1993, Palestinian head to the negotiations table with Occupation to restore their rights under international sponsorship. Oslo mentioned 40 articles for Palestinian rights. Article 40 talks about the water and sewage agreement between two conflict parties in a transitional phase. In this article, the Israeli Occupation pledges to Palestinians to restore their rights in water. The two agreed to give Palestinians more amount in water, manage their resources, appropriate good drilling and locations, cooperation in managing water resources, and more where all this must end in 1999.

In 1966, International Law Association (ILA) adopted Helsinki Rules that applied to two riparian countries. 37 articles are created to solve conflicts between two riparian countries. Article IV and V are appropriate to create fair shared in basins between them dependent on many factors such as population, land, climate, drainage, and more.

In this thesis, we will try to use the international water laws, especially the Helsinki rules to reach the Palestinian equitable utilization of water resources available. The percentages that will be extracted will show the variation between the present and equitable utilization for the riparian countries from the shared international drainage basin.

1.2 Research Objectives

The main objectives of this research can be summarized in the following three main points:

- Develop a water balance for the different Palestinian water resources both shared and indigenous ones.

- Based on the application of International Law to the current political situation in Palestine, Conclude the future Palestinian water rights and its share of all available resources.

1.3 Methodology

Conclude the equitable utilization of available west bank groundwaters, Gaza strip groundwater, and Jordan River for the State of Palestine from international water laws. The factors of Helsinki Rules mentioned in article V will be used as criteria separation of the riparian countries. So, the methodology that will be used in this study consists of the following steps:

1. Data collection which will include data regarding the yield and renewable quantities in each resource, population, socio-economic data, and other data related to the different principles in the international water laws and principles.

2. Development of water balance for the different resources using existing data. Data regarding supply and demand for each available water resource will be collected. If data is not available, results of hydrological models from different previous research will be used to develop an estimate of the available water quantities in each resource. In addition, water quantities from non-conventional water resources will be estimated to be used in assigning weights and values to the different attributes of international law.

3. A questionnaire as presented in appendix A will be built up and designed precisely and carefully where each factor of Helsinki rules in article V will interpret. Hydrological and water experts in Palestine will fill the marks and weights fairly for each factor according to international laws. and weights from these factors will be calculated.

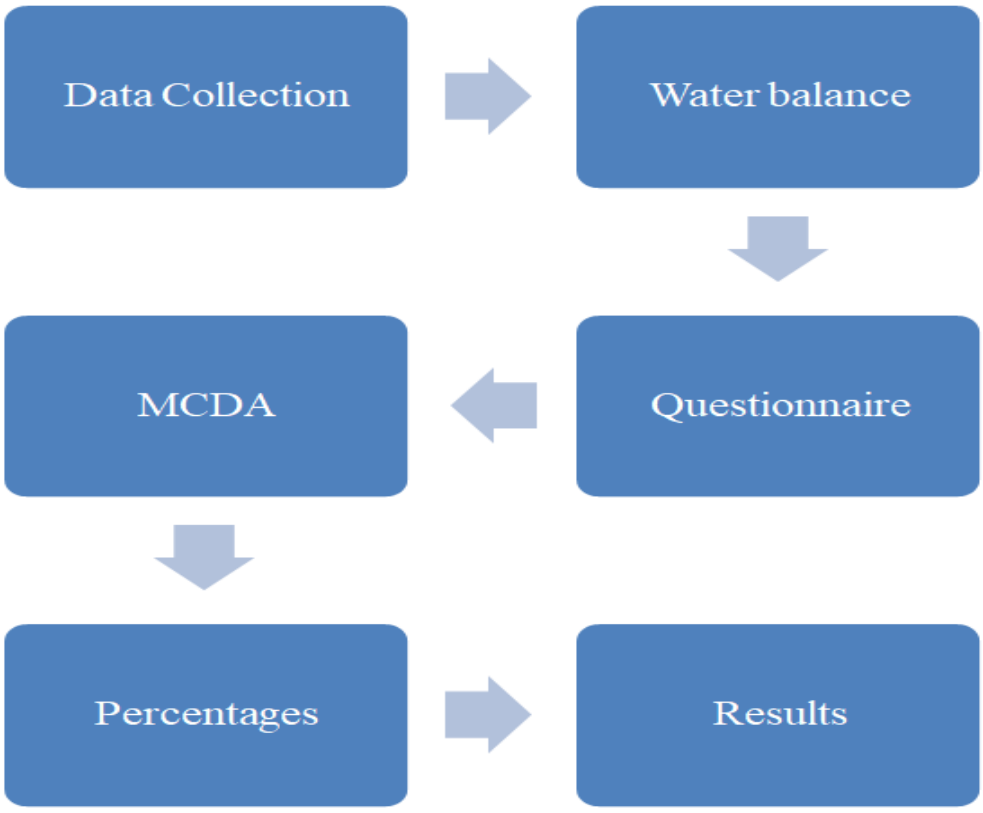
4. A multiple criteria decision analysis -MCDA- will be developed to evaluate the utilization share of each riparian country from the different shared water resources after gathering the percentages and weights for each factor of Helsinki rules.

5. Percentages from each source for each country will be calculated using multiple criteria decisions. Each expert will give its weight where there will be no percentage similarity between them. So, weights will be analyzed, and obtain percentages.

Infer Palestinian water rights. Percentages will show the equitable percentages for each country. Variations between real and equitable percentages will be mentioned and noted. All results will be in tables and figures to be as references to other research.

Figure 1.1

Methodology



1.4 Literature Review

Water scarcity all over the world due to several factors is considered one of the major issues that are facing nations. These factors, that countries have been suffering from include climate change, population growth, contamination, and many more. Therefore, analysts have expected that climate change will intensify the security concerns, both within and between countries those share basins, domestically and internationally. (Dinar & Diner, 2017). The scarcity of water has been being converted into conflicts between countries and nations. There are 263 watersheds and untold aquifers that cross the underlie the political boundaries of two or more countries which causes political tensions (Priscoli & Wolf, 2009). Most wars that happened in the world were at odds over a border or a water basin.

It is obvious, that conflicts in water appeared not only to get fresh and agricultural water but also hydrostatic power and dams' construction to generate electricity contributed in arising these conflicts. Nations get into political tensions over basins and some of them move their army to control boundary watersheds. To name a few, the Nile River and its eleven riparian countries, the Turkey-Syrian-Iraqi conflicts over the Euphrates and Tigris rivers, transboundary water disputes between Afghanistan and Iran, Turkish-Armenia, USA-Mexican and Palestinian- Israeli Occupation conflicts.

After World War II, the enhanced harnessing of the hydropower potential of international rivers was seen as a necessity. That was due to the increasing demand for electric energy production because of the population growth and in parallel with the growing needs for the development of nations. Engineering aspects of harnessing rivers were not the problem; the challenge was the applicable law. In general, the lack of accepted and relevant international law rules has been a major economic obstacle in the world (Bogdanovic S. , 2019).

1.5 International Water Law

To reduce political tensions and conflicts between nations, international institutions play a leading role in solving water conflicts. In 1873, the International Law Association (ILA) was established, and in 1954 turned its attention to studying and setting the principles and rules of international law applicable to the rivers that are intersected by states' boundaries (Bogdanovic S. , 2019).

Six chapters consisting of 37 articles were adopted in Helsinki, Finland in 1966. The general rules of international law, as outlined in these chapters, apply to the use of the waters of an international drainage basin except as may be provided otherwise by a convention, agreement, or binding custom among the basin States (ILA, 1966). In 1991, the International Law Commission (ILC), an organization created by United Nations, developed the Helsinki Rules and completed the drafting and provisional adaptation of the articles in the law of the non-navigational uses of international watercourses (Mimi & Sawalhi, 2003). United Nations after negotiations and meetings spelled out that Helsinki Rules had been adopted to reduce political tensions between parties involved.

1.6 The Oslo Accords

Seventy-three years of suffering and occupation started from Balfour Declaration. From 1948, when Palestine's mandate from Great Britain ended, until 1993 there was unrest between the Jews of Israeli Occupation and Palestinians. At the beginning of 1978 (Shoham, 1996), Arab nations and the Israeli Occupation slowly began to open lines of communication (Weiner, 1999). The Middle East Peace Process was opened in 1991 in the wake of the Gulf War (R. Shehadeh, 1997). The ensuing negotiations were divided into a series of bilateral talks between the Israeli Occupation and its neighbors (Watson, 2000).

The first Israeli Occupation prime minister said “we are in a water war with Arabs” (Salman, 1997). In 1995, former prime minister Shimon Peres refused to discuss Palestinians' rights and refused at the same time to reduce Israeli water consumption (Brichs, 2005). Israeli Occupation was not just land occupation, but water also played an important role in putting their hands on Palestine as long as possible and imposing their control on land and negotiations.

Under United Nations and world countries' supervision, Palestine Liberation Organization and Israeli Occupation signed a group of agreements called the Oslo Accords. In Washington DC, they signed the first Oslo Accord called the Declaration of Principles (DOP) on September 13th,1993. The second agreement that is known as Gaza-Jericho Agreement was signed on May 5th,1994 in Cairo. Also, a third agreement is known as the Interim Agreement on the West Bank and the Gaza Strip, Oslo 2 or Taba agreement in Washington DC on September 28th,1995 (Alqam, 2016). Five years

transitional period started from Oslo 1 passing by Gaza-Jericho agreement until Oslo 2 which governed the transnational period (Brown, 2003). These Accords were considered expired at the beginning of 1999 (Dellapenna, 2002). It was supposed to be an interim agreement that would pave the path toward the Permanent Status Settlement. In fact, The Permanent Status Settlement was to have been signed by 2000 (Kerret, 2010).

Article 40 describes the reality of water that was agreed upon between two sides in the interim Oslo Accords named water and sewage. Conflicts parties agreed that the Israeli Occupation recognizes the Palestinian water rights, the necessity to develop additional water for various uses, and respect for each side's power and responsibilities. Also, both sides recognize the necessity to provide to the Palestinians during the interim period a total quantity of 28.6 mcm/year. Moreover, both sides have agreed that the future needs of the Palestinians in the West Bank are estimated to be between 70 - 80 mcm/year and more as mentioned in appendix 1 (affairs, 1995). Unfortunately, until this time there is no sign of a permanent agreement.

1.7 Helsinki Rules

In 1954, The ILA started their conferences on inland water rights and obligations of the state. Many conferences have taken place around the world from the Edinburg Conference, Dubrovnik Statement of Principles, New York Conference, Hamburg Resolution, Brussels Conference, and Tokyo Conference until Helsinki Conference in 1966 where Helsinki Rules were achieved (Bogdanovic S. , 2019). Equitable utilization of the waters of an international drainage basin is mentioned in chapter two of the fifty-second ILA conference held in Helsinki in 1966. Article IV to VIII describes the conflict solutions between riparian countries.

Security Council resolutions must be taken into consideration, especially, 194 and 242 Resolutions that are related to peace in the Middle East. These resolutions will be the base of the water peace agreement between conflict parties consolidated with the Helsinki Rules. 194 Resolution resolves that the Refugees wishing to return to their homes and live at peace with their neighbors should be permitted to do at the earliest practicable date, and that compensation should be paid for the property of those choosing not to return and for loss of or damage to property which, under principles of

international law or in equity, should be made good by the governments or authorities responsible (SC, 1948). 242 Resolution concerning the withdrawal of Israel's armed forces from territories occupied in the recent conflict and termination of all claims of states of belligerency and respect for and acknowledgment of the sovereignty, territorial integrity, and political independence of every state in the area and their right to live in peace within secure and recognized boundaries free from threats or acts of force (SC, 1967).

Article IV (ILA, 1966)

Each basin State is entitled, within its territory, to a reasonable and equitable share in the beneficial uses of the waters of an international drainage basin.

Article V (ILA, 1966)

1. What is a reasonable and equitable share within the meaning of Article IV is to be determined in the light of all the relevant factors in each particular case.

2. Relevant factors which are to be considered include, but are not limited to:

(a) the geography of the basin, including in particular the extent of the drainage area in the territory of each basin State;

The geography of the basin determines the amount of rainfall caught and, consequently, the total volume of surface and groundwater run-off into the mainstream courses (Mimi & Sawalhi, 2003). The factor will be applied to the situation prior 1967 war according to 242 Resolution.

(b) the hydrology of the basin, including in particular the contribution of water by each basin State;

The hydrology of the basin affects the discharge of the stream which can be defined as the total volume of water flowing past a given point in a known unit of time (Mimi & Sawalhi, 2003).

(c) the climate affecting the basin;

The climate affecting the basin is related to many climatic factors such as precipitation, evapotranspiration, temperature, and humidity that should be considered (Mimi & Sawalhi, 2003).

(d) the past utilization of the waters of the basin, including in particular existing utilization

Israel is currently the dominant user of the waters of the basins. The factor will be representing the situation prior 1967 war.

(e) the economic and social needs of each basin State;

The economic and social needs of each basin state can be quantified by estimating the projected water demands from all sources or riparian states (Mimi & Sawalhi, 2003).

(f) the population dependent on the waters of the basin in each basin State;

This factor will be applied in the situation prior 1967 war and with the enforcement of the 194 resolution.

(g) the comparative costs of alternative means of satisfying the economic and social needs of each basin State.

Alternative water resources refer specifically to potential sources such as desalination and imported water that are not presently exploited. The impact of these alternatives on the equation of equitable apportionment depends on their availability and the comparative costs of harnessing them (Elmusa, 1994). Both desalination and importation of water could be available alternatives since all riparian states have ground brackish water and enjoy seafront on the Mediterranean Sea.

The comparative costs are a yardstick of the parties' ability to harness alternative resources. The party that is more capable of paying for water and tapping the desalination option than other riparian states would be entitled to a smaller share of the common waters (just within the confines of this factor). So, in this research GDP was taken as a measure of comparison to reach the equity standard (Mimi & Sawalhi, 2003).

(h) the availability of other resources;

Renewable water resources, water demands, and Water Stress Index (WSI) in the countries of the basins are presented. The WSI is the ratio of water withdrawal or demand to water availability. The state that has less WSI would be entitled to a smaller share of the common waters (just within the confines of this factor) (Mimi & Sawalhi, 2003).

(i) the avoidance of unnecessary waste in the utilization of waters of the basin;

(j) the practicability of compensation to one or more of the co-basin States as a means of adjusting conflicts among uses; and

(k) the degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State.

The words ‘appreciable harm’ has created definitional problems for all riparian states (Elmusa, 1994). (Goldbeg, 1992) defined appreciable harm as the costs that can be objectively measured as a result of the denial of allocation. The implication of this factor is obvious: to achieve equitable division no riparian can deny water to a co-riparian if that denial causes appreciable harm. Water must be reallocated to stop the infringement. To assess the significant harm in this research, the following statement for the ILC cited (Goldbeg, 1992) may be helpful: ‘harm must be capable of being established by objective evidence. There must be a real impairment of use, i.e., a detrimental impact of some consequence upon, for example, public health, industry, property, agriculture, or the environment in the affected state’. In other words, appreciable harm can be gauged by its impact on social, economic, and environmental needs. Accordingly, if the appreciable harm factor is broadened to focus on the social and economic needs, it will become effectively identical to the economic and social needs of each basin State Factor discussed previously. Therefore, the appreciable harm Factor will have the same equity standards derived for the social and economic needs Factor.

3. The weight to be given to each factor is to be determined by its importance in comparison with that of other relevant factors. In determining what is a reasonable and equitable share, all relevant factors are to be considered together and a conclusion reached on the basis of the whole.

Article VI

A use or category of uses is not entitled to any inherent preference over any other use or category of uses.

Article VII

A basin State may not be denied the present reasonable use of the waters of an international drainage basin to reserve for a co-basin State a future use of such waters.

Article VIII

1. An existing reasonable use may continue in operation unless the factors justifying its continuance are outweighed by other factors leading to the conclusion that it be modified or terminated so as to accommodate a competing incompatible use.

2. (a) A use that is in fact operational is deemed to have been an existing use from the time of the initiation of construction directly related to the use or, where such construction is not required the undertaking of comparable acts of actual implementation.

   (b) Such a use continues to be an existing use until such time as it is discontinued with the intention that it be abandoned.

3. A use will not be deemed an existing use if at the time of becoming operational it is incompatible with an already existing reasonable use.

1.8 Multiple Criteria Decision Analysis -MCDA-

MCDA is a valuable tool that we can apply to many complex decisions. It is most applicable in solving problems that are characterized as a choice among alternatives (Addor & Smutko., 2018). Realistic evaluations should be taken into account. In reality, we have different attributes (criteria) that differ in importance. So, the “difference in

importance" makes it essential to give weight (Wi) to each attribute (Helsinki factors). Then, the evaluation measures each factor, and equitable percentage results are computed (Almasri, 2009).

What can we expect from MCDA? (Belton & Stewart, 2002)

1. MCDA will be the right answer

2. MCDA will provide an objective analysis that will relieve decision markers of the responsibility of making difficult judgments.

3. MCDA will take the pain out of decision making

After gathering equitable share percentages of each factor of Helsinki Rules, MCDA will take a place in Judgment between riparian countries. Rules will be applied in the situation prior 1967 war where some of the factors will be applied after 50 years from the setback exactly in the 2017 year from numbers existed to get an accurate result.

Chapter Two

International Watercourses in the Palestinian Israeli Case

2.1 Background

The definition of the UN convention on the law of the non-navigational uses of international watercourses of the term international watercourses, “a system of surface waters and groundwaters constituting by their physical relationship a unitary whole”. This definition calls the attention of states to the interrelationship between all parts of the system of surface and underground waters that make up an international watercourse (McCaffrey, 2001).

Palestinian lands significantly depend on groundwater as a source of freshwater. Pose approximately 90% of freshwater utilized (PWA, 2012). All aquifers give annual sustainable yield which citizens rely on it. Israeli Occupation consumes and drains these aquifers more than 85% of actual yield.

2.2 Historical Palestinian Watercourses

Historical Palestine relay on two main water resources which are surface water and groundwater which are formed due to rain falling on Palestine Mountain ranges where rain considers the main feeder for these resources. Jordan, Lebanon, and Syria Exploit part of these resources but, for 63 years, the Israeli Occupation utilize the biggest part of these resources (Yacobi & Abdel-Gafor, 2001).

2.2.1 Surface water resources

Surface basins suffers from Israeli Occupation since 1948 when they put their hands on and minimized Palestine's rights from them. Any water gather above the surface from seas, lakes, rivers, and wadies is dominated by the Israeli Occupation.

1. Jordan River

Jordan River is considered one of the most important geographical places in the Middle East. The river is considered the only surface water source for the West Bank. It flows from the north from Golan Heights 2200m above sea level to the south to the Dead Sea 425 below sea level with 350 km length and 18,285 km^2 area. Palestine, Jordan, Syria, Lebanon, and Israeli Occupation are the five riparian countries on it (Yacobi & Abdel-Gafor, 2001).

Jordan River is distinguished by its many tributaries that feed the upstream and downstream flow. Three tributaries feed the Upper Jordan River and they are: -

- Hasbani River: originates from the Golan Heights form in north of Lebanon. The estimated yearly discharge is about 157 MCM (Yacobi & Abdel-Gafor, 2001).

- Banias River: originates from the Golan Heights in Banias town near Sheikh Mount in the southwest of Syria. The estimated discharge is approximately 140 MCM per year (Yacobi & Abdel-Gafor, 2001).

- Dan River: is considered the largest and the most important tributary of the Jordan River. originates from Sheikh Mount in Syrian land. The estimated discharge is about 257 MCM per year (Yacobi & Abdel-Gafor, 2001).

The Upper Jordan River passes through Hula Lake and pours into Tiberias Lake. The river discharged from Tiberias Lake called the Lower Jordan River where Yarmouk and Zarqa Rivers pour into it until reaching the Dead Sea.

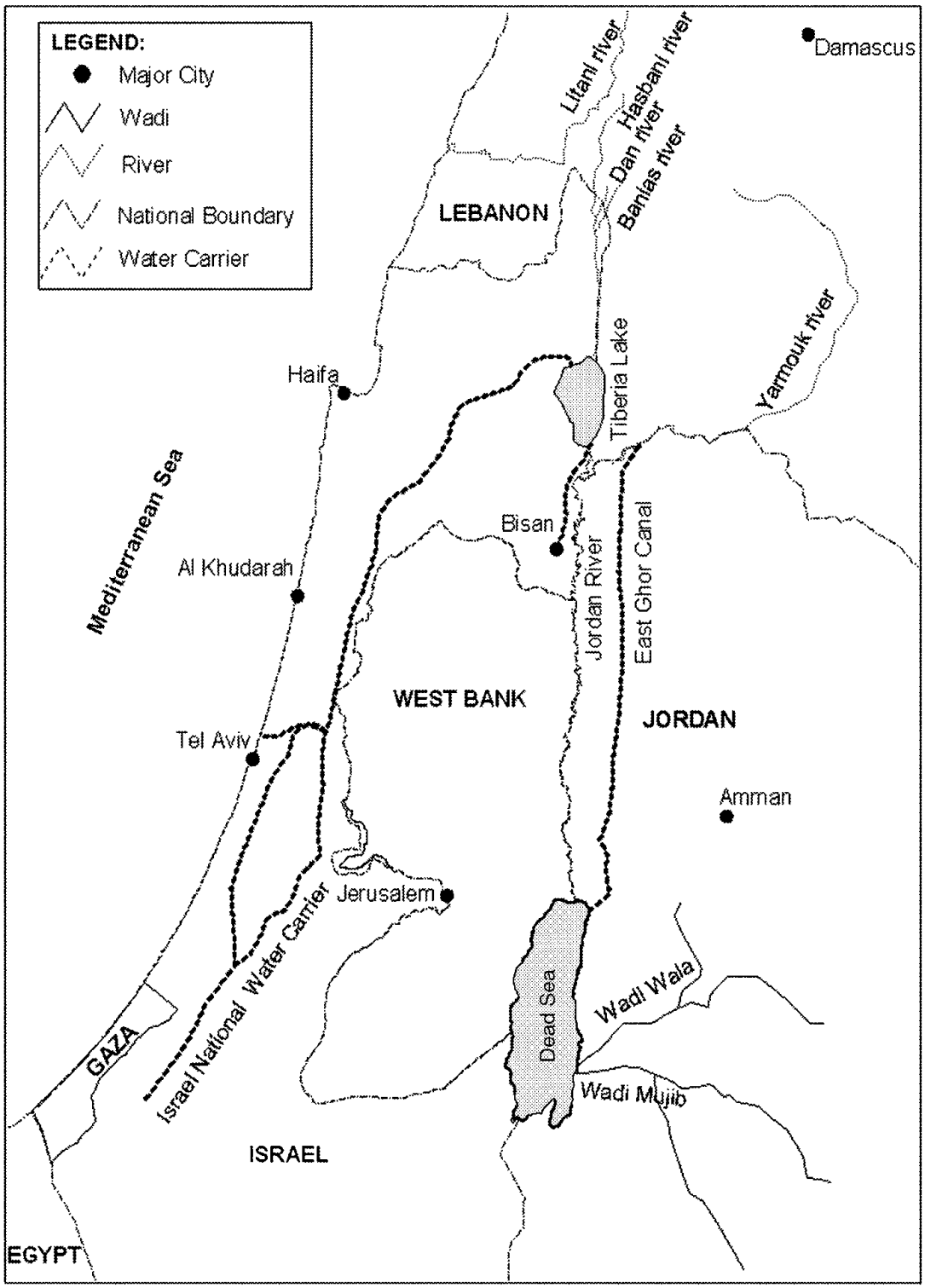
- Yarmouk River: is considered the largest tributary pours in the Lower Jordan River. originates from Jabal al-Arab in Syria. The estimated yearly discharge is about 475 MCM (Yacobi & Abdel-Gafor, 2001).

- The Lateral Valleys: originate from Palestine, Jordan, Syria, and Upper Galilee regions.

Figure 2.1 shows the Upper and Lower Jordan River and its tributaries that discharge on it.

Figure 2.1

Jordan River and its tributaries (Mimi & Sawalhi, 2003).



2. Lake Tiberias

The lake is a separator between the Upper and Lower Jordan River and the main surface reservoir for the Jordan Basin where the estimated storage amount is about 4000 MCM with a 169 km2 area. The water of the lake contains a high salt content due to salty springs. The Israeli Occupation controls the lake's water (Yacobi & Abdel-Gafor, 2001).

3. Hula Lake

Small lake with a 14 km^2 area, located on Upper Jordan River and surrounded by swamps. The Israeli Occupation dried the lake from 1951 until 1957 and converted it to agricultural land (Yacobi & Abdel-Gafor, 2001).

Figure 2.2. shows Tiberias and Hula Lakes and Jordan River before the 1957 Hula dried project.

Figure 2.2

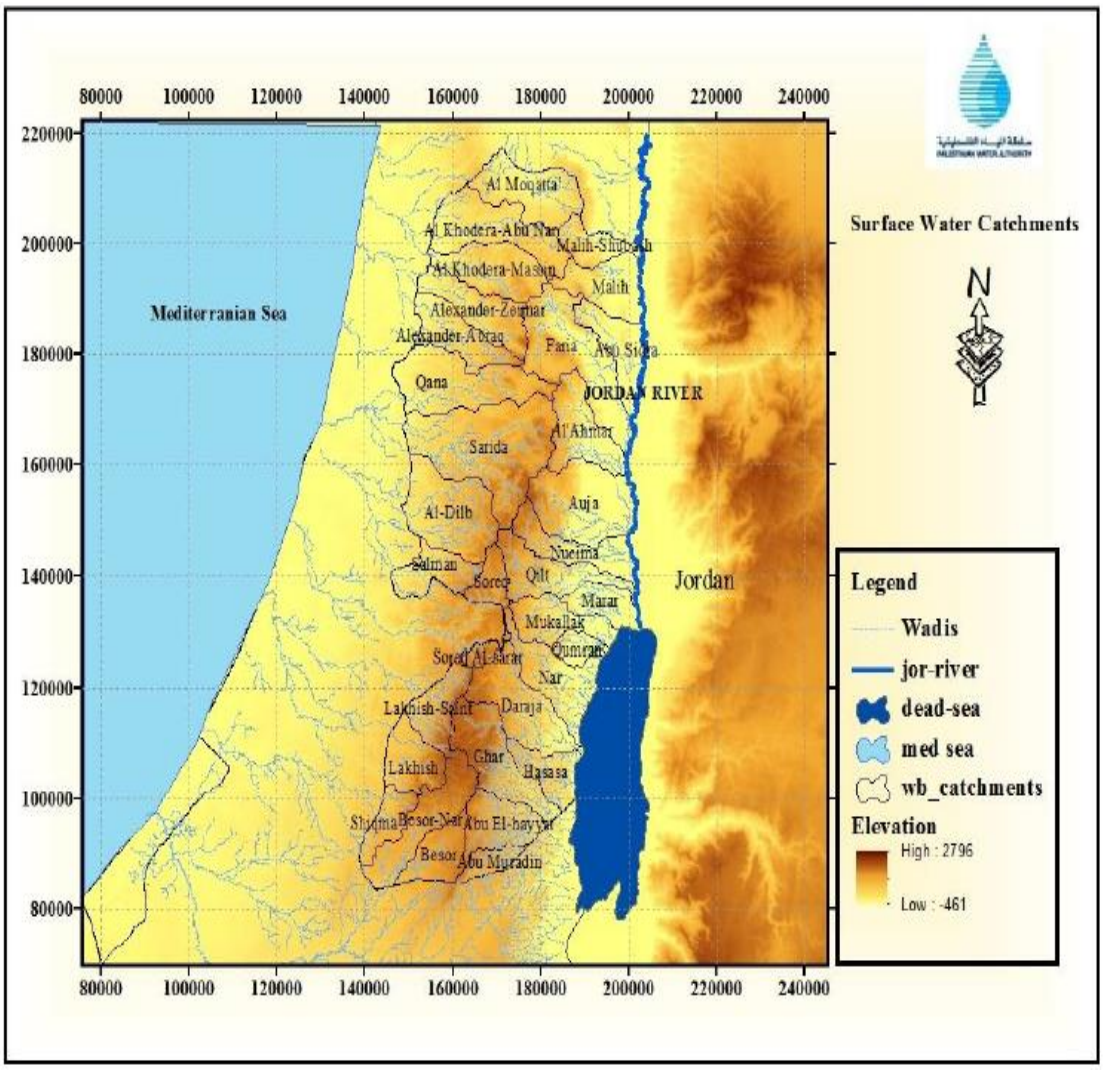
Tiberias Lake and Hula Lake

4. Valleys and Wadies

Several seasonal wadies where water gathered from the south and west mountains and discharged to the east towards Jordan Valley and the Dead Sea and west towards the Mediterranean. Approximately 30 reservoirs with 400 MCM per year discharge. These wadies are neglected from the Palestinian's side due to their high cost in general and Israeli Occupation policies such as Palestinians prevented to build dams on it. (Yacobi & Abdel-Gafor, 2001). The long-term average annual flow of floodwater through wadis in the West Bank is estimated at 165 MCM/y. During the 2011/2012 season, the average reached 179 MCM/y (PWA, 2012). Figure 2.3 shows the West Bank surface catchments and Wadies.

Figure 2.3

West Bank surface catchments and Wadies



2.2.2 Groundwater resources

Palestine relies on groundwater resources in the first place to meet its needs in drinking, agricultural and industrial. The geological formation consists of limestone, Dolomitic limestone, marl, and basalt rash which differ from the mountains in the north to the desert in the south where groundwater basins formed. In addition to sandy geological formation extending over the Coastal plain. Water is stored between karst gaps and waterways that formed due to cracks and rock breaks. Groundwater reservoirs differ in thickness usually the differential its be within some meters. Most reservoirs are renewable type that depends on rain to recharge them. A few unrenewable reservoirs that mostly present in the south of Palestine.

According to the movements of water underground and the geological formation, the basins are classified. Eight main groundwater reservoirs that rating from the north to the south.

1. Tiberias Lake Basin

Basin extends from the north of Jenin to the Tiberias Lake and Golan in the north. Consists of several groundwater reservoirs. The expected yield of this basin is about 510 – 528 MCM per year and it is exploited totally by the Israeli Occupation via springs and wells that exist in the basin (Yacobi & Abdel-Gafor, 2001).

2. West Galilee Basin

Basin extends from Afula in the south to the Lebanon boundaries in the north. Consists of several groundwater reservoirs. The basin is exploited totally by the Israeli Occupation via springs and wells exists in the basin and the expected yield of this basin is about 122 MCM per year (Yacobi & Abdel-Gafor, 2001).

3. Carmel basin

Basin is located in the far northwest of Palestine where it is extending down of Carmel Mountains. Consists of several groundwater reservoirs. The expected yield of this basin is about 40 MCM per year and it is exploited totally by the Israeli Occupation via springs and wells that exist in the basin (Yacobi & Abdel-Gafor, 2001).

4. Coastal basin

Basin extends on the Palestinian coast on the Mediterranean Sea in the west to the Gaza Strip. The Palestinian exploit a small part of the basin, while the Israeli Occupation exploits the largest part of it. The expected yield of this basin is about 578 MCM per year (Yacobi & Abdel-Gafor, 2001).

5. Negeb and the Arabah Basin

Basin extends from the Beersheba to the Gulf of Aqaba in the south. Consists of several groundwater reservoirs. The expected yield of this basin is about 104 MCM per year and it is exploited totally by the Israeli Occupation via springs and wells that exist in the basin (Yacobi & Abdel-Gafor, 2001).

2.3 West Bank and Gaza Strip Watercourses

2.3.1 Groundwater aquifer basins: -

- Eastern Aquifer Basin

The basin is divided into three main sub-aquifers, namely Mountainous Heights, North-eastern tip, and Jordan Valley. The estimated annual sustainable yield is approximately 145-185 MCM. However, this basin is heavily exploited by the Israeli Occupation at rates between 50 MCM per year from wells in addition to 100 MCM from Dead Sea springs. Palestinians in 2012 utilized about 53 MCM per year about less than 32.12% of the basin's actual yield (PWA, 2012).

- North-Eastern Aquifer Basin

The annual estimated sustainable yield of this basin is about 100-145 MCM. However, this basin is heavily exploited by the Israeli Occupation at rates between 100 MCM per year. Palestinians in 2012 get less than 23 MCM per year about 18.78% of the basin's actual yield (PWA, 2012).

- Western Aquifer Basin

This basin considers the most important one and the largest basin in Palestine. The annual sustainable yield is estimated between 362-400 MCM. However, this basin is heavily exploited by the Israeli Occupation at rates between 340-430 MCM per year. Palestinians in 2012 get less than 28MCM per year about less than 7.27% of the basin's actual yield (PWA, 2012).

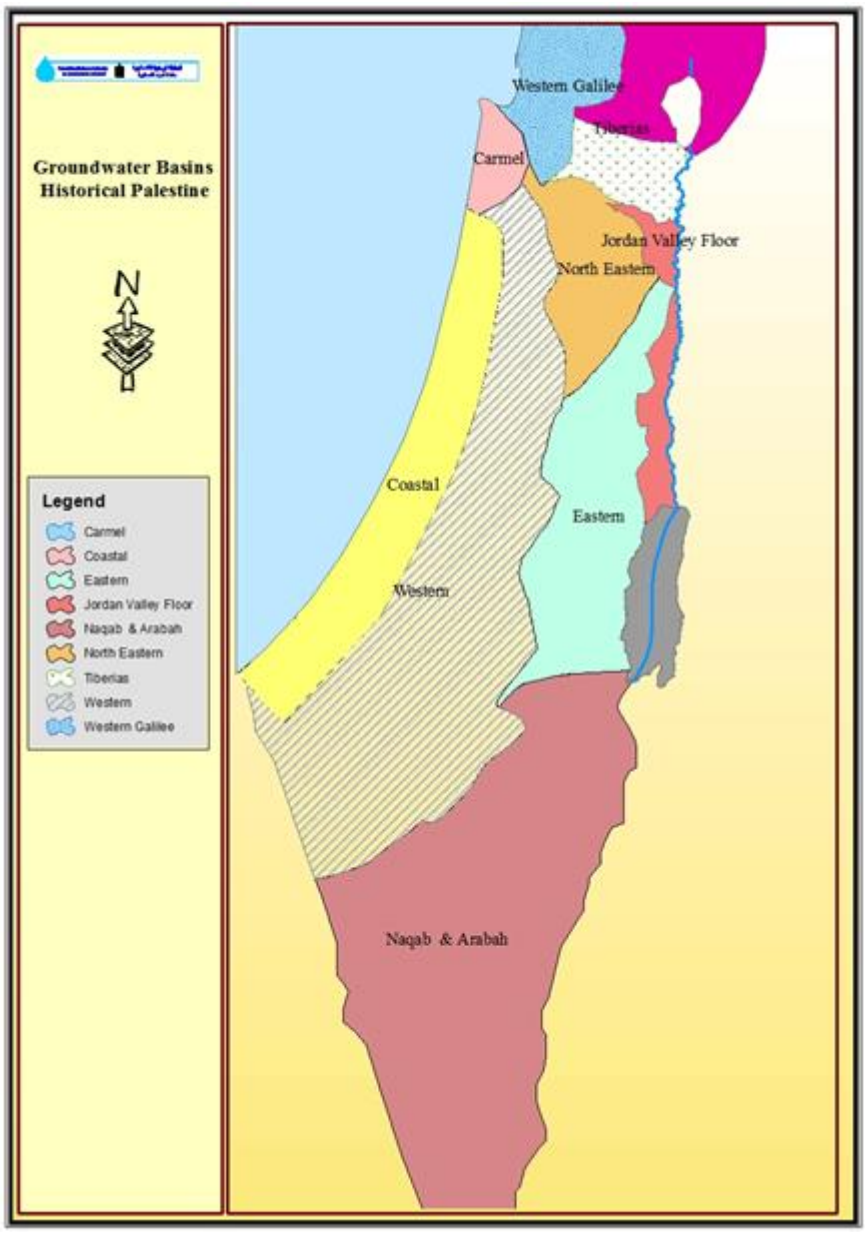
- Gaza Coastal Aquifer Basin

Coastal Basin is considered the source of this basin (Yacobi & Abdel-Gafor, 2001). The basin suffers from a lack of recharge which is estimated at approximately 55-60 MCM per year and with low permeability because of non-productive layers of clay. The Palestinian utilization from this aquifer is about 185 MCM per year in 2012 (PWA, 2012).

Figure 2.4 shows the eight groundwater aquifers basins in historical Palestine.

Figure 2.4

The main groundwater basins in historical Palestine



2.3.2 Surface water

Surface water sources in historical Palestine are the Jordan River and ephemeral wadies which flow in three basic directions: the Mediterranean Sea, Jordan valley, and the Dead Sea (PWA, 2012).

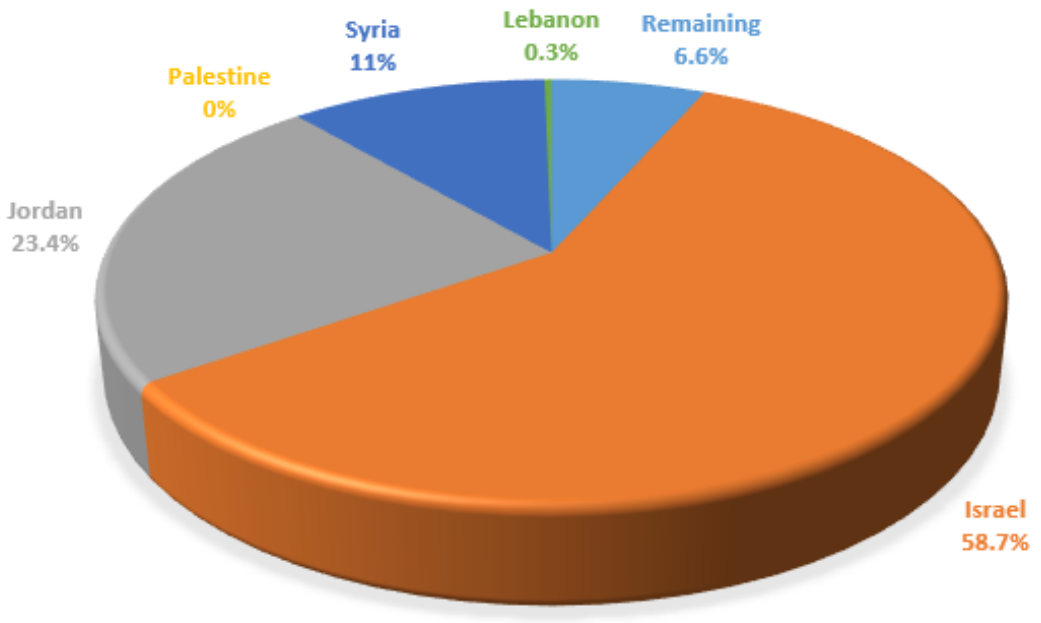
- Jordan River

The river is considered one of the most important rivers in the area. It flows from the north from Golan Heights 2200m above sea level to the south to the Dead Sea 425 below sea level (PWA, 2012). Five countries shared the border with the river: Palestine, Jordan, Syria, Lebanon, and Israeli Occupation (Hoff, Bonzi, Joyce, & Tielbörger, 2011).

Jordan River discharging to the Dead Sea was estimated at 1400 MCM per year. But, because of Israeli Occupation was heavily exploited by it over the last six decades, the amount of discharging significantly decreased to no more than 30 MCM per year. Construction many of Dams in the Upper Jordan River, more than 500 MCM diverted by Israeli Occupation through the national Israel Water Carrier and natural factors such as evaporation (PWA, 2012). Figure 2.5 shows the present utilization of the Jordan River.

Figure 2.5

Present Jordan River utilization



Chapter Three

Analysis and Results

3.1 The Questionnaire

The West Bank and Gaza Strip groundwater resources are shared between Palestine and Israel, while the Jordan River is shared between five riparian countries. Helsinki Rules are applied to these two shared resources according to the situation before the 1967 War.

To divide resources between riparian countries, MCDA is used as a tool to extract the equitable share of each state. A questionnaire was developed to assess the response of experts towards the importance of each factor of the eleven Helsinki factors. The Questionnaire was distributed to water and law experts to give the scores of each factor according to its importance as Shown in Appendix A. Each factor of article V will be applied to each basin to give each side an equitable percentage share of a particular resource.

Scours that are presented in Appendix B are considered as the point of judging between conflict parties. The weights of this source can be calculated according to the equation 3.1.

$$W_i = \frac{S_i}{\sum_1^m S_i} \quad (3.1)$$

Where: W_i: Weight calculated for each factor

S_i: Average Scores of each factor from Palestinian water experts' answers

$\sum_1^m S_i$: All Scores

The questionnaire was distributed to 12 Palestinian experts. Answers received are presented in Appendix B. Because of the deficiency of the target group to answer the questionnaire, additional data is used from the previous (Mimi & Sawalhi, 2003) research. They took similar data and designed his questionnaire for nine Helsinki factors. Appendix C shows the water experts' answers to the distributed questionnaire

and data used from (Mimi & Sawalhi, 2003) research, and considering the responses in both tables, table 3.1 shows the average weight used in our research.

Table 3.1

Average weights used

Helsinki factors	Questionnaire weights	Dr. Mimi weights	Average weights (W_i)
(a) the geography of the basin, including in particular the extent of the drainage area in the territory of each basin State;	12.50	8	10.25
(b) the hydrology of the basin, including in particular the contribution of water by each basin State;	12.01	15	13.51
(c) the climate affecting the basin;	11.06	14	12.53
(d) the past utilization of the waters of the basin, including in particular existing utilization;	6.73	20	13.37
(e) the economic and social needs of each basin State;	13.95	12	12.97
(f) the population dependent on the waters of the basin in each basin State;	12.50	10	11.25
(g) the comparative costs of alternative means of satisfying the economic and social needs of each basin State;	9.13	8	8.56
(h) the availability of other resources;	10.10	8	9.05
(k) the degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State.	12.01	5	8.51
Sum	100%	100%	100%

3.2 Data Collected Per Water Resource

3.2.1 Groundwater aquifers data

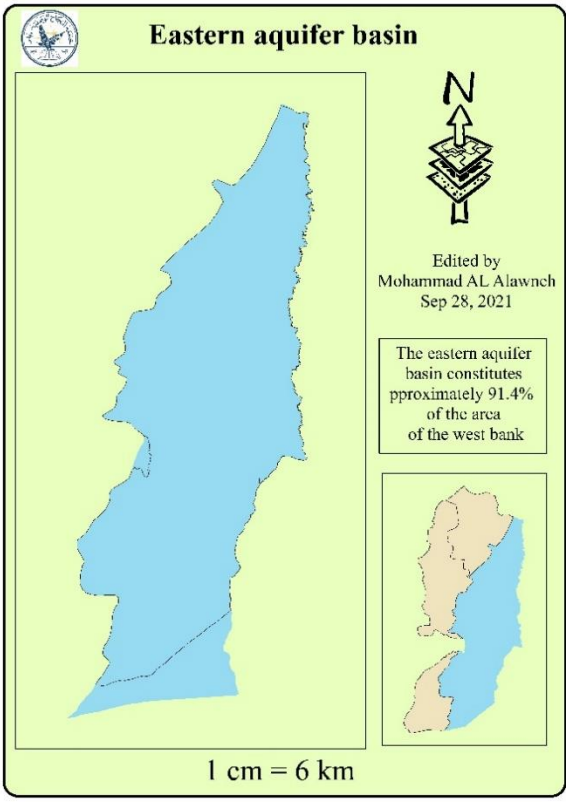
The data collected for the different shared groundwater aquifers gathered from previous research, calculations, and GIS such as basin area, recharge and discharge, precipitation during 1967, utilization before war 1967, water demand for the year 2017, population before war 1967, GDP and WSI are presented below. This data will be used to assess the share of each riparian.

3.2.1.1 Eastern Aquifer Basin

a. Geography factor: according to the 242 Resolution, the basin geography factor below will be applied to the situation prior 1967 War. Figure 3.1 shows the geographical percentage of the Eastern Aquifer Basin from the West Bank. Appendix C shows Palestinian and Israel's geography share from the Eastern Aquifer Basin.

Figure 3.1

Eastern Aquifer Basin



b. Hydrology factor: about 83% of the total area of aquifer recharge of the mountain basin system lies within the boundaries of Palestine territories (Yacobi & Abdel-Gafor, 2001). Appendix D shows the Palestine and Israels' recharge share for the Eastern Aquifer Basin

c. Climate factor: Appendix D shows Palestinian and Israel's total annual rainfall during 1967 and the riparian countries' equitable share percentages from Eastern Aquifer Basin.

d. Utilization factor: this sensitive factor will be a critical point of conflict. So, the most appropriate situation to apply this factor is prior 1967 War. Appendix D shows the riparian countries' utilization of the Eastern Aquifer Basin before the 1967 War.

e. Economic and social need factor: The population of Palestine and Israel in 2017 was respectively 4,747,227 and 8,243,848 (Worldometer, 2021). The number of Palestinians who lived in 1948 lands was 1,471,000 in 2017 (Statistics, 2107). The number of Palestinian refugees in 2017 was 5,851,355 (Statistics, 2017). According to the World Health Organization (WHO), around 100 liters of water per capita per day are needed to meet the most basic needs. Appendix D shows the estimated population of Palestine and Israel in 2017, the projected water demand for the two countries, and the needs percentages from the Eastern Aquifer Basin for riparian countries.

f. Population factor: The population of Palestine and Israel prior 1967 War was respectively 1,165,750 and 2,558,712 (Worldometer, 2021). About 292,000 people migrated from Palestinian lands after the 1967 war (Courbage, 1995) and according to the 194 Resolution, they also count. The estimated Palestinian population who did not leave their homeland in 1948 was about 324,100 (Statistics, 2017). Appendix D shows the Eastern Aquifer Basin share percentage for riparian countries according to population factor percentages for Palestine and Israel before the 1967 War.

g. The comparative costs of alternative means of satisfying the economic and social needs of each basin State factor: The comparative costs can be restated as the relative ability of the consumer to pay for higher-priced alternative supplies such as desalinated water. Based on the present consumer prices in all riparian states as well as on various estimates of desalination costs, the following can be inferred. In Israel, desalinated brackish and saline water is affordable for municipal use and economical for agriculture, while desalinated seawater is affordable for domestic use and may be economical for some crops. Palestinian, Syrian, Lebanese, and Jordanian consumers, conversely, would be heavily burdened by the costs of desalinated water (Kally, 1994).

Appendix D shows GDP measurement in 1970 to reach the equity standard, ranks of each country, and the equitable share percentage from Eastern Aquifer Basin for riparian countries according to this factor.

h. The availability of other resources factor: The water stress index (WSI) is the ratio of water demand to water availability. The total renewable water resources for Palestine and Israel are 215 and 1104 (MCM) respectively (Mimi & Sawalhi, 2003). Appendix D shows the water stress index (WSI) and the riparian countries' equitable share of the Eastern Aquifer Basin. As shown below the equation 3.2 refers to water demand, equation 3.3 refers to water available, and equation 3.4 refers to water stress index (WSI)

1. Water demand = $\frac{\text{Population} * \text{WHO } (l/c.\text{d}) * 365(\text{d/Yr})}{1000(l/m^3) * 1{,}000{,}000(m^3/MCM)}$ (3.2)

Water demand for Palestine = $\frac{12{,}069{,}582 * 100\ (l/c.\text{d}) * 365(\text{d/Yr})}{1000(l/m^3) * 1{,}000{,}000(m^3/MCM)} = 440.54 Mcm/Yr$

Water demand for Israel = $\frac{8{,}243{,}848 * 100\ (l/c.\text{d}) * 365(\text{d/Yr})}{1000\ (l/m^3) * 1{,}000{,}000(m^3/MCM)} = 300.9 Mcm/Yr$

Water available = water available from all renewable water – water available from eastern aquifer (3.3)

Water available for Palestine = 215 - 53 = 162 Mcm/Yr

Water available for Israel = 1104 – 150 = 954 Mcm/Yr

2. WSI ratio = $\frac{Water\ demand}{water\ available}$ (3.4)

WSI ratio for Palestine $= \frac{440.54}{162} = 2.72$

WSI ratio for Israel $= \frac{300.9}{954} = 0.32$

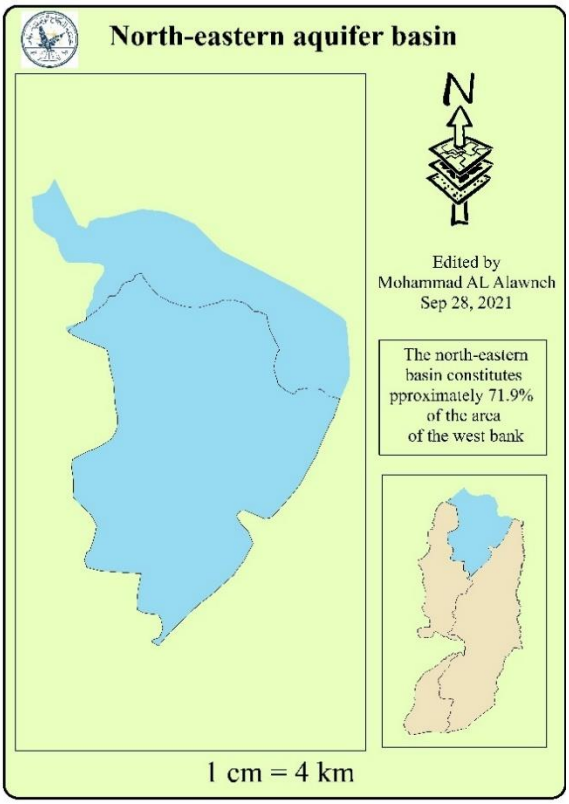
k. The degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State: as discussed previously**,** Appendix D shows an equitable share percentage from Eastern Aquifer Basin from appreciable harm Factor that will have the same equity standards derived for the social and economic needs factor.

3.2.1.2 North-Eastern Aquifer Basin

a. Geography factor: according to the 242 Resolution, the basin geography factor below will be applied to the situation prior 1967 War. Figure 3.2 shows the geographical percentage of the North-Eastern Aquifer Basin from the West Bank. Appendix E shows Palestinian and Israel's geography share from the North-Eastern Aquifer Basin.

Figure 3.2

North-Eastern Aquifer Basin



b. Hydrology factor: about 83% of the total area of aquifer recharge of the mountain basin system lies within the boundaries of the Palestinian territories (Yacobi & Abdel-Gafor, 2001). Appendix E shows the Palestine and Israel recharge share for the North-Eastern Aquifer Basin.

c. Climate factor: Appendix E shows Palestine and Israel's total annual rainfall during 1967 and the riparian countries' equitable share percentages from North-Eastern Aquifer Basin.

d. Utilization factor: Appendix E shows the riparian countries' utilization of the North-Eastern Aquifer before the 1967 War.

e. Economic and social need factor: as presented before in the Eastern Aquifer Basin, Appendix E shows the estimated population of Palestine and Israel in 2017, the projected water demand for the two countries, and the needs percentages from the North-Eastern Aquifer Basin for riparian countries.

f. Population factor: as presented before in Eastern Aquifer Basin, Appendix E shows the equitable share percentage from North-Eastern Aquifer Basin for riparian countries according to population factor percentages for Palestine and Israel before the 1967 War.

g. The comparative costs of alternative factor: Appendix E shows GDP measurement in 1970 to reach the equity standard, ranks of each country, and the equitable share percentage from North-Eastern Aquifer Basin for riparian countries according to this factor.

h. The availability of other resources factor: the total renewable water resources for Palestine and Israel are 215 and 1104 (MCM) respectively (Mimi & Sawalhi, 2003). Appendix E shows the water stress index (WSI), and equitable share percentage from North-Eastern Aquifer Basin for the riparian countries. As shown below the equation 3.2 refers to water demand, equation 3.3 refers to water available, and equation 3.4 refers to water stress index (WSI)

3. Water demand = $\frac{\text{Population} * \text{WHO } (l/c.\text{d}) * 365(\text{d/Yr})}{1000(l/m^3) * 1{,}000{,}000(m^3/MCM)}$ (3.2)

Water demand for Palestine = $\frac{12{,}069{,}582 * 100\ (l/c.\text{d}) * 365(\text{d/Yr})}{1000(l/m^3) * 1{,}000{,}000(m^3/MCM)} = 440.54 Mcm/Yr$

Water demand for Israel = $\frac{8{,}243{,}848 * 100\ (l/c.\text{d}) * 365(\text{d/Yr})}{1000(l/m^3) * 1{,}000{,}000(m^3/MCM)} = 300.9 Mcm/Yr$

Water available = water available from all renewable water – water available from north-eastern aquifer (3.3)

Water available for Palestine = 215 – 23 = 192 Mcm/Yr

Water available for Israel = 1,104 – 100 = 1,004 Mcm/Yr

4. WSI ratio = $\frac{Water\ demand}{water\ available}$ (3.4)

WSI ratio for Palestine $= \frac{440.54}{192} = 2.3$

WSI ratio for Israel $= \frac{300.9}{1{,}004} = 0.3$

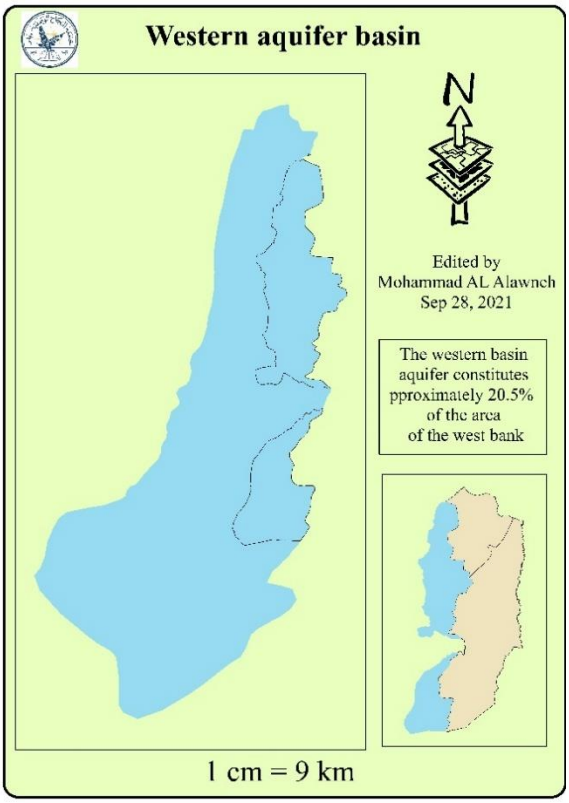
k. The degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State: as discussed previously, Appendix E shows an equitable share percentage from North-Eastern Aquifer Basin from appreciable harm Factor which will have the same equity standards derived for the social and economic needs Factor.

3.2.1.3 Western Aquifer Basin

a. Geography factor: according to the 242 Resolution, the basin geography factor below will be applied to the situation prior 1967 War. Figure 3.3 shows the geographical percentage of the Western Aquifer Basin from the West Bank. Appendix F shows the Palestinian and Israel's geography share from the Western Aquifer Basin.

Figure 3.3

Western aquifer basin



b. Hydrology factor: the Western Aquifer Basin is considered one of the most important aquifers because of its extension across the lands of historic Palestine. The Palestinian part of Western Aquifers is considered a heavy rain area where it recharges the aquifer no less than 73% of the whole basin recharge (Yacobi & Abdel-Gafor, 2001). Appendix F shows the Palestine and Israel occupation recharge share from the Western Aquifer Basin.

c. Climate factor: Appendix F shows Palestine and Israel's total annual rainfall during 1967 and the riparian countries' equitable share percentages from Western Aquifer Basin.

d. Utilization factor: Appendix F shows the riparian countries' utilization of the Western Aquifer Basin before the 1967 War.

e. Economic and social need factor: s presented before in the Eastern Aquifer Basin, Appendix F shows the estimated population of Palestine and Israel in 2017, the

projected water demand for the two countries, and the needs percentages from the Western Aquifer Basin for riparian countries.

f. Population factor: as presented before in the Eastern Aquifer Basin, Appendix F shows the equitable share percentage from the Western Aquifer Basin for riparian countries according to population factor percentages for Palestine and Israel before the 1967 War.

g. The comparative costs of alternative factor: Appendix F shows GDP measurement to reach the equity standard, ranks of each country, and equitable share percentage from Western Aquifer Basin for riparian countries according to this factor.

h. The availability of other resources factor: The total renewable water resources for Palestine and Israel are 215 and 1104 (MCM) respectively (Mimi & Sawalhi, 2003). Appendix F shows the water stress index (WSI) and Equitable share percentage from Western Aquifer Basin for riparian countries. As shown below the equation 3.2 refers to water demand, equation 3.3 refers to water available, and equation 3.4 refers to water stress index (WSI)

5. Water demand = $\frac{\text{Population} * \text{WHO } (l/c.\text{d}) * 365(\text{d/Yr})}{1000(l/m^3) * 1{,}000{,}000(m^3/MCM)}$ (3.2)

Water demand for Palestine = $\frac{12{,}069{,}582 * 100\ (l/c.\text{d}) * 365(\text{d/Yr})}{1000(l/m^3) * 1{,}000{,}000(m^3/MCM)} = 440.54 Mcm/Yr$

Water demand for Israel = $\frac{8{,}243{,}848 * 100\ (l/c.\text{d}) * 365(\text{d/Yr})}{1000(l/m^3) * 1{,}000{,}000(m^3/MCM)} = 300.9 Mcm/Yr$

Water available = water available from all renewable water – water available from western aquifer (3.3)

Water available for Palestine = 215 – 28 = 187 Mcm/Yr

Water available for Israel = 1,104 – 385 = 719 Mcm/Yr

6. WSI ratio = $\frac{Water\ demand}{water\ available}$ (3.4)

WSI ratio for Palestine $= \frac{440.54}{187} = 2.36$

WSI ratio for Israel $= \frac{300.9}{719} = 0.42$

k. The degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State: as discussed previously, Appendix F shows the equitable share percentage for Western Aquifer Basin from the appreciable harm Factor that will have the same equity standards derived for the social and economic needs Factor.

3.2.1.4 Gaza Costal Aquifer Basin

a. Geography factor: The Coastal Aquifer Basin covers a total area of 18,370 km2, of which around 71% lies in Egypt, 27% in Israeli Occupation, and 2% in Palestine, mainly in the Gaza Strip (UN-ESCWA & BGR, 2013). Appendix G shows the Palestinian and Israeli occupation area share from the Coastal Basin Aquifer.

b. Hydrology factor: For Coastal Aquifer the long-term average recharge from Israel was estimated 247 MCM/yr. In the Gaza Strip, rainfall recharge estimates range from 38 to 48 MCM/yr (UN-ESCWA & BGR, CHAPTER 20 - COASTAL AQUIFER BASIN, 2013). Appendix G shows the Palestine and Israel recharge share percentages for Coastal Aquifer Basin.

c. Climate factor: Appendix G shows Palestine and Israel's total annual rainfall during 1967 and the riparian countries' equitable share percentages from Coastal Aquifer Basin.

d. Utilization factor: Appendix G shows the riparian countries' utilization of Coastal Aquifer Basin prior 1967 War.

e. Economic and social need factor: as presented before in the Eastern Aquifer Basin, Appendix G shows the estimated population of Palestine and Israel in 2017, the projected water demand for the two countries, and the needs percentages from the Coastal Aquifer Basin for riparian countries.

f. Population factor: as presented before in the Eastern Aquifer Basin, Appendix G shows the equitable share percentage for Coastal Aquifer Basin for riparian countries according to population factor percentages for Palestine and Israel prior 1967 War.

g. The comparative costs of alternative factor: Appendix G shows GDP measurement to reach the equity standard, ranks of each country, and equitable share percentage from Coastal Aquifer Basin according to this factor.

h. The availability of other resources factor: The total renewable water resources for Palestine and Israel are 215 and 1104 (MCM) respectively (Mimi & Sawalhi, 2003). Appendix G shows the water stress index (WSI) and equitable share percentage for Coastal Aquifer Basin for riparian countries. As shown below the equation 3.2 refers to water demand, equation 3.3 refers to water available, and equation 3.4 refers to water stress index (WSI)

7. Water demand = $\frac{\text{Population} * \text{WHO } (l/c.\text{d}) * 365(\text{d/Yr})}{1000(l/m^3) * 1{,}000{,}000(m^3/MCM)}$ (3.2)

Water demand for Palestine = $\frac{12{,}069{,}582 * 100\ (l/c.\text{d}) * 365(\text{d/Yr})}{1000(l/m^3) * 1{,}000{,}000(m^3/MCM)} = 440.54 Mcm/Yr$

Water demand for Israel = $\frac{8{,}243{,}848 * 100\ (l/c.\text{d}) * 365(\text{d/Yr})}{1000(l/m^3) * 1{,}000{,}000(m^3/MCM)} = 300.9 Mcm/Yr$

Water available = water available from all renewable water – water available from Coastal aquifer (3.3)

Water available for Palestine = 215 – 165 = 50 Mcm/Yr

Water available for Israel = 1,104 – 385 = 664 Mcm/Yr

8. WSI ratio = $\frac{Water\ demand}{water\ available}$ (3.4)

WSI ratio for Palestine = $\frac{440.54}{50} = 8.81$

WSI ratio for Israel = $\frac{300.9}{664} = 0.45$

k. The degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State: as discussed previously, Appendix G shows the equitable share percentage for Coastal Aquifer Basin from appreciable harm Factor that will have the same equity standards derived for the social and economic needs Factor.

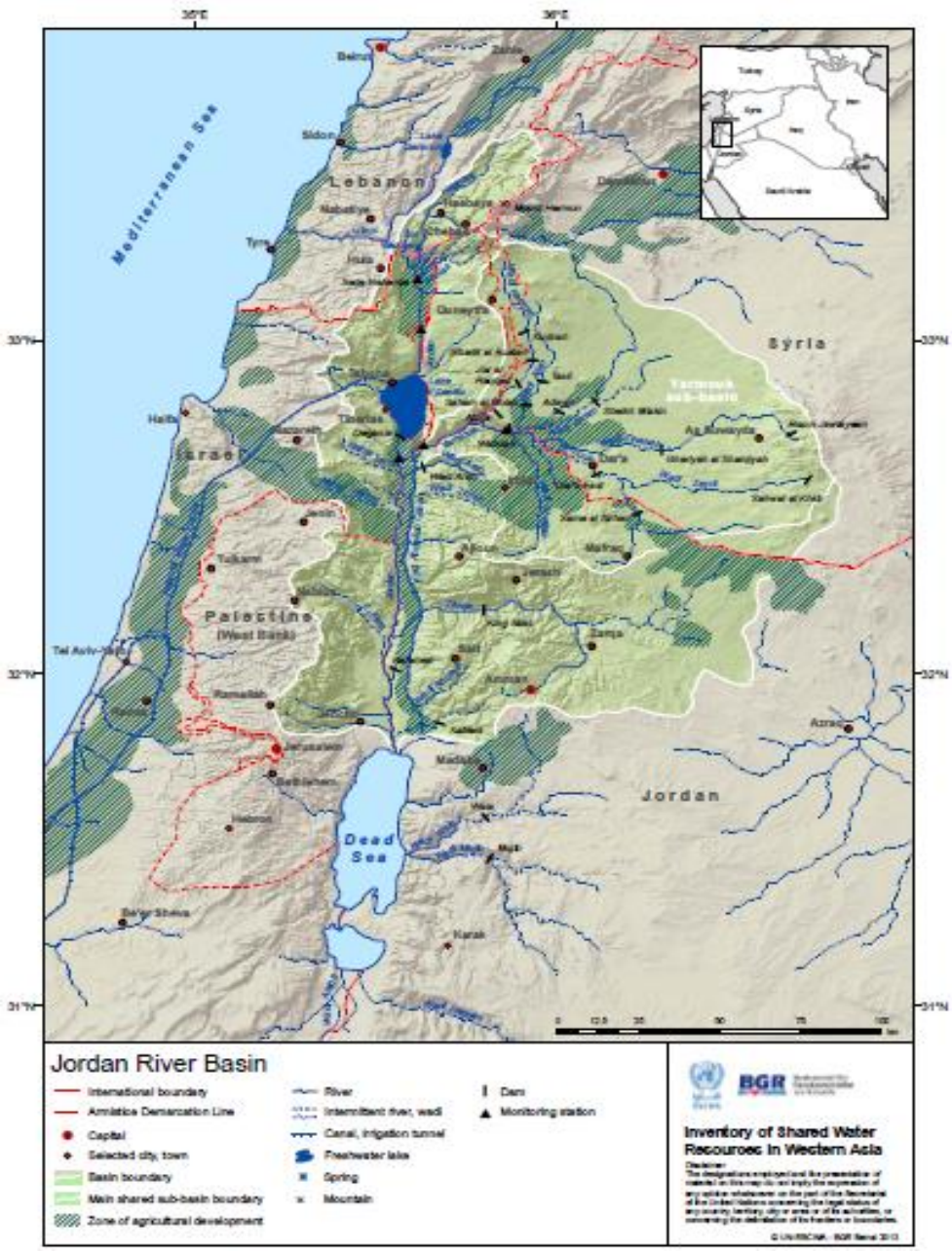
3.2.2 Surface water resources data

3.2.2.1 Jordan River

a. Geography factor: figure 3.4 shows the catchment area of the Jordan River and its riparian countries' contribution. Appendix H shows the Catchment area percentages of riparian countries' contributions to the Jordan River Basin.

Figure 3.4

Jordan River Basin. Source: (UN-ESCWA & BGR, Chapter 6: Jordan river basin, 2013)



b. Hydrology factor: The current annual discharge of the Lower Jordan River into the Dead Sea is estimated at 20-200 MCM compared to 1300 MCM prior 6 decades (UN-ESCWA & BGR, 2013)**.** Appendix H shows the riparian's contribution to the flow of the Jordan River Basin.

c. Climate factor: Appendix H shows total annual rainfall during 1967 in riparian countries and equitable share percentages for the Jordan River from climate factor.

d. Utilization factor: in the late 1950s, the outflow from Lake Tiberius decreases from 605 to 70 MCM/yr due to 440 MCM/yr pumped from lake Tiberius through Israel's national water carrier and about 100 MCM/yr for north irrigation. In the early 1970s, Jordan utilized about 305 MCM/yr from King Abdullah canal (KAC), several side wadies in the south, Zarqa river valleys, Yarmouk, and Amman-Zarqa basins. For Syria, the flow from Lower Yarmouk to the Jordan River reduced from 470 to 380 MCM/yr due to utilizing 90 MCM/yr of irrigation from Upper Yarmouk Rive (Courcier, Venot, & Molle). Annual abstractions in the Hasbani Sub-Basin in Lebanon are estimated at 9-10 MCM (UN-ESCWA & BGR, 2013). Appendix H shows the riparian countries' utilization of the Jordan River before the 1967 War.

e. Economic and social need factor: Appendix H shows the estimated population in 2017, projected water demands for riparian countries, and the equitable share percentage from the Jordan River for riparian countries according to economic and social need factors.

f. Population factor: Appendix H shows the equitable share percentage from the Jordan River for riparian countries according to population factor percentages prior 1967 War.

g. The comparative costs of alternative factor: Appendix H shows GDP in 1970 measurement to reach the equity standard, ranks of each country, and the equitable share percentages from Jordan River for riparian countries according to this factor.

h. The availability of other resources factor: The total renewable water resources for riparian countries (Mimi & Sawalhi, 2003). Appendix H shows the water stress index (WSI) and the riparian countries' equitable share percentages from the Jordan River Basin. As shown below the equation 3.2 refers to water demand, and equation 3.4 refers to water stress index (WSI)

9. Water demand = $\frac{\text{Population} * \text{WHO } (l/c.\text{d}) * 365(\text{d/Yr})}{1000(l/m^3) * 1{,}000{,}000(m^3/MCM)}$ (3.2)

Water demand for Palestine = $\frac{12{,}069{,}582 * 100\ (l/c.\text{d}) * 365(\text{d/Yr})}{1000(l/m^3) * 1{,}000{,}000(m^3/MCM)} = 440.54 Mcm/Yr$

Water demand for Israel = $\frac{8{,}243{,}848 * 100\ (l/c.d) * 365\,(d/Yr)}{1000\,(l/m^3) * 1{,}000{,}000\,(m^3/MCM)} = 300.9 Mcm/Yr$

Water demand for Jordan = $\frac{9{,}785{,}843 * 100\ (l/c.d) * 365\,(d/Yr)}{1000\,(l/m^3) * 1{,}000{,}000\,(m^3/MCM)} = 357.18 cm/Yr$

Water demand for Lebanon = $\frac{6{,}819{,}373 * 100\ (l/c.d) * 365\,(d/Yr)}{1000\,(l/m^3) * 1{,}000{,}000\,(m^3/MCM)} = 248.49 Mcm/Yr$

Water demand for Syria = $\frac{17{,}465{,}575 * 100\ (l/c.d) * 365\,(d/Yr)}{1000\,(l/m^3) * 1{,}000{,}000\,(m^3/MCM)} = 637.49 Mcm/Yr$

10. WSI ratio = $\frac{Water\ demand}{water\ available}$ (3.4)

WSI ratio for Palestine = $\frac{440.54}{215} = 2.05$

WSI ratio for Israel = $\frac{300.9}{1{,}104} = 0.27$

WSI ratio for Jordan = $\frac{357.18}{627} = 0.57$

WSI ratio for Lebanon = $\frac{248.91}{3100} = 0.08$

WSI ratio for Syria = $\frac{637.49}{21475} = 0.03$

k. The degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State: as discussed previously, Appendix H shows the equitable share percentage for Jordan River from appreciable harm Factor that will have the same equity standards derived for the social and economic needs Factor.

3.3 Analysis

MDCA applied to achieve an equitable share amount between riparian countries. Table 3.2 shows the average weights of each factor from (Mimi & Sawalhi, 2003) and our questionnaire, where the summation of weights must be equal to 100%.

Table 3.2

Average weights of equitable factors

Helsinki factors	Average weights (W_i)
(a) the geography of the basin, including in particular the extent of the drainage area in the territory of each basin State;	10.25
(b) the hydrology of the basin, including in particular the contribution of water by each basin State;	13.51
(c) the climate affecting the basin;	12.53
(d) the past utilization of the waters of the basin, including in particular existing utilization;	13.37
(e) the economic and social needs of each basin State;	12.97
(f) the population dependent on the waters of the basin in each basin State;	11.25
(g) the comparative costs of alternative means of satisfying the economic and social needs of each basin State;	8.56
(h) the availability of other resources;	9.05
(k) the degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State.	8.51
Sum	100%

To determine the optimal allocation outcome for each riparian country's data equation 3.5 will be applied.

$$E_{XX} = \frac{\sum_{i=1}^{9} W_i P_i}{\sum_{i=1}^{9} W_i} \quad (3.5)$$

Where: E_{XX}: The equitable share of each riparian country from catchments.

P_i: Percentages of riparian Countries that were determined for each factor.

The four groundwater resources in West Bank and Gaza Strip are the most important conflict issues between Palestine and Israel. So, Appendix I shows the equitable share for the two riparian countries from groundwater aquifer basins according to average weights calculated and Helsinki factors.

Jordan River considers one of the most important issues in the Middle East because of its location between five countries and the conflicts that happed since the Israeli Occupation of Palestinian lands. So, after gathering all equitable share percentages for Jordan River. Appendix I shows the equitable share percentages between the five riparian countries according to average weights calculated and Helsinki factors.

3.4 Results

The previous data collection and analysis showed the precise handling of Helsinki factors from marks, weights, and factors percentages to obtain and conclude the equitable share amounts from groundwater aquifer basins and Jordan River basins for the riparian countries.

So, the final consequence of a sequence of actions obtained from the Helsinki Rules for international watercourses in the Middle East for the riparian countries that contributed to them was fair enough and equitable between them according to factors that world international admit. The variation between the real percentages and equitable percentages extracted will be clear and calculated according to equation 3.6.

$$\Delta V_{XX} = P_{XX} - E_{XX} \quad (3.6)$$

Where: ΔV_{XX}: Variation in use percentage between the reality share and the equitable share for the water resource.

R_{XX}: Present percentages share between riparian countries' water resources.

E_{XX}: The equitable share percentages of each riparian country from water resource.

Variation results from the deference in percentages will be either negative which means that there is a deficiency in use or positive where it means more in use than allowed. The outputs that came from the Helsinki Rules for the groundwater resources and Jordan River with the utilization variation in water quantities for riparian countries will show in tables (3.2-.3.6).

Table 3.3

Eastern Aquifer Basin results

Groundwater catchment	Palestine	Israel
Present share percentage from Eastern aquifer basin (P_{EX})	32.12%	67.88%
Equitable share percentage from Eastern aquifer basin (E_{EX})	67.94%	32.06%
Variation (ΔV_{EX})	-35.82%	+35.82%

Table 3.4

North-Eastern Aquifer Basin results

Groundwater catchment	Palestine	Israel
Present share percentage from north-eastern aquifer (P_{NEX})	18.78%	81.22%
Equitable share percentage from north-eastern aquifer basin (E_{NEX})	59.55%	40.45%
Variation (ΔV_{NEX})	-40.77%	+40.77%

Table 3.5

Western Aquifer Basin results

Groundwater catchment	Palestine	Israel
Present share percentage from western aquifer basin (P_{WX})	7.27%	92.73%
Equitable share percentage from western aquifer basin (E_{WX})	50.96%	49.04%
Variation (ΔV_{EX})	-43.69%	+43.69%

Table 3.6

Coastal Aquifer Basin results

Groundwater catchment	Palestine	Israel
Present share percentage from Coastal Aquifer Basin (R_{CX})	27.27%	72.73%
Equitable share percentage from Coastal Aquifer Basin (E_{CX})	45.52%	54.48%
Variation (ΔV_{CX})	-18.25%	+18.25%

Table 3.7

Jordan River results

Groundwater catchment	Palestine	Israel	Jordan	Lebanon	Syria
Present share percentage from Jordan River (P_{JX})	0%	58.7%	23.4%	0.3%	11%
Equitable share percentage from Jordan River (E_{JX})	20.86%	18.73%	23.22%	12.21%	24.98%
Variation (ΔV_{JX})	-20.86%	+39.97%	-2.18%	-11.91%	-13.98%

The previous five tables showed the variation between the Present and equitable share between riparian countries. Results showed that Palestine utilize less than its fair share whereas Israel used more than its fair share from different shared water resources. These percentages and variations make a conflict and political tension in the area. The equitably shared amounts from different shared water resources for Palestine must rise where table 3.7 shows the equitable amount from groundwater resources that Palestine deserves to use and table 3.8 shows the equitable utilization amount from the Jordan River for the Palestinian side.

Table 3.8

Equitable utilization for Palestinians from groundwater resources

Groundwater resources	Eastern Aquifer Basin	North-eastern Aquifer Basin	Western Aquifer Basin	Coastal Aquifer Basin
Equitable percentage utilization for the Palestinian side	67.94%	59.55%	50.96%	45.52%
Equitable amount utilization for the Palestinian side (MCM/yr)	112.10	72.95	194.16	263.11

Table 3.9

Equitable utilization for Palestinians from the Jordan River

Surface water	Jordan River
Equitable percentage utilization for the Palestinian side	20.86%
Equitable amount utilization for the Palestinian side (MCM/yr)	292.04

The Previous two tables showed the annual equitable amount utilization from Eastern, North-eastern, Western, Gaza Aquifer basins, and Jordan River for the State of Palestine. Where these amounts must be used in future negotiations between riparian countries to recover Palestinians' rights in water cases.

Chapter Four

Conclusion and Recommendation

4.1 Conclusion

Based on the results of the analysis presented above, the following conclusions can be drawn:

1. At first sight, it can be noticed that Israel utilizes water resources more than any riparian country in the area.

2. For groundwater aquifers, Palestinian at present uses less than 15% of the available groundwater resources. For surface water, Palestinian used 0% of the Jordan River. The results showed that Palestine has the right to equitable quantities of groundwater and surface resources more than the current use. Table 4.1 summarizes the average equitable percentage utilization from groundwater resources and percentage utilization from Jordan for Palestine.

Table 4.1

Equitable total amount and utilization for Palestinians from available watercourses

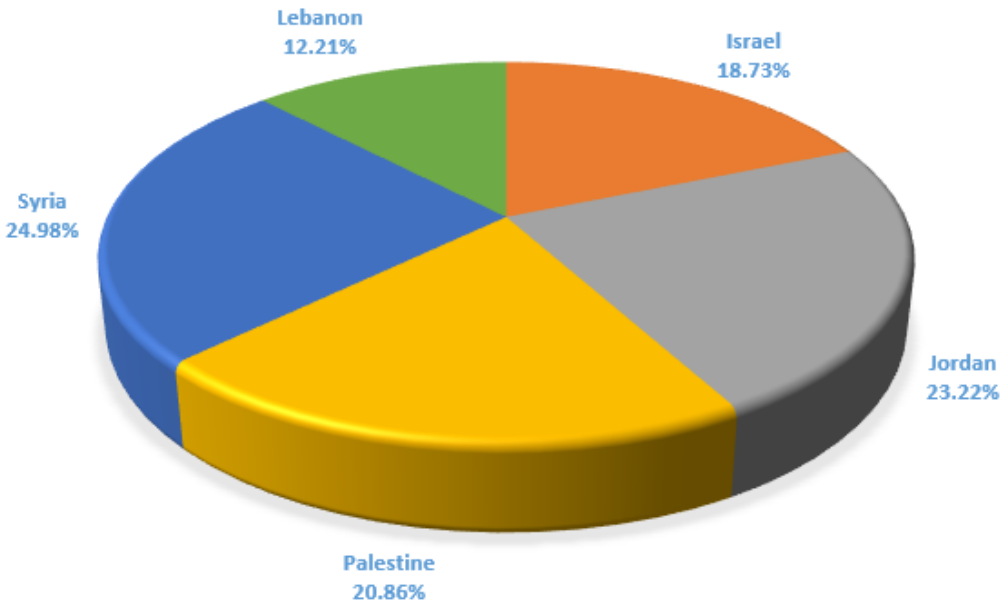
Palestinian equitable share	Groundwater resources	Jordan River	Total
Equitable percentage utilization for the Palestinian side	55.99%	20.86%	
Equitable amount utilization for the Palestinian side (MCM/yr)	642.31	292.04	934.35

3. For groundwater aquifers, Israel used more than 85% of the West Bank and Gaza Strip's groundwater resources. For surface water, they utilize 58.7% of the Jordan River. The results showed that Israel has to utilize less than its current use of groundwater resources and the Jordan River.

4. For the Jordan River, the equitable utilization of the river is widely different from its current use. As previously shown from the Jordan river results, Palestine, Jordan, Lebanon, and Syria have the right to increase their utilization of the Jordan river, whereas Israel's current use is more than equitable utilization. Figure 4.1 shows the equitable share percentages of riparian countries from the Jordan River.

Figure 4.1

Equitable utilization of the Jordan River for the riparian countries



5. The utilization of any riparian country from any water resources must not harm the quantity of the water catchment, which could affect the other riparian country.

6. The dams, water line carriers, and other things that could be used to take advantage form watercourses are allowed under conditions that must not affect and harm another country's utilization.

4.2 Recommendation

The following are the main recommendation based on the above results:

1. The international Law should be used in any future negotiations between Israel and Palestine

2. Negotiations should be based on the percentages from each transboundary watercourse rather than quantities, especially in light of the expected climate change effect.

3. Data collection regarding available quantities for each transboundary watercourse should be a continuous process. Groundwater modeling of different groundwater

basins is highly recommended since recharge and utilization of the different ground aquifers change especially due to climate change effect.

List of Abbreviations

Abbreviation	Meaning
PWA	Palestinian Water Authority
ILA	International Law Association
ILC	International Law Commission
MCDA	Multiple Criteria Decision Analysis
DOP	Declaration of Principles
UN	United Nation
SC	Security Council
GDP	Gross Domestic Product
WSI	Water Stress Index
MCM	Million Cubic Meter
GIS	Geographic Information System
WHO	World Health Organization
KAC	King Abdullah Canal

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APPENDICES

Appendix A

Questionnaire

بسم الله الرحمن الرحيم

الموضوع: استبانة تقييم حصة دولة فلسطين من المصادر المائية المشتركة حسب القوانين الدولية.

هذه الاستبانة جزء من دراسة تحت عنوان **الحقوق المائية الفلسطينة حسب القوانين الدولية،** للحصول على درجة الماجستير في هندسة المياه والبيئة. حيث تهدف الى تقييم حصة دولة فلسطين من المصادر المائية المشتركة بناءاً على مبادئ القوانين الدولية وتحديداً مبادئ هلسينكي. وعليه يرجى التكرم بالإجابة على أسئلة الاستبانة التالية، علما أن الإجابة ستكون سرية ولأغراض البحث العلمي فقط: -

- **الجزء الأول: عام:**

1. التخصص:.....
2. مجال العمل:.....
3. سنوات الخبرة: .....
4. هل هنالك تصور مسبق عن حصة دولة فلسطين بالمياه المشتركة؟ .....
5. اذا كانت اجابتك على السؤال الرابع بنعم، فكم هي هذه النسبة الحالية لدولة فلسطين من: -

   أ- المياه الجوفية؟ .....

   ب- نهر الأردن؟ .....
6. هل هنالك تصور مسبق عن القوانين الدولية وتحديداً مبادئ هلسينكي؟ .....

❖ **الجزء الثاني: أهمية عوامل مبادئ هلسينكي: -**

حسب المادة الرابعة من مبادئ هلسينكي فإنه يحق لكل دولة حوض، داخل أراضيها حصة معقولة ومنصفة في الاستخدامات المفيدة لمياه حوض تصريف دولي.

وحسب المادة الخامسة من مبادئ هلسينكي فإن: -

1. النصيب معقول والمنصف بالمعنى المقصود في المادة الرابعة يجب تحديده في ضوء جميع العوامل ذات الصلة في كل حالة معينة.

2. وتشمل العوامل ذات الصلة التي يجب أخذها في الاعتبار، حيث تتكون مبادئ هلسينكي من أحد عشر عاملاً، نرجو من حضرتكم تحديد أهميتها بإعطاء علامة من **10** في خانة أهمية المبدأ لكل عامل من العوامل، ليعكس اهمية هذا العامل في تحديد حصة الدولة المشاطئة: -

الرقم	مبادئ هلسينكي	أهمية المبدأ
.1	جغرافية الحوض، بما في ذلك على وجه الخصوص مدى منطقة الصرف في أراضي كل دولة حوض.	
.2	هيدرولوجيا الحوض، بما في ذلك على وجه الخصوص مساهمة المياه من قبل كل دولة حوض.	
.3	المناخ الذي يؤثر على الحوض.	
.4	الاستخدام السابق لمياه الحوض ، بما في ذلك على وجه الخصوص الاستخدام الحالي	
.5	الاحتياجات الاقتصادية والاجتماعية لكل دولة حوض.	
.6	السكان الذين يعتمدون على مياه الحوض في كل دولة حوض	
.7	التكاليف المقارنة للوسائل البديلة لتلبية الاحتياجات الاقتصادية والاجتماعية لكل دولة حوض	
.8	توافر الموارد الأخرى.	
.9	تجنب الهدر غير الضروري في استغلال مياه الحوض.	
10	إمكانية التعويض العملي لواحدة أو أكثر من دول الحوض المشترك كوسيلة لتعديل التضارب بين الاستخدامات.	
.11	الدرجة التي يمكن عندها تلبية احتياجات دولة الحوض، دون التسبب في ضرر كبير لدولة الحوض المشترك.	

❖ **الجزء الثالث: حصة دولة فلسطين من المصادر المائية المشتركة**

بناءاً على خبرتكم في مجال المياه، يرجى إعطاء نسبة تشمل حصة دولة فلسطين العادلة من المصادر المائية التالية:

الرقم	الحوض	النسبة
.1	الحوض الساحلي	
.2	الحوض الشرقي	
.3	الحوض الشمالي الشرقي	
.4	العوض الغربي	
.5	نهر الاردن	

إنتهاء الإستبانة

أتقدم لكم بجزيل الشكر والعرفان لمساعدتكم لتعبئة نموذج الاستبانة لأغراض البحث العلمي للحصول على درجة الماجستير في مجال هندسة المياه والبيئة. وهذه المعلومات المستوفاة من حضرتكم ستكون سرية بشكل تام.

م. محمد العلاونة

محافظة جنين/ بلدة قباطية

Appendix B

Water experts questionnaire answers

الاسئلة	A	B	C	D
الجزء الأول: عام: -				
التخصص	هندسة مياه	هندسة مدنية	العلوم السياسية والقانون العام	مياه
مجال العمل	مؤسسة غير حكومية	في مؤسسة حقوق الانسان	جامعة النجاح	أكاديمي
سنوات الخبرة	30	20	21	13
هل هنالك تصور مسبق عن حصة دولة فلسطين بالمياه المشتركة؟	نعم	لا	نعم	لا
اذا كانت اجابتك على السؤال الرابع بنعم، فكم هي هذه النسبة الحالية لدولة فلسطين من المياه الجوفية؟	20%		من كل 20% المياه الجوفية في جبال فلسطين الوسطى	30%
اذا كانت اجابتك على السؤال الرابع بنعم، فكم هي هذه النسبة الحالية لدولة فلسطين من نهر الاردن؟	0%		حاليا هي صفر لكن حصة فلسطين حددت في خطة جونستون 1953وتصل الى 215 مليون متر مكعب	0%
هل هنالك تصور مسبق عن القوانين الدولية وتحديداً مبادئ هلسينكي؟	نعم	لا	نعم	لا
الجزء الثاني: أهمية عوامل مبادئ هلسينكي: -				
جغرافية الحوض، بما في ذلك على وجه الخصوص مدى منطقة الصرف في أراضي كل دولة حوض.	8		10	8
هيدرولوجيا الحوض، بما في ذلك على وجه الخصوص مساهمة المياه من قبل كل دولة حوض.	8	لا اعرف	10	7
المناخ الذي يؤثر على الحوض.	7	لا اعرف	10	6
الاستخدام السابق لمياه الحوض ، بما في ذلك على وجه الخصوص الاستخدام الحالي	3	لا اعرف	2	9
الاحتياجات الاقتصادية والاجتماعية لكل دولة حوض.	9	لا اعرف	10	10
السكان الذين يعتمدون على مياه الحوض في كل دولة حوض	9	لا اعرف	10	7
التكاليف المقارنة للوسائل البديلة لتلبية الاحتياجات الاقتصادية والاجتماعية لكل دولة حوض	6	لا اعرف	5	8
توافر الموارد الأخرى.	7	لا اعرف	5	9
تجنب الهدر غير الضروري في استغلال مياه الحوض.	8	لا اعرف	10	9
إمكانية التعويض العملي لواحدة أو أكثر من دول الحوض المشترك كوسيلة لتعديل التضارب بين الاستخدامات.	6	لا اعرف	10	8
الدرجة التي يمكن عندها تلبية احتياجات دولة الحوض، دون التسبب في ضرر كبير لدولة الحوض المشترك.	6	لا اعرف	10	9

الجزء الثالث: حصة دولة فلسطين من المصادر المائية المشتركة				
الحوض الساحلي	30	لا اعرف	لا يحصل الفلسطينون على مياه لان اسرائيل تعتبر الحوض غير مشترك	60
الحوض الشرقي	100	لا اعرف	حصة الفلسطينيين 172\54 مليون متر مكعب	100
الحوض الشمالي الشرقي	80	لا اعرف	145\42 مليون متر مكعب	90
الحوض الغربي	100	لا اعرف	362\22 مليون متر مكعب	80
نهر الاردن	18	صفر	صفر	30

Appendix C

Weights

The table below shows Palestinian water Experts' average scores and weights for Helsinki factors

Helsinki factors	Score (S_i)	Weight (W_i)
(a) the geography of the basin, including in particular the extent of the drainage area in the territory of each basin State;	8.67	12.50
(b) the hydrology of the basin, including in particular the contribution of water by each basin State;	8.33	12.01
(c) the climate affecting the basin;	7.67	11.06
(d) the past utilization of the waters of the basin, including in particular existing utilization;	4.67	6.73
(e) the economic and social needs of each basin State;	9.67	13.95
(f) the population dependent on the waters of the basin in each basin State;	8.67	12.50
(g) the comparative costs of alternative means of satisfying the economic and social needs of each basin State;	6.33	9.13
(h) the availability of other resources;	7	10.10
(k) the degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State.	8.33	12.01
Sum	69.34	100%

The table able below shows Experts' average scores and weights for Helsinki factors from Dr. Mimi & Sawalhi questionnaire

Helsinki factors	Rang	Weight (W_i)
(a) the geography of the basin, including in particular the extent of the drainage area in the territory of each basin State;	7-12	8
(b) the hydrology of the basin, including in particular the contribution of water by each basin State;	12-16	15
(c) the climate affecting the basin;	12-15	14
(d) the past utilization of the waters of the basin, including in particular existing utilization;	17-22	20
(e) the economic and social needs of each basin State;	10-13	12
(f) the population dependent on the waters of the basin in each basin State;	8-11	10
(g) the comparative costs of alternative means of satisfying the economic and social needs of each basin State;	7-9	8
(h) the availability of other resources;	7-11	8
(k) the degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State.	2-7	5
Sum		100%

Appendix D

Eastern Aquifer Basins percentages according to Helsinki rules

Geography factor for Eastern Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Eastern Aquifer Basin area (km^2)	2,817.6	266.7	3,084.3
Equitable share percentage from Eastern Aquifer Basin	**91.4%**	**8.6%**	**100%**

Hydrology factor for Eastern Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Eastern Aquifer Basin recharge share Percentage	**83%**	**17%**	**100%**

- Source: (Yacobi & Abdel-Gafor, 2001)

Climate factor for eastern aquifer basin

Helsinki factor	Palestine	Israel	Total
Total annual rainfall during 1967 (mm)	500.14	310.72	810.86
Equitable share percentage from Eastern Aquifer Basin	**61.68%**	**38.32%**	**100%**

- Source: (Palestine Average Precipitation), (Israel Average Precipitation)

Utilization factor for Eastern Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Utilization quantity prior 1967 War (Mcm/yr)	65	35	100
Equitable share percentage from Eastern Aquifer Basin	**65%**	**35%**	**100%**

Source: (Gvirtzman, 2012)

Economic and social needs factor for Eastern Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Population in 2017	12,069,582	8,243,848	20,313,430
World Health Organization (WHO) (l/c.d)	100	100	100
Water demand for the year 2017 (m^3/ d)	1,206,958.2	824,384.8	2,031,343
Equitable share percentage from Eastern Aquifer Basin	**59.42%**	**40.58%**	**100%**

Population factor for Eastern Aquifer Basin

Helsinki factor	Palestine	Israel	Total
Population prior 1967 War (capita)	1,781,850	2,558,712	4,340,562
Equitable share percentage from Eastern Aquifer Basin	**41.05%**	**58.95%**	**100%**

The comparative costs factor for Eastern Aquifer Basin

Helsinki factors	Palestine	Israel	Total
GDP in 1970 (million $)	177	7,073	7,250
Rank	2	1	3
Equitable share percentage from Eastern Aquifer Basin	**66.7%**	**33.3%**	**100%**

Source: (Countryeconomy.com)

The availability of other resources factor for Eastern Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Water demand in 2017 (Mcm/Yr)	440.54	300.9	741.44
Water available (Mcm/yr)	162	954	1,116
WSI	2.72	0.32	3.04
Equitable share percentage from Eastern Aquifer Basin	**89.5%**	**10.5%**	**100%**

Appreciable harm factor for Eastern Aquifer Basin.

Helsinki factors	Palestine	Israel	Total
Equitable share percentage for Eastern Aquifer Basin	**59.42%**	**40.58%**	**100%**

Appendix E

North-Eastern Aquifer Basins percentages according to Helsinki rules

Geography factor for North-Eastern Aquifer Basin

Helsinki factors	Palestine	Israel	Total
North-Eastern Aquifer Basin area (km^2)	985.6	385.2	1,370.8
Equitable share percentage from North-Eastern Aquifer Basin	**71.9%**	**28.1%**	**100%**

Hydrology factor for North-Eastern Aquifer Basin

Helsinki factors	Palestine	Israel	Total
North-Eastern Aquifer Basin recharge percentage	**83%**	**24%**	**100%**

Source: (Yacobi & Abdel-Gafor, 2001)

Climate factor for North-Eastern Aquifer Basin

Helsinki factor	Palestine	Israel	Total
Total annual rainfall during 1967 (mm)	500.14	310.72	810.86
Equitable share percentage from North-Eastern Aquifer Basin	**61.68%**	**38.32%**	**100%**

Source: (Palestine Average Precipitation), (Israel Average Precipitation)

Utilization factor for North-Eastern Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Utilization quantity prior 1967 war (Mcm/yr)	25	115	140
Equitable share percentage from North-Eastern Aquifer Basin	**17.86%**	**82.14%**	**100%**

Source: (Gvirtzman, 2012)

Economic and social needs factor for North-Eastern Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Population in 2017	12,069,582	8,243,848	20,313,430
World Health Organization (WHO) (l/c.d)	100	100	100
Water demand for the year 2017 (m^3/ d)	1,206,958.2	824,384.8	2,031,343
Equitable share percentage from north-Eastern Aquifer Basin	**59.42%**	**40.58%**	**100%**

Population factor for North-Eastern Aquifer Basin

Helsinki factor	Palestine	Israel	Total
Population prior 1967 War (capita)	1,781,850	2,558,712	4,340,562
Equitable share percentage from north-eastern aquifer basin	**41.05%**	**58.95%**	**100%**

The comparative costs of alternative factor for North-Eastern Aquifer Basin

Helsinki factors	Palestine	Israel	Total
GDP in 1970 (million $)	177	7,073	7,250
Rank	2	1	3
Equitable share percentage from North-Eastern Aquifer Basin	**66.7%**	**33.3%**	**100%**

Source: (Countryeconomy.com)

The availability of other resources factor for north-eastern aquifer basin

Helsinki factors	Palestine	Israel	Total
Water demand in 2017 (Mcm/Yr)	440.54	300.9	741.44
Water available (Mcm/yr)	192	1,004	1,196
WSI	2.3	0.3	2.6
Equitable share percentage from North-Eastern Aquifer Basin	**88.5%**	**11.5%**	**100%**

Appreciable harm factor for North-Eastern Aquifer Basin.

Helsinki factors	Palestine	Israel	Total
Equitable share percentage from North-Eastern Aquifer Basin	**59.42%**	**40.58%**	**100%**

Appendix F

Western Aquifer Basins percentages according to Helsinki rules

Geography factor for Western Aquifer Basin

Helsinki factors	Palestine	Israeli Occupation	Total
Western Aquifer Basin area	1,843.2	7,136.8	8,980
Equitable share percentage from Western Aquifer Basin	**20.5%**	**79.5%**	**100%**

Hydrology factor for Western Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Western Aquifer Basin recharge percentage	**73%**	**27%**	**100%**

Source: (Yacobi & Abdel-Gafor, 2001)

Climate factor for Western Aquifer Basin

Helsinki factor	Palestine	Israel	Total
Total annual rainfall during 1967 (mm)	500.14	310.72	810.86
Equitable share percentage from Western Aquifer Basin	**61.68%**	**38.32%**	**100%**

Source: (Palestine Average Precipitation), (Israel Average Precipitation)

Utilization factor for Western Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Utilization quantity prior 1967 War (Mcm/yr)	20	340	360
Equitable share percentage from Western Aquifer Basin	**5.56%**	**94.44%**	**100%**

Source: (Gvirtzman, 2012)

Economic and social needs factor for Western Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Population in 2017	12,069,582	8,243,848	20,313,430
World Health Organization (WHO) (l/c.d)	100	100	100
Water demand for the year 2017 (m^3/c.d)	1,206,958.2	824,384.8	2,031,343.0
Equitable share percentage from Western Aquifer Basin	**59.42%**	**40.58%**	**100%**

Population factor for western aquifer basin

Helsinki factor	Palestine	Israel	Total
Population prior 1967 War (capita)	1,781,850	2,558,712	4,340,562
Equitable share percentage from Western Aquifer Basin	**41.05%**	**58.95%**	**100%**

The comparative costs of alternative factor for Western Aquifer Basin

Helsinki factors	Palestine	Israel	Total
GDP in 1970 (million $)	177	7,073	7,250
Rank	2	1	3
Equitable share percentage from Western Aquifer Basin	**66.7%**	**33.3%**	**100%**

Source: (Countryeconomy.com)

The availability of other resources factor for Western Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Water demand in 2017 (Mcm/Yr)	440.54	300.9	741.44
Water available (Mcm/yr)	187	719	906
WSI	2.36	0.42	2.78
Equitable share percentage from Western Aquifer Basin	**84.9%**	**15.1%**	**100%**

Appreciable harm factor for Western Aquifer Basin.

Helsinki factors	Palestine	Israel	Total
Equitable share percentage from Western Aquifer Basin	**59.42%**	**40.58%**	**100%**

Appendix G

Coastal Aquifer Basins percentages according to Helsinki rules

Geography factor for Coastal Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Coastal Aquifer Basin area (km^2)	360.77	5,006	5,366.77
Equitable share percentage from Coastal Aquifer Basin	**6.72%**	**93.28%**	**100%**

Hydrology factor for Coastal Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Costal Aquifer Basin recharge (MCM/yr)	43	247	290
Equitable share percentage from Coastal Aquifer Basin	**14.83%**	**85.17%**	**100%**

Climate factor for Coastal Aquifer Basin

Helsinki factor	Palestine	Israel	Total
Total annual rainfall during 1967 (mm)	500.14	310.72	810.86
Equitable share percentage from Coastal Aquifer Basin	**61.68%**	**38.32%**	**100%**

Utilization factor for Coastal Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Utilization quantity (Mcm/yr)	165	440	605
Equitable share percentage from Coastal Aquifer Basin	**27.27%**	**72.73**	**100%**

Source: (UN-ESCWA & BGR, CHAPTER 20 - COASTAL AQUIFER BASIN, 2013)**.**

Economic and social needs factor for Coastal Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Population in 2017	12,069,582	8,243,848	20,313,430
World Health Organization (WHO) (l/c.d)	100	100	100
Water demand for the year 2017 (m^3/c.d)	1,206,958.2	824,384.8	2,031,343.0
Equitable share percentage from Coastal Aquifer Basin	**59.42%**	**40.58%**	**100%**

Population factor for Coastal Aquifer Basin

Helsinki factor	Palestine	Israel	Total
Population prior 1967 War (capita)	1,781,850	2,558,712	4,340,562
Equitable share percentage from Coastal Aquifer Basin	**41.05%**	**58.95%**	**100%**

The comparative costs of alternative factor for Coastal Aquifer Basin

Helsinki factors	Palestine	Israel	Total
GDP in 1970 (million $)	177	7,073	7,250
Rank	2	1	3
Equitable share percentage from Coastal Aquifer Basin	**66.7%**	**33.3%**	**100%**

The availability of other resources factor for Coastal Aquifer Basin

Helsinki factors	Palestine	Israel	Total
Water demand in 2017 (Mcm/Yr)	440.54	300.9	741.44
Water available (Mcm/yr)	50	664	714
WSI	8.81	0.45	9.26
Equitable share percentage from Coastal Aquifer Basin	**95.14%**	**4.86%**	**100%**

Appreciable harm factor for Coastal Aquifer basin.

Helsinki factors	Palestine	Israel	Total
Equitable share percentage from Coastal Aquifer Basin	**59.42%**	**40.58%**	**100%**

Appendix H

Jordan River percentages according to Helsinki rules

Geography factor for Jordan River

Helsinki factors	Palestine	Israel	Jordan	Lebanon	Syria	Total
Catchment area (km^2)	1,564	1,906	7,352	688	6,775	18,285
Equitable share Percentage	**8.6%**	**10.4%**	**40.2%**	**3.8%**	**37%**	**100%**

Hydrology factor for Jordan River

Helsinki factors	Palestine	Israel	Jordan	Lebanon	Syria	Total
Historical discharge (MCM/yr)	148	155	506	115	416	1340
Equitable share Percentage	**11%**	**12%**	**38%**	**8%**	**31%**	**100%**

Source: (GTZ, 1996)

Climate factor for Jordan River

Helsinki factors	Palestine	Israel	Jordan	Lebanon	Syria	Total
Total annual rainfall during 1967 (mm)	500.14	310.72	121.38	802.97	392.12	2127.33
Equitable share Percentage	**23.51%**	**14.61%**	**5.71%**	**37.75%**	**18.43%**	**100%**

Utilization factor for Jordan River

Helsinki factors	Palestine	Israel	Jordan	Lebanon	Syria	Total
Utilization quantity prior 1967 war (Mcm/yr)	20*****	535	305	10	90	960
Equitable share Percentage	**2.08%**	**55.73%**	**31.77%**	**1.04%**	**9.38%**	**100%**

Source: (Mimi & Sawalhi, 2003)

Economic and social needs factor for Jordan River

Helsinki factors	Palestine	Israel	Jordan	Lebanon	Syria	Total
Population in 2017 (capita)	12,069,582	8,243,848	9,785,843	6,819,373	17,465,575	54,384,221
World Health Organization (WHO) (l/c.d)	100	100	100	100	100	
Water demand for the year 2017 (m^3/c.d)	1,206,958.2	824,384.8	978,584.3	681,937.3	1,746,557.5	5,438,422.1
Equitable share Percentage	**22.19%**	**15.16%**	**17.99%**	**12.54%**	**32.12%**	**100%**

Population factor for Jordan River

Helsinki factors	Palestine	Israel	Jordan	Lebanon	Syria	Total
Population in 1967 (capita)	1,781,850	2,558,712	1,378,998	2,174,738	5,740,710	13,635,008
Equitable share Percentage	**13.07%**	**18.77%**	**10.11%**	**15.95%**	**42.10%**	**100%**

The comparative costs of alternative factor for Jordan River

Helsinki factors	Palestine	Israel	Jordan	Lebanon	Syria	Total
GDP in 1970 (million $)	177	7,073	640	1,990	1,780	11,660
Rank	5	1	4	2	3	15
Equitable share Percentage	**33.33%**	**6.67%**	**26.67%**	**13.33%**	**20%**	**100%**

11. Source: (Countryeconomy.com)

The availability of other resources factor for Jordan River

Helsinki factors	Palestine	Israel	Jordan	Lebanon	Syria	Total
Water demand in 2017 (Mcm/Yr)	440.54	300.9	357.18	248.91	637.49	1985.02
Water available (Mcm/yr)	215	1,104	627	3100	21475	26521.00
WSI	2.05	0.27	0.57	0.08	0.03	3.00
Equitable share Percentage	**68.27%**	**9.08%**	**18.98%**	**2.68%**	**0.99%**	**100%**

Appreciable harm factor for Jordan River

Helsinki factors	Palestine	Israel	Jordan	Lebanon	Syria	Total
Equitable share Percentage	**22.19%**	**15.16%**	**17.99%**	**12.54%**	**32.12%**	**100%**

Appendix I

Analytics tables

The equitable share of each riparian country from Eastern Aquifer Basin

Helsinki factors	Average weights (W_i)	Palestine percentages (P_p)	Israeli percentages (P_i)	E_p W_iP_p	E_i W_iP_i
Factor (a)	10.25	91.40	8.60	937.01	88.17
Factor (b	13.51	83.00	17.00	1121.05	229.61
Factor (c)	12.53	59.70	40.30	748.08	504.99
Factor (d)	13.37	65.00	35.00	868.89	467.86
Factor (e)	12.97	59.42	40.58	770.85	526.44
Factor (f)	11.25	41.05	58.95	461.89	663.29
Factor (g)	8.56	66.70	33.30	571.25	285.20
Factor (h)	9.05	89.50	10.50	809.76	95.00
Factor (k)	8.51	59.42	40.58	505.46	345.20
E_E				67.94%	32.06%

Equitable share of each riparian country from North-Eastern Aquifer Basin

Helsinki factors	**Average weights (W_i)**	**Palestine percentages (P_p)**	**Israeli percentages (P_i)**	**E_p W_iP_p**	**E_i W_iP_i**
Factor (a)	10.25	71.90	28.10	737.10	288.08
Factor (b	13.51	83.00	17.00	1121.05	229.61
Factor (c)	12.53	59.70	40.30	748.08	504.99
Factor (d)	13.37	17.86	82.14	238.74	1098.00
Factor (e)	12.97	59.42	40.58	770.85	526.44
Factor (f)	11.25	41.05	58.95	461.89	663.29
Factor (g)	8.56	66.70	33.30	571.25	285.20
Factor (h)	9.05	88.50	11.50	800.71	104.05
Factor (k)	8.51	59.42	40.58	505.46	345.20
E_{NE}				**59.55%**	**40.45%**

Equitable share of each riparian country from Western Aquifer Basin

Helsinki factors	Average weights (W_i)	Palestine percentages (P_p)	Israeli percentages (P_i)	E_p W_iP_p	E_i W_iP_i
Factor (a)	10.25	20.50	79.50	210.16	815.02
Factor (b	13.51	73.00	27.00	985.98	364.68
Factor (c)	12.53	59.70	40.30	748.08	504.99
Factor (d)	13.37	5.56	94.44	74.32	1262.42
Factor (e)	12.97	59.42	40.58	770.85	526.44
Factor (f)	11.25	41.05	58.95	461.89	663.29
Factor (g)	8.56	66.70	33.30	571.25	285.20
Factor (h)	9.05	84.90	15.10	768.14	136.62
Factor (k)	8.51	59.42	40.58	505.46	345.20
E_W				**50.96%**	**49.04%**

Equitable share of each riparian country from Coastal Aquifer Basin

Helsinki factors	Average weights (W_i)	Palestine percentages (P_p)	Israeli percentages (P_i)	E_p W_iP_p	E_i W_iP_i
Factor (a)	10.25	6.72	93.28	68.89	956.29
Factor (b	13.51	14.83	85.17	200.30	1150.36
Factor (c)	12.53	59.70	40.30	748.08	504.99
Factor (d)	13.37	27.27	72.73	364.53	972.22
Factor (e)	12.97	59.42	40.58	770.85	526.44
Factor (f)	11.25	41.05	58.95	461.89	663.29
Factor (g)	8.56	66.70	33.30	571.25	285.20
Factor (h)	9.05	95.14	4.86	860.79	43.97
Factor (k)	8.51	59.42	40.58	505.46	345.20
E_C				**45.52%**	**54.48%**

Equitable share of each riparian country from Jordan river

Helsinki factors	Average weights (W_i)	Palestine percentages (P_p)	Israeli percentages (P_I)	Jordan percentages (P_J)	Lebanon percentages (P_L)	Syria percentages (P_S)	E_p W_iP_p	E_i W_iP_i	E_J W_iP_J	E_L W_iP_L	E_S W_iP_L
Factor (a)	10.25	8.6	10.4	40.20	3.80	37.00	88.15	106.60	412.05	38.95	379.25
Factor (b	13.51	11	12	38.00	8.00	31.00	148.61	162.12	513.38	108.08	418.81
Factor (c)	12.53	23.51	14.61	5.71	37.75	18.43	294.58	183.06	71.5463	473.0075	230.9279
Factor (d)	13.37	2.08	55.73	31.77	1.04	9.38	27.81	745.11	424.7649	13.9048	125.4106
Factor (e)	12.97	22.19	15.16	17.99	12.54	32.12	287.80	196.63	233.3303	162.6438	416.5964
Factor (f)	11.25	13.07	18.77	10.11	15.95	42.10	147.04	211.16	113.7375	179.4375	473.625
Factor (g)	8.56	33.33	6.67	26.67	13.33	20.00	285.30	57.10	228.2952	114.1048	171.2
Factor (h)	9.05	68.27	9.08	18.98	2.68	0.99	617.84	82.17	171.769	24.254	8.9595
Factor (k)	8.51	22.19	15.16	17.99	12.54	32.12	188.84	129.01	153.0949	106.7154	273.3412
E_J							**20.86%**	**18.73%**	**23.22%**	**12.21%**	**24.98%**

جـامعـــة النجاح الوطنية

كليـــة الدراســـات العليـــا

حقوق المياه الفلسطينية في القانون الدولي

إعداد

محمد العلاونة

إشراف

د. عنان جيوسي

قدمت هذه الرسالة استكمالا لمتطلبات الحصول علي درجه الماجستير في هندسة المياه والبيئة، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس– فلسطين.

2022

حقوق المياه الفلسطينية في القانون الدولي

إعداد

محمد العلاونة

إشراف

د. عنان جيوسي

الملخص

عانت فلسطين من عدة احتلالات بسبب أرضايها وموقعها في قلب الشرق الأوسط. حيث تربط آسيا وأروربا وإفريقا بأرضايها وبحرها الأبيض المتوسط. منذ عام 1917، عانت فلسطين من عدة حروب من الجيش البريطاني، الذين قامو بإنهاء انتدابهم عام 1948 باعطاء العصابات الصهيونية وعد بلفور.

كانت قضية المياه بين الفلسطينيين والاحتلال الإسرائيلي من أهم القضايا التي لا يزال الصراع قائما عليها ليومنا هذا. بعد حرب 1967، سيطر الإحتلال الإسرائيلي على جميع الموارد المياه المتاحة في الضفة الغربية وقطاع غزة وبدأ في إستغلالها مع منع الفلسطينيين من تطوير أي موارد إضافية. تتحدث المادة 40 في اتفاقية اوسلو الثانية عن كميات حصة المياه لكل دولة لفترة الانتقالية البالغة مدتها خمس سنوات، ويجدر الإشارة إلى أن الكميات المذكورة ليست منصفة لأي وقت بعد عام 1999، حيث تعتبر إتفاقيات منتهية الصلاحية. لذلك، فإن مبادئ هيلسينكي التي تم استحداثها في عام 1966، تنص على الإستخدام العادل لمياه حوض التصريف الدولي. ذكرت المادة الخامسة أحد عشر عاملاً يجب مراعتها عند تحديد الحصة العادلة من المجاري المائية الدولية المشتركة لكل دولة على ضفاف النهر.

تم توزيع إستبانة على خبراء المياه الفلسطينيين لإعطاء علامات لعوامل هلسينكي وقفا لأهميتها. وتطبيق أداة المعايير المتعددة لتحليل القرار كأداة للحكم بين البلدان المشاطئة. أظهر النتائج النهائية أن نسبة الموارد المائية التي يجب تخصيصها لدولة فلسطين تبع حوالي 56% من موارد المياه الجوفية أي ما يعادل 642.31 مليون متر مكعب/سنة، حيث تقل نسبة الإستخدام الحالية عن 15%. بالنسبة لحوض

نهر الأردن، تبلغ نسبة الإستخدام العادل حوالي 20.86% أي ما يعادل 292.04 مليون متر مكعب سنويا بينما يبلغ الإستخدام الحالي منه صفر%.

الكلمات المفتاحية: قواعد هلسنكي، الدول المشاطئة، المجاري المائية الدولية، خزانات المياه الجوفية، نهر الأردن، الحصة العادلة، الصراع، والاستخدام.