



An-Najah National University
Faculty of Graduate Studies

**GOVERNANCE ASSESSMENT OF
BRACKISH WATER DESALINATION IN THE
WEST BANK, PALESTINE**

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**This Thesis is Submitted in Partial Fulfillment of the Requirements for the Degree of
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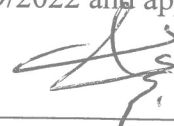
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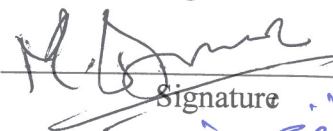
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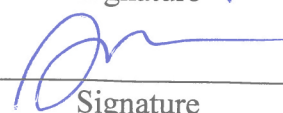
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Dedication

I dedicate my thesis to my parents, my husband, my sisters, my brothers, and my children who have always supported and inspired me.

Acknowledgements

Foremost, I thank Allah for everything that he has given to me to finish my thesis.

I would like to thank Dr. Abdel Fattah Hasan for all the efforts he gave me. Also for every teacher who passed through my life until I reached this moment.

Most importantly, none of this could have happened without my family. I thank them for everything they have supported me with.

Further thanks to my friends who rejoiced at my success.

Declaration

I, the undersigned, declare that I submitted the thesis entitled:

GOVERNANCE ASSESSMENT OF BRACKISH WATER DESALINATION IN THE WEST BANK, PALESTINE

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

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Date: 20/9/2022

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GOVERNANCE ASSESSMENT OF BRACKISH WATER DESALINATION IN THE WEST BANK, PALESTINE

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Abstract

Background: Brackish water is one of the sources of water in Palestine. Due to the scarcity of fresh water in the West Bank, solutions must be found to make use of desalinated water for drinking water and agricultural use.

Aim: The main objective of this research is to study the availability of small and affordable water desalination and purification systems in the West Bank. Strategies and policies that guide the use of desalinated water were assessed in this research, also the degree of success of this use in the West Bank.

Methodology: The Governance Assessment Tool (GAT), is a framework that is used and elaborated in this thesis to assess the use of desalinated water. The developed governance assessment tool is made up of a 'matrix' like model consisting of five elements (actors and networks, goal ambitions and perceptions of the problem, strategies and instruments, resources and organization and levels and scales) and four criteria (flexibility, coherence, extent and intensity)

Results: The search results are summarized as follows:

- The governance system in terms of actors, it's highly supportive. Since most of actors are involved and the interaction between actors are stable and there is trust. It is simple to include new actors and some actors are pressuring to improve the desalination sector.
- The governance system is restrictive in terms of problem perspectives and goal ambitions, especially there is aspects of the goals must be reassessed and some changes to the current policy must be done to achieve the goal.

- The governance system in terms of strategies and instruments, it's moderate to supportive. All instruments are used but there are some conflicts between them. There is chance to use and combine between various instruments as it's stipulated in law.
- The governance system is moderate in terms of responsibilities and resources, the responsibilities are clearly defined but some resources are missing. Also actors enhance collaboration within and across foundation. And the responsibilities can aggregation assigned but there is a Lack of resources to comply with the responsibilities.
- The governance system is supportive in terms of level and scale, all levels are involved in the use project but the levels deem little multi-level cases exist and recognize their dependence. It is possible to move up and down levels in some cases. Also most levels are doing to make behavioral change or management reform.

Conclusion: The governance system qualities assessment of desalination of brackish water in West Bank showed that in terms of flexibility and extent, the context of governance is supportive. And in terms of intensity and coherence, it's moderately supportive.

Keywords: Brackish Water; Desalination water; Governance Assessment Tool (GAT); Water Governance; Water Scarcity.

Chapter One

Introduction

1.1 Background

The issue of water scarcity is becoming increasingly concerning, particularly in areas that are (semi)arid and in many developing countries. The request for water for domestic, agricultural, and industrial purposes is rapidly increasing [1]. And as a result of the rapid increase in population in the West Bank, Palestine, the consumption of fresh water has significantly increased. The Palestinian sector faces limited access to water and a seriously deteriorating water distribution situation due to Israeli policies and its control over fresh water sources [2]. Palestinians currently utilize less than one fifth of the estimated potential of the aquifer, with Israel extracting the balance, and overdrawing by more than 50 percent on the aquifer's estimated potential. [3] Article 40 of the Oslo II Agreement (1995) defines the quantity of water which the Palestinians are allowed to withdraw from their aquifers regardless of how much water is available in these aquifers and regardless the rapidly growing population. [4] It is evident that more water is being used than can be replenished. Many studies have found water shortages in the area and these studies have focused on ways to split the water among the Middle Eastern countries and the water conflicts between them. [5] The Palestinians need to protect their water resources and work by a "sustainable way". [6] It became necessary to find technologies that provide the needed quantities of fresh water. At the same time, these technologies should be affordable.

Brackish water is one kind of highly saline water which cannot be used directly, but when used in agriculture, it affects the productivity of the plant and increases the salinity of the soil [7]. This source of water is located in the West Bank in different locations and in varying proportions. About 10-12 MCM/Y of brackish water which is a characteristic of ground water are extracted by Palestinian from Jordan valley wells [8]. This water cannot be used directly, but when used in agriculture, it affects the productivity of the plant and increases the salinity of the [7]. The maximum permitted in the Palestinian Standard for drinking water for Total dissolved salts (TDS) is 1000 mg/L and total hardness (TH (CaCO₃)) is 500 mg/L [9].

Table 1

The standards for acceptable levels of drinkable water in Palestine [10].

No.	Parameter	Unit	Value
1	pH		6.5-8.5
2	Turbidity	NTU	5
3	Carbonate (CO ₃ ⁼)	mg/l	ND
4	Bicarbonate (HCO ₃ ⁻)	mg/l	ND
5	Total Dissolved Solids (TDS) at 180o C	mg/l	1000
6	Sulphate	mg/l	200
7	Ammonium	mg/l	ND
8	Chloride (Cl)	mg/l	250
9	Nitrate (NO ₃)	mg/l	50
10	Calcium (Ca)	mg/l	100
11	Magnesium (Mg)	mg/l	100
12	Iron (Fe)	mg/l	0.03
13	Manganese (Mn)	mg/l	0.01
14	Sodium (Na)	mg/l	200
15	Potassium (K)	mg/l	10
16	Total Suspended Solids (TSS) at 105o C	mg/l	ND

1.2 Research Description

This thesis studies the different aspects of the governance of applying the CED – system (Capacitive Electro Dialysis). This unit can desalinate and purify polluted brackish water to turn it into drinkable fresh water. The unit uses the energy of a little more than an average light bulb and turns 12 liters of brackish water into 2 liters of brine and 10 liters of drinking water per hour. A usual larger farming device can purify around 1000 liters of water per day with a saline level of under 5 g per liters.

This research discusses the governance requirements for effective and sustainable implementation of the CED system for agricultural usage and other usages. Also, the research discusses the requirements and possible constraints to create an enabling environment for implementing the CED system at the test location in the West Bank in terms of governance, regulations, licensing, local commitment and ownership.

The various aspects of governance are represented by: when to use or not, minimum requirements, and comparison with other sources / desalination methods, water availability, water scarcity, water quality, water demand, accessibility, sustainability, socio-cultural dimension, and legal-institutional and political dimension.

1.3 Research Objectives

The major objective of this thesis is to study the governance aspects of desalinated water in the West Bank. This thesis assesses the strategies and policies that guide the use of CED system and the degree of success of this system in the West Bank.

The certain objectives of this thesis are:

- Demonstrate the items of desalination water governance in terms of instruments, actors, resources, responsibilities, strategies, goal ambitions, problem perceptions, level and scale.
- To equip recommendations for actors to do necessary procedures for improving the desalinated water.

1.4 Questions of Research

The Major Question

How can the enforcement of policies related desalinated water and its use in the West Bank be enhanced?

The Minor Questions

1- In what ways can the dimensions be used to describe the governance context of desalinated water and its usage in the West Bank?

- a) Strategies and instruments.
- b) Actors.
- c) Level and scale.
- d) Goal ambitions and problem perceptions.
- e) Resources and responsibilities.

2- Drawing upon the evaluation of the four qualities and the five governance dimensions (flexibility, extent, intensity, and coherence), how are the context of governance of desalinated water and its use in the West Bank supportive?

1.5 Research Problems

Due to limited access to available water resources, Palestinians are experiencing a water crisis. The Jordan Valley, in particular, is encountering difficulties concerning both the quantity and quality of water. An annual rise in demand for agricultural water is jeopardizing the availability and quality of water. However, it is evident that water desalination will serve as the ultimate solution to mitigate the water supply shortage.

Water sector problems in the Jordan Valley area:

- Rising demand for domestic freshwater alongside augmented irrigation water for agriculture.
- The high salinity of groundwater wells in the Jordan Valley area.
- Crops are damaged due to high TDS in irrigation water and soil salinity.
- Inadequate knowledge among the public regarding the possible applications of brackish water.

Chapter Two

Literature Review

2.1 Governance

Over time, the concept of 'governance' has different definitions and interpretations, but the more well-known definition is one that refers to the capacity of a political system to govern efficiently and to provide the necessary political conditions for the public good [11].

Another definition of "Governance" is the combination of actor-networks and scales, the relevant multiplicity of responsibilities and resources, goals, and instrumental strategies that forms a context that, to some degree, restricts and, to some degree, enables actions and interactions [12].

The meaning of governance can be existent in various forms and classified in many contexts. For example, 'global governance' [13], 'water governance' [1], 'distributed governance' [14], 'self-governance' [15], 'good water governance' [16], 'improved water governance' [17], 'governance in education' [18] and 'modern governance' [19].

2.2 Water Governance

It can be considered that the water problems are best seen as governance issues. The amount of water could be enough but inequality, and the solutions are known. But management problems and a lack of access still exist. So, the application of the solutions is the actual challenge [17].

In water sector, the governance concept is significant and prevalent. But there is no mutual conception of the definition and use [17]. This encouraged many researchers to categorize those meanings [20].

Based on a normative perspective, the Organization for Economic Cooperation and Development (OECD) promotes governance. Also, the principles of water governance of the OECD were published on June 2015. These principles guide to do actions to get better water governance at all levels based on three main goals (management, trust, and effectiveness) [21] [22].

In this thesis, the definition of water governance is the context that organizes and leads the procedures and interactions between the actors that involved in water resources management [12]. It can be said that water governance is efficacious if there is an environmentally sustainable and equitable and effective use of resources of water. However, there is no unified opinion about effective or inefficient governance [23].

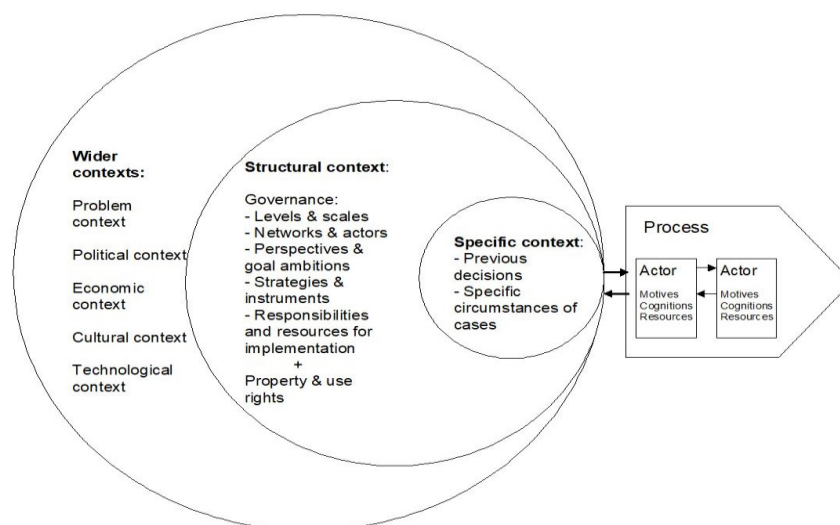
2.3 Governance Assessment Tool

To solve the problems of governance that need certain answers, researchers are invited to contextual consideration [17]. The diverse perspectives have played a role in creating novel frameworks that account for contextual nuances. The Governance Assessment Tool (GAT), is a framework that is used and elaborated in this thesis to assess the use of desalinated water.

The Governance Assessment Tool is fundamental to the theory of policy implementation that is labelled Contextual Interaction Theory. This theory shows implementation processes as multi-actor interaction processes that are leading by the actor [24]. Contextual Interaction theory incorporates the multi-actor network and other contextual factors as influential elements that impact the motivation, thoughts, and resources of the actors involved [25]. Figure 1 shows these contexts as overlapping entities.

Figure 1

Layers of contextual factors for actor characteristics [26].



“The figure can be best read from right to left, implying that each step leftwards gives a context for the previous circle”

In this thesis, the governance assessment tool developed is made up of a ‘matrix’ like model consisting of five elements and four criteria, which we use as the basis of a more specific tool [12].

The five dimensions of governance are [12]:

1. Actors and networks: Governance acknowledges the involvement of multiple actors within the relevant network(s)
2. Perceptions of the problem and goal ambitions: Governance recognizes the multifaceted nature of problems and ambitions.
3. Strategies and instruments: Governance assumes the multi-instrumental nature of the strategies employed by the involved actors.
4. Resources and organization (tasks and responsibilities) of implementation: Governance assumes a complex implementation based on multiple resources.
5. Levels and scales (not necessarily administrative levels): Governance assumes that all other dimensions have a general multi-level character.

These five dimensions can be employed to methodically depict the contents of a governance system in a particular area with respect to a specific matter [12].

The evaluation of these dimensions is conducted through the use of four qualities of governance. The four quality are: (flexibility, extent, coherence, and intensity) [12] and characterized by the subsequent questions:

1. Extent: Has every relevant element pertained to the use of the material been considered in the five dimensions?
2. Coherence: Do the elements within the governance dimension support each other rather than conflict with each other?
3. Flexibility: Is there allowance and encouragement for multiple avenues toward achieving the goals?
4. Intensity: To what extent do the elements within the governance dimensions push for changes to the current state of affairs?

2.4 Study Area

Study area is West Bank with population is 2,881,687, with an estimated area of 5,655 km² particularly the Jordan Valley area with population of 50000 and area (608 km²) because brackish water is concentrated in the Jordan Valley [26] [27].

2.5 Water Scarcity in West Bank:

West Bank is experiencing water crisis and this problem poses the biggest challenge to Palestinians. This problem is exacerbated over time as a result of population growth and limited water resources.

Where the average per capita water consumption is approximately 55 L/c/d by the Palestinian population while the WHO minimum standard of 100 L/c/d [28]. Figure below Illustrates Per capita renewable availability in the countries of the Jordan River basin. The Palestine is the lowest in the world [28].

Figure 2

Per capita renewable availability in the countries of the Jordan River basin

Countries	Annual Per-capita withdrawals renewable (billions of m ³)	Average per capita renewable availability (m ³)
Israel	1.9	375
Jordan	1.0	213
Lebanon	0.8	1200
Syria	5.5	385
Palestine	0.2	105

Palestinians can access to 118 Mm³/year only (18% of resource) according to Oslo II. While actually they use 87 Mm³/year (less than the allocated quantities) [29].

On the other side in Israel, the average per capita water consumption is 300 L/c/d [30]. Israel is prevent from get one drop of water from the Jordan River. Moreover, Israel sells part of the water supply (56 MCM part of the water supply in 2010) to Palestinians [30].

2.6 Water Resources in West Bank

2.6.1 Surface Water

The surface water resource are very scarce in Palestine. There is one river only in West Bank (Jordan River) and there are some seasonal wadis. In addition to that, there are some surface water bodies like the seasonal lakes of Marj Sanur. The Palestinians do not have access to Jordan River since 1967. Most of the Wadis flow for a few weeks a year only and it is hard to use and capture [31] [29].

2.6.2 Ground Water

The main resource of water in Palestine is ground water. The aquifers are divided into three main aquifers-Basins (Western, Eastern and North-Eastern). The total renewable groundwater resources is about 578-814 Mm³/year in West Bank. Israel controls the major part of ground water resources [28] [31]. The utilization of the aquifers are in Appendix A.2 (According to Oslo II Accords)

2.6.3 Springs

In west bank, there are 297 springs. The average annual yield for spring is about 60.8 mM³/y. most of this water from springs are used for irrigation, while 1.6 mM³/y only used for domestic consumption [28].

2.6.4 Non-conventional resources

2.6.4.1 Desalination of Sea Water

There is one desalination sea water plant only in Gaza strip (Deir El Balah). The capacity of this plant is 600 m³/day and it will be expanded 2600 m³/day. In West Bank, the sea water resources are not available except as part of a long-term strategy of regional water resources management [29].

2.6.4.2 Desalination of Brackish Water

There are small projects of desalination for brackish water mainly exist in the Jordan Valley. The private sector has established these projects with a total capacity of less than 0.5 Mm³/year and are used mainly for agricultural [29].

2.6.4.3 Treated Wastewater

There are few projects and plant for treated wastewater in west bank. Where 75% of wastewater (Which amounts to about 31 million cubic meter (MCM)) are discharged directly into the environment without any treatment. An example for treatment plant is Al-Bireh wastewater treatment plant (WWTP) with capacity of 5750 m³/day [32].

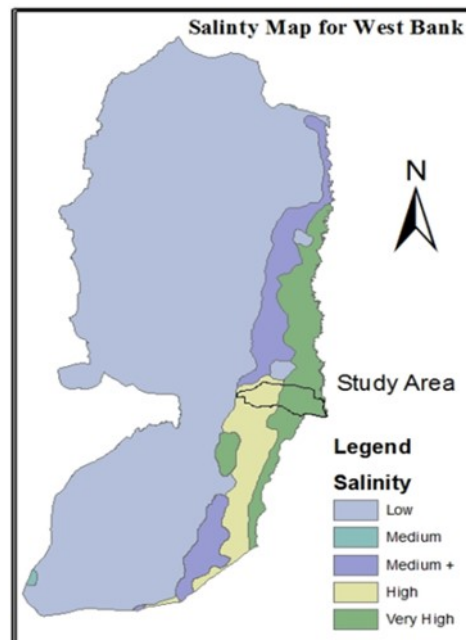
2.7 Brackish Water in West Bank

Brine were formed during major several of geological history, which is hazard to ground water reservoir of the Dead Sea – Jordan rift system. The saline in the Jordan Rift valley come during many generation of time started in the late proterzoic-early cambrian by the evaporation in the middle east, also by the large scale marine oscillation of normal

shelf and international hyper saline to brackish environment that laid down of the present of Jordan river and day by day the water become more saline due to the evaporation and subsequent flushing of evaporation that allow the water in the dead see specially a very high saline water in the world [33].

Figure 3

Salinity map for West Bank [30].



This figure shows high salinity in west bank especially Jericho area. In the Jordan Valley, the high demand for water for domestic and agricultural purposes necessitates the

In Palestine, the demand for freshwater for industrial, agricultural, and domestic use is increasing rapidly while the supply is falling short (See Appendix A.3). However, the good news is that the cost of desalination has been consistently decreasing. The PWA annual report for 2011 suggests that desalination of brackish water is a promising solution that has not yet been fully embraced in the West Bank. Currently, it is only being implemented on a small scale, providing approximately 2-3 MCM/Y of drinking water [10].

2.8 Brine effects on soil

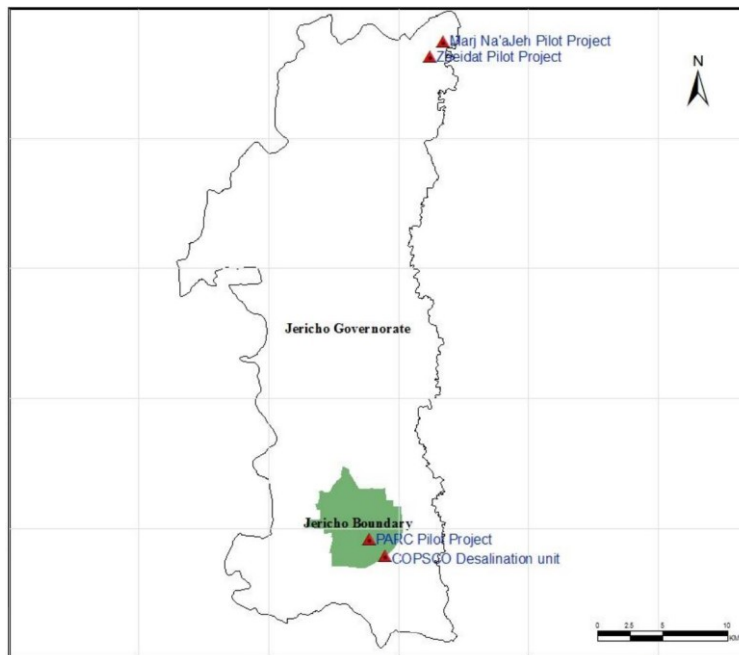
Brine has several adverse effects on soil both physically and chemically. Physically, it raises the sodium concentration on the soil surface, leading to reduced soil fertility, while the high temperatures of brine can also kill beneficial soil organisms. Chemically, brine contains toxic substances that can harm the soil's structure and composition. Additionally, it impairs the soil's ability to retain water and transport essential plant nutrients. Which leads to poor soil quality.

2.9 Desalinating Plants in the Jordan Valley

There are four small scale desalinated projects in the Jordan valley area as shown in figure (5) and Appendix A.4.

Figure 5

Location map for Desalinating projects in the Jordan Valley



2.10 Desalination in Gaza

There are four small-size brackish water desalination plants in Gaza that are publicly owned, three out of them are operated by municipalities where water is pumped into distribution networks for a limited number of hours. The fourth plant had been erected at Gaza Industrial Estate (GIE), where it is rarely operated since GIE is not functioning as planned due to implications of the political situation.

On the other hand, two seawater desalination plants are under construction. Both plants are publicly owned and were planned to distribute water for drinking purposes only. The operation had been planned to be carried out by the private sector. Another large-scale seawater desalination plant (60,000 m³/d as a first phase) is to be publicly owned as well as in the phase of bidding. It will be operated by the private sector and water will be distributed in the municipal water distribution system.

The result of opening the door for the private desalination plants is right now licensing of 18 small size brackish water desalination plants with an average production capacity of 120 m³/d each since 1996. In addition, PWA had licensed more than 10 desalinated water distribution companies. This sector of business produces water with a variety of qualities

and prices. The installed capacity of plants owned by the private sector results in the availability of 1.8 l/c/d of desalinated water for Gaza residents. This makes the total availability of desalinated water from both publicly owned and privately owned plants to be in the order of 5.4 l/c/d if operated at full capacity.

Since a lot of people started to be aware of the bad municipal water quality in terms of salinity, nitrates, and possible bacteria pollution in some cases this business has been faced with the fact that more than 20,000 domestic RO units have been installed at homes. The average installed unit capacity is 60 l/d. Since these units may be oversized compared with the family's needs, they cannot practically be operated at full capacity. It can be concluded that domestic RO units provide desalinated water for about 140,000 inhabitants (out of 1.2 million) in the Gaza strip. So, the installed capacity by the public and private sectors can provide about 6.1 l/c/d [36]. Table (3) provides some details on the desalination plants operating in Gaza Strip.

Table 3

Desalination plants in Gaza Strip [37].

Plant name	Feed water	Feed water TDS (mg/l)	Plant capacity (m ³ /h)	Plant Productivity (m ³ /h)
Industrial Zone	Brackish water	1400	95	75
Beit Lahia	Beach wells	1300	60	50
Deir El Balah (1)	Beach wells	3100	78	45
Deir El Balah (2)	Sea water	35000	30	20
Deir El Balah (3)	Sea water	35000	-	2000
Khan Younis El-Sharqi	Beach wells	2500	60	50
Khan Younis Al-Sa'ad	Beach wells	2000	80	65

2.11 Desalination in Jordan

In Jordan, the potential for water resources ranges from 1,000 to 1,200 MCM, including recycled treated wastewater. Water resources consist primarily of surface and groundwater, with treated wastewater being used on an increasing scale for irrigation, mostly in the Jordan Valley. Renewable water resources are estimated at about 750 MCM/y, including groundwater at 277 MCM/y and surface water at 692 MCM/y, of

which only 70% is economically usable. Also, at least 50 MCM/y is expected to be accessible for urban use after desalination [38].

The water quality in Jordan has been negatively impacted by pollution from multiple sources and excessive water abstraction, which has led to salination. To address this issue, the Water Authority, Ministry of Environment, and Royal Scientific Society in Jordan have launched a collaborative program to monitor water quality in the country. According to reports, the program has yielded the following findings [39]:

- Approximately 70% of spring water is contaminated with biological impurities.
- Surface water is heavily polluted by fecal coliforms, originating from non-point pollution sources such as wastewater treatment plants that are operating beyond their capacity.
- Water resources have a significant level of toxicity.
- Industrial effluents are not treated adequately, if at all.
- Excessive abstraction of groundwater for irrigation purposes has led to a drop in the water table by 5 meters in some aquifers and tripled the salinity.
- Unregulated application of fertilizers and pesticides has resulted in elevated levels of nitrates and phosphorus in water sources.

Jordan has had limited success with desalination of seawater or brackish water. Seawater desalination is not practical due to Jordan's limited shoreline along the Gulf of Aqaba, which is distant from the main centers of population, and the high elevations of these centers, resulting in high pumping costs. Seawater desalination is only a viable option in exceptional cases, such as domestic or industrial use in areas with no other freshwater sources or for inelastic water demand activities like tourism. The more feasible option in the short term is desalination of brackish water, which has a lower total dissolved solid content of 1,000 to 5,000 mg/L compared to seawater's 35,000 mg/L, making it more affordable for drinking and irrigation. Jordan has reserves of brackish water, and a few brackish water desalination plants have been constructed. There are 19 plants on 13 sites with a total capacity of 11000 m³/d (See Table 4) [40].

Table 4*List of existing desalination plants*

Location	Total capacity (m ³ /d)	Units	Water quality	User
Amman	360	1	Brackish	Indu
Amman	3028	4	Sea	Indu
Amman	1200	1	Brackish	Indu
Amman	409	1	Brackish	Mil
Amman	719	1	Brackish	Indu
Irbid	545	2	Sea	Muni
Irbid	1584	2	Brackish	Power
Azraq	600	1	River	Indu
Aqaba	1100	1	Sea	Power
Aqaba	818	1	Brackish	Unknown
Aqaba	800	2	Sea	Muni
Aqaba	1	1	Sea	Demo
Hisban	4	1	River	Muni
Total	11168	19		

2.12 Desalination in Israel

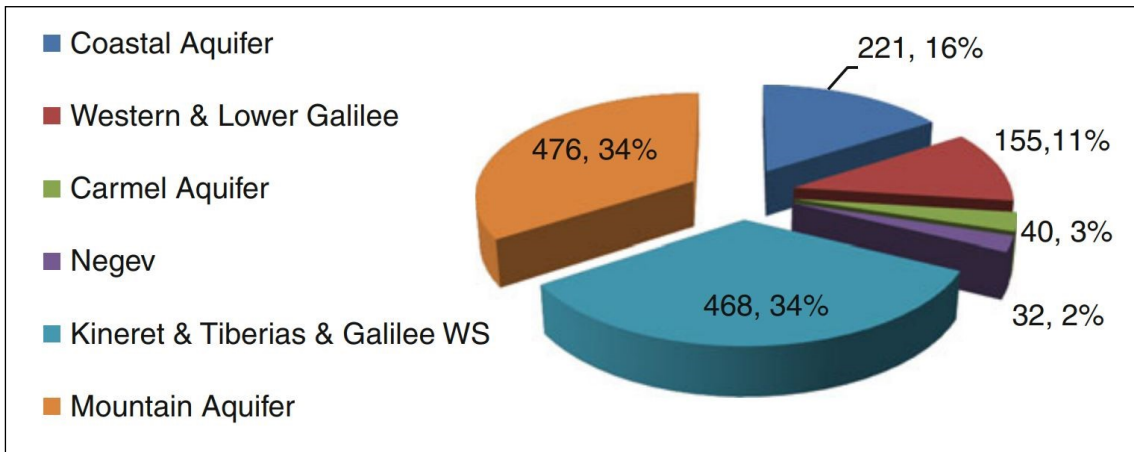
At present, Israel has access to renewable freshwater sources that amount to approximately 1,300-1,400 million cubic meters (MCM) each year, providing a per capita supply of roughly 180 m³ annually. However, the current yearly water consumption in Israel is around 2,100 MCM, which equates to a per capita usage of 268 m³.

The primary natural and renewable sources of water supply in Israel consist of the Sea of Galilee and Jordan basin springs and rivers, the Mountain Aquifer, and the Coastal Aquifer. The remaining natural supply is comprised of a number of smaller aquifers.

The distribution of natural water sources can be seen in Figure 6, which displays the figures in MCM and the percentage they make up out of the total of 1,392 MCM of available renewable supply sources.

Figure 6

Distribution of water resources in Israel



The demand for water in Israel stems from three primary sectors: agriculture, industry, and domestic use (households). In recent years, a fourth sector has become increasingly relevant, which is the allocation of water for nature in the form of in-stream flow to various rivers. In 2010, the total water consumption in Israel was 2,013 MCM.

It's worth noting that the majority of water allocated to agriculture is reclaimed and treated water, and typically no more than 500 MCM of freshwater is designated for agricultural use. This is due to a significant shift in Israel's water policy.

Over time, the gap between water supply and demand in Israel has been growing. To address this issue, the country's primary policy objective has been to augment the available supply of water, while simultaneously decreasing demand.

To enhance the supply of water, Israel has employed various methods, such as utilizing marginal water sources, desalination, wastewater treatment, and water harvesting. The details of each approach are outlined below:

Desalination: In 2011, Israel desalinated 296 MCM of water from seawater and an additional 45 MCM from brackish water sources. The country currently operates three desalination plants that employ reverse osmosis technology: one in Palmachim producing 46 MCM, another in Ashkelon producing 120 MCM, and a third in Hadera producing 127 MCM. Several other plants are currently under construction, with the aim of increasing annual desalination capacity to 700 MCM by 2020, followed by an additional 100 MCM every four years.

Treated wastewater: Israel is a global leader in managing treated and reclaimed wastewater. In 2007, 92% of the country's wastewater was treated, with over 75% being earmarked for reuse in irrigation. Presently, approximately 450 MCM of treated wastewater is utilized for agricultural purposes, and this number was expected to rise to 600 and 700 MCM by 2020 and 2030, respectively.

Water harvesting: Water harvesting in Israel is currently estimated at about 70 MCM. This practice encompasses capturing runoff from rooftops and local catchments, collecting seasonal floodwaters from local streams, and conserving water through watershed management techniques.

The augmentation of marginal water supply in Israel has been in response to the mounting disparity between renewable freshwater supply and demand. While this measure might seem sufficient, its implementation was met with resistance. Furthermore, recent research has demonstrated that climate change is likely to exacerbate Israel's already semi-arid climate, further increasing pressure on the country's water resources. To address this challenge, the Water Authority has adopted a two-pronged approach, which involves addressing both the demand and supply side of the equation. Among the methods utilized to curb demand are modifications to water tariffs and non-price measures.

Water policy makers in Israel are chiefly preoccupied with the gap between supply and demand. However, it is crucial to adopt a broader perspective when considering water policy beyond this singular issue.

The supply of water to all sectors of the Israeli economy, including agriculture, is predicated on two principal foundations. The first is the Water Law of 1959, which asserts that all water sources within the country are public property and that no private property rights can be claimed over water or its use. The second foundation is the national system and the North-South Carrier, which constitute the backbone of the country's water system. Leveraging these constructs, Israel has been able to provide water for agriculture, not only in the rainy north but also in the arid southern regions of the country since its inception.

In the early days of agriculture in Israel, fresh water was the primary source of irrigation. However, over time, the availability of freshwater decreased due to reduced precipitation and population growth. This led to a shift towards other sources of water such as

desalinated seawater and treated sewage, which were used to supplement the reduced freshwater supply. The legal framework of public ownership and the interconnectedness of the national water system allowed for a relatively smooth transition towards this new water economy. This shift resulted in a significant reduction in the amount of freshwater used for agriculture, dropping to less than 40% of the 1985 allotment by 2010. It would have been much more challenging and costly to accomplish this transformation under a decentralized infrastructure and a legal doctrine of private property rights in water.

Currently, regional and local cooperatives own the majority of the facilities supplying 40% of the water used in agriculture, while the rest is provided by Mekorot. In the early days of the state, agriculture was limited to local sources of water, such as the Sea of Galilee, wells, and rivers for fields located nearby. However, after the completion of the national carrier, which was one of the largest projects undertaken by the young state, the supply to agriculture quadrupled and expanded to all parts of the country. Despite this expansion, the quantity supplied to the agricultural sector has not grown significantly in the past 50 years.

During the early days of the state, the majority of water supplied to agriculture was fresh water, with the supply gradually increasing and peaking in 1985. However, since then, the amount of water received by the sector has decreased. This reduction can be attributed to a combination of factors including reduced precipitation, possibly caused by global warming, and the expansion of urban populations. As a result, freshwater was diverted to urban consumption while additional quantities of desalinated seawater and recycled sewage effluent were supplied to agriculture. The national system's interconnectedness and the public ownership legal framework enabled a smooth transition in the water economy. By 2010, the amount of freshwater allocated to agriculture was less than 40% of the 1985 allotment. Achieving this transformation would have been much more challenging and costly under a decentralized infrastructure and private property rights doctrine for water.

Over the past 30 years, the supply of water to agriculture has shown a declining and fluctuating trend despite several decades of growth. This has resulted in uncertainty in crop planning and sometimes mid-season cutbacks in provision. However, recent advancements in seawater desalination in Israel suggest that, unless there are climate

catastrophes, agriculture can anticipate a stable water supply in the years to come. Moreover, the provision of recycled effluent may increase as the population grows and treatment facilities expand.

In the years ahead, farmers will face rising costs for water despite the fact that having enough water is expensive. While agriculture is valued in Israel as a source of fresh food and as an environmental steward, it only accounts for a mere 2% of the net national product. As a result, it is unlikely that agriculture will continue to enjoy the political power it once had, which allowed it to benefit from heavily subsidized water tariffs.

The first development of desalination occurred in Israel in 1965. Israel's drive to desalinate seawater is driven by the need to supplement natural freshwater sources, which are insufficient to meet current and anticipated demand due to population expansion, overuse, improper allocation, and contamination.

In 1997, the Desalination Master Plan was formulated to address the growing discrepancy between the rising demand for freshwater resources and the limited supply in Israel. The plan aimed to establish an unrestricted source of water to bridge this gap over the next two decades. The Israeli Water Authority's overarching objective, as stated in the plan, is to ensure the sustainability, availability, and dependability of water in adequate quantities, locations, and quality. The Water Authority has embarked on a program to fulfill all of Israel's domestic water requirements using desalinated seawater, which involves expanding existing facilities, constructing new ones, promoting technological advancements in pre- and post-treatment, and encouraging the use of energy-efficient technologies.

As part of the Plan, an assessment was made to determine the necessary sizes and distribution of desalination plants required to fulfill the demand for desalinated water. Economic factors, such as the expenses involved in the desalination process, transportation to the national water supply network, as well as costs associated with energy requirements, storage capacity, and operation, were taken into account.

Previously, desalination was confined to the southern tourist destination of Eilat and its adjacent agricultural settlements due to a lack of viable alternatives. However, modern advancements in membrane technology, enhanced energy efficiency, and reduced

expenses have enabled the extensive deployment of desalination plants along the Mediterranean coastline.

At present, in Israel, all major desalination facilities utilize the reverse osmosis method, which is the most efficient in terms of energy and cost compared to other desalination techniques. The reverse osmosis process involves four primary stages: (1) pretreatment, (2) pressurization, (3) membrane separation, and (4) post-treatment stabilization.

During the first stage of pretreatment, the feed water undergoes removal of suspended solids, pH adjustment, and addition of a threshold inhibitor for membrane preservation. Subsequently, the electric pumping system elevates the pressure of the pretreated water to a level suitable for the membrane capacity and seawater salinity. Operating pressures for seawater desalination vary between 800 to 1,000 psi. The third phase employs intensified pressure to divide the concentrated seawater into two separate streams:

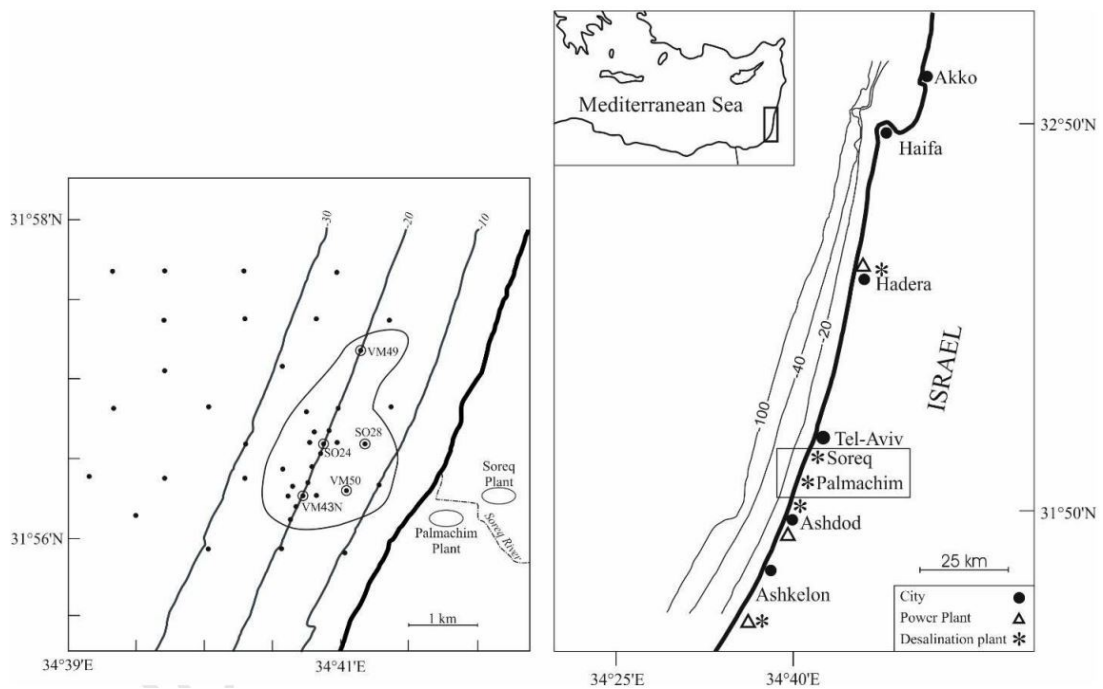
The permeable membrane in the third phase enables the solvent (water) to pass through while leaving behind the solute (salts and other non-permeating substances) in a highly concentrated brine form. Although the membrane system isn't 100% efficient in rejecting dissolved salts, only a small percentage of salts remain in the freshwater product stream. The posttreatment stage includes several stabilization procedures such as boron removal and remineralization, which are necessary to meet drinking water quality requirements. Unlike thermal desalination processes, there is no phase change or heating involved in this process. The primary energy consumption in the RO method is for pressurizing the feed water, and the energy requirements are directly proportional to the concentration of salts in the feed water.

As of the beginning of 2012, Israel contains three prominent seawater reverse osmosis (SWRO) desalination facilities situated along the Mediterranean coast in Ashkelon, Palmachim, and Hadera. In May 2011, a financing agreement was executed for the construction and operation of a desalination plant in Sorek, situated 2.2 km from the Mediterranean coast and 15 km south of Tel Aviv. Three months following that, the Ministry of Finance entered into an agreement for the development of a fifth SWRO plant located in the northern industrial zone of Ashdod.

In aggregate, the five desalination plants situated along the Mediterranean shoreline of Israel will generate 540 MCM annually by the year 2013, making up 85% of the nation's domestic water consumption. Through the expansion of existing facilities, the total production capacity will increase to 750 MCM annually by 2020, resulting in 100% of Israel's domestic water requirements being met through desalination.

Figure 7

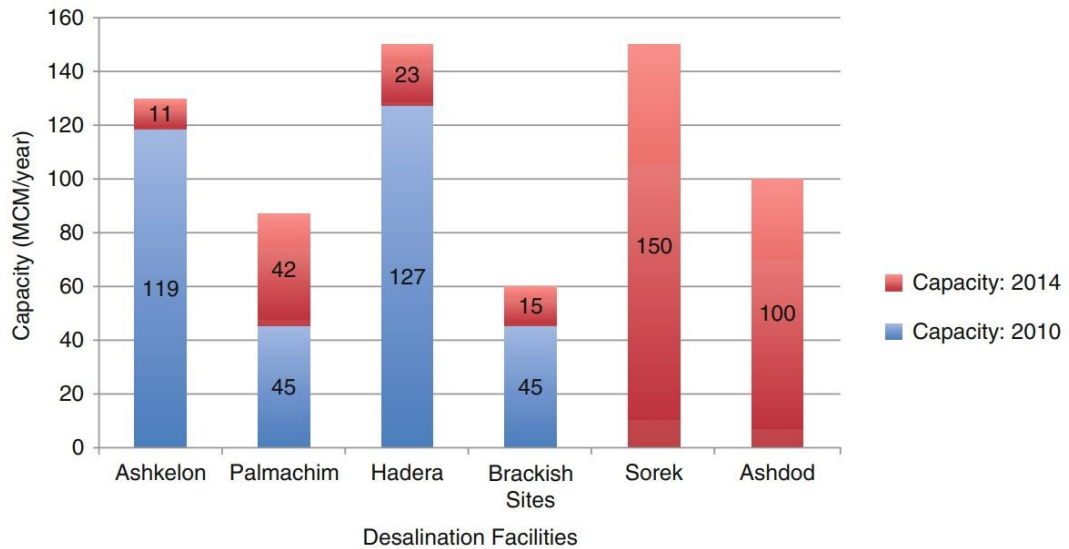
Israel's desalination plants



Many small-scale desalination plants are utilized to desalinate brackish water sourced from groundwater wells, or a combination of seawater and brackish water. The most substantial of these plants, situated in Eilat, generates around 13 million cubic meters of water per year by using a mix of brackish and seawater sources. Altogether, facilities in Eilat, the Arava, and the southern coastal plain of the Carmel generate 30 million cubic meters of water annually from brackish sources. Anticipated future developments will result in a production capacity of 60 million cubic meters per year by 2013 and 80-90 million cubic meters per year by 2020, as demonstrated in Figure 8.

Figure 8

Israel's desalination capacity



The master plan includes a second stage beyond the 2020 target of producing 750 million cubic meters of desalinated water. The newly announced plan involves constructing an additional five desalination plants between 2040 and 2050, to cater to the water needs of both Israel and the West Bank. These plants will each have a production capacity of 150-200 million cubic meters per year, resulting in a total of 1.75 billion cubic meters of desalinated water. The initial plant in this stage is scheduled to be built in the Western Galilee of northern Israel, and it is expected to commence production in 2017. The estimated cost of constructing the plants and associated infrastructure is approximately \$15 billion [41].

Chapter Three

Methodology

3.1 Research Framework

Defining the purpose of the research

The main objective of this research is to study the availability of small and affordable water desalination and purification systems in west bank. The study evaluates the effectiveness of the strategies and policies governing the utilization of the CED system in the West Bank and the extent to which this system has been successful.

Identifying the subject of the research

The research focuses on the practices and policies of the desalination of saline water, investigating the CED system in the West Bank.

Establishing the nature of research perspective

Using the Governance Assessment Tool (GAT), this study examines the quality of governance in the water sector of the West Bank, specifically with regard to its actors, level and scale, strategies and instruments, goal ambitions and problem perception, and responsibilities and resources for implementation. The assessment is based on the dimensions of flexibility, coherence extent, and intensity, in relation to the research objectives stated above [42].

The analysis of Palestinian's desalinated water sector governance will lead to an improved comprehension of the effectiveness of the governance system and the relationships among its actors.

Determining the research perspective sources

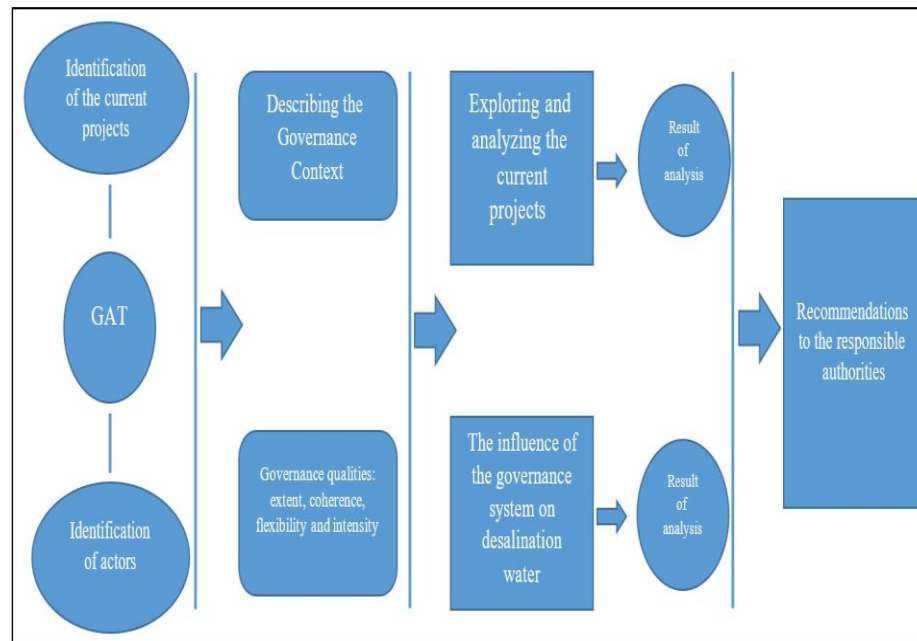
The creation of the conceptual model involved an examination of materials pertaining to:

1. Scientific literature (books, articles, and thesis).
2. Experts, practitioners, and policy-makers (meetings and interviews).
3. Practices and policies (laws and regulations).

Developing a schematic representation of the thesis framework

Figure 9

Methodology of the study



Creating the research structure using arguments:

1. An analysis of documents concerning the stakeholders involved in the Palestinian water sector, standards and regulations for desalinated water usage, and ongoing initiatives related to the use of desalinated water.
2. Utilization of GAT and initial research to delineate the components of the context of governance for saline water.
3. Evaluation of the characteristics of the governance framework for desalinated water usage and its impact on the ongoing utilization initiatives.
4. An assessment and comparison of the findings with the literature review.
5. Proposals to the relevant authorities for enhancing the utilization of desalinated water.

Verifying if any modifications are necessary for the model:

The thesis is a recursive process, and as additional data is gathered regarding the thesis subject, adjustments could be implemented to the framework.

3.2 Explanation of essential terms

Stakeholder: is a member of the groups whose backing is critical for the organization's survival. [43].

Policy effectiveness: the impact of a policy in terms of its usefulness, quality, competitiveness, and accessibility, as measured by economic, legal, technical, and marketing considerations associated with the topic at hand. [44].

Policy success: A policy can be deemed successful if it accomplishes the intended objectives without substantial criticism and/or receives almost unanimous support. [45].

Governance: the complex interplay of multiple goals, responsibilities, resources, actors, instruments, scales, and strategies, which collectively create a context that both limits and enables actions and interactions [24].

Water Governance: The framework that directs and arranges the conduct and engagement of individuals or groups participating in the administration of water resources [12].

3.3 Collection Methods and Data Sources

To obtain the necessary information for addressing the research inquiries, diverse techniques such as document analysis, observation, and interviews were employed. The subsequent section outlines the interview approach as a data source and provides details on the participant organizations, duration, and selection criteria.

Table 5 presents the information needed and the corresponding approach for obtaining it, as determined by the research inquiries.

Table 5*The information required and its accessing method*

Research Question	Data/Information Required to Answer the Question	Sources of Data	Accessing Data
How can the governance context of desalinated water and use in Palestine be described in terms of the following dimensions? a) actors b) problem perceptions and goal ambitions, c) strategies and instruments, d) responsibilities and resources. e) level and scale.	Who are the actors of water sector, their responsibilities, goals, strategies and/or policies used, policies, or strategies, instruments and the resources allocated. - Data about current desalination projects.	Secondary Data: Publicly available documents, Policies, articles, and reports People: WSRC, MOA, PSI, PARC, Municipalities and Farmers.	Content Analysis Search method Questioning Observation Interview
Based on the assessment of four governance dimensions a) actors b) problem perceptions and goal ambitions c) strategies and instruments d) responsibilities and resources. Using the four qualities (extent, coherence, flexibility and intensity), how supportive is the governance context of desalinated water treatment and use in Palestine?	Results of the Governance assessment of the wastewater treatment and use in Palestine	Secondary Data: Publicly available official governmental documents and articles. Primary Data: People: WUA, WSRC, MOA, PSI, PARC, Municipalities and Farmers.	content analysis Search Method Questioning Observation Interview Content Analysis

3.3.1 Interviews

Using the GAT as a framework, an interview guide was developed to establish the scope of the research and streamline the data gathering and analysis process. The queries posed to the actors were grounded on the GAT matrix (see Appendix A1).

A total of 15 key stakeholders were interviewed in desalinated water use sector as it is displayed in Table 6.

Table 6

Stakeholders of desalinated water use sector

Level of state			
1	Ministry of Agriculture	Sept.2019	Essam Nofal
2	Ministry of Health	Oct. 2019	
3	Jericho Municipality	Feb.2020	Mohammed Alfetiany
4	Palestinian Standards Institution	Oct.2019	Belal Abu Rob
5	Palestinian Water Authority	Sept.2019	Deeb Abdulghafoor
Civil Society			
6	Water Sector Regulatory Council	Sept. 2019	Mohammed Alhmaidi
7	Agricultural Expert (2 experts)	Feb.2020	
Individual actors			
8	Farmers/ Jericho (5 farmers)	Feb.2020	
9	Padico Holding	Mar.2021	Lina shakhshir
10	Jericho mineral Water	Mar.2021	Samer Alfetiany

The researcher conducted the interviews via phone, email, and face-to-face. Prior to the interview, the participants were given a comprehensive overview of the research and its objectives.

3.3.2 Document Reviews

Qualitative data were gathered through reports, scholarly articles, and relevant policy documents during the process of reviewing the literature. The focus of the collected data was on the water, agricultural development policies, and strategies for both short-term and long-term periods (MoA-2014, PWA-2013, PWA-2016, PWA 2014, PWA-2017), plans and action plans (SCP/2016, SDP-2013), laws (14/2014, 3/2002), the documents that were issued in Palestine underwent a review. Additionally, reports from

governmental bodies regarding water statistics in Palestine were examined (PCBS-2016, PWA-2013, PWA-2011). Lastly, books, reports, and scientific articles from local, regional, and international sources were scrutinized for information on the utilization of desalinated water and the evaluation of its governance in various countries.

3.4 Data Analysis

3.4.1 Analytical Framework

The aim of data analysis is to acquire practical and beneficial insights. In this study, a qualitative analysis was conducted with the following steps:

The first step involved reviewing documents and outlining the context of the governance system based on various governance dimensions, including goal ambitions, strategies and instruments, actors, problem perceptions, responsibilities and resources, and level and scale. This step addressed the initial sub-question.

The second step involved evaluating the desalinated water governance context in West Bank based on qualities (flexibility, intensity, extent, and coherence). This was accomplished by analyzing standards, policies, and interview responses using the GAT matrix and a set of questions that described the impact of the system of governance on the utilization of desalinated water (see Appendix 1). Additionally, a manual was created to evaluate responses to the questions in the GAT matrix, customized to fit the thesis case. Based on the evaluation of all dimensions, the level of supportiveness was measured for all quality criterion as follows:

- If there are at least two supportive dimensions for implementation and no dimensions that restrictive, the context is evaluated as "supportive".
- If there are three moderately support dimensions for implementation and there is one dimension restrictive maximum, the context is evaluated as "moderate".
- If there are two dimensions restrict at least for implementation, the context is evaluated as "restrictive".

Moreover, instead of using the term "networks," the term "actors" was utilized to refer to the system of politics in Palestine, where stakeholders often operate as individual actors rather than networks. This step addressed the second sub-question.

Step three involved consolidating the analysis results from the two previous steps to form a basis for developing recommendations to be presented to the relevant public authorities. This step addressed the main research question.

3.4.2 Validation of Data Analysis

To ensure the validity of the information gathered, various sources of data were utilized. Moreover, a range of research methods were employed to examine the same concept, which allowed for cross-verification of data from two or more sources. This was achieved by cross-referencing data from interviews, literature reviews, and other sources.

Chapter Four

Results and Discussion

4.1 Governance Assessment of Desalinated water Use

4.1.1 Description of the Governance Dimensions

In this portion, a response to the initial sub-question of this research was provided by detailing how the governance context surrounding the utilization of desalinated water in the West Bank can be characterized concerning the five dimensions of governance, namely level and scale, strategies and instruments, actors, responsibilities and resources, and goal ambitions and problem perspectives.

However, due to its significance as a national issue, the administration of desalinated water usage is overseen by governmental bodies such as MoA and PWA [29]. And for drinking water MoH Participates in managing the use of desalinated water (Interviewies, 2019; MoA, Interviewies, 2019; MoH).

4.1.1.1 Actors and Stakeholders Analysis

Definition of a stakeholder analysis

The approach involves understanding a system by identifying its key actors or stakeholders and evaluating their interests and involvement in the system.

Objectives of a stakeholder analysis

- To identify all individuals, groups, or organizations that could be impacted by an intervention or have the ability to influence its outcomes.
- To recognize the local institutions and procedures that can be leveraged.
- To lay the groundwork and plan for stakeholder engagement and participation.
- To initiate an understanding of the needs and interests of the key stakeholders.

Classify/Categorize Stakeholders

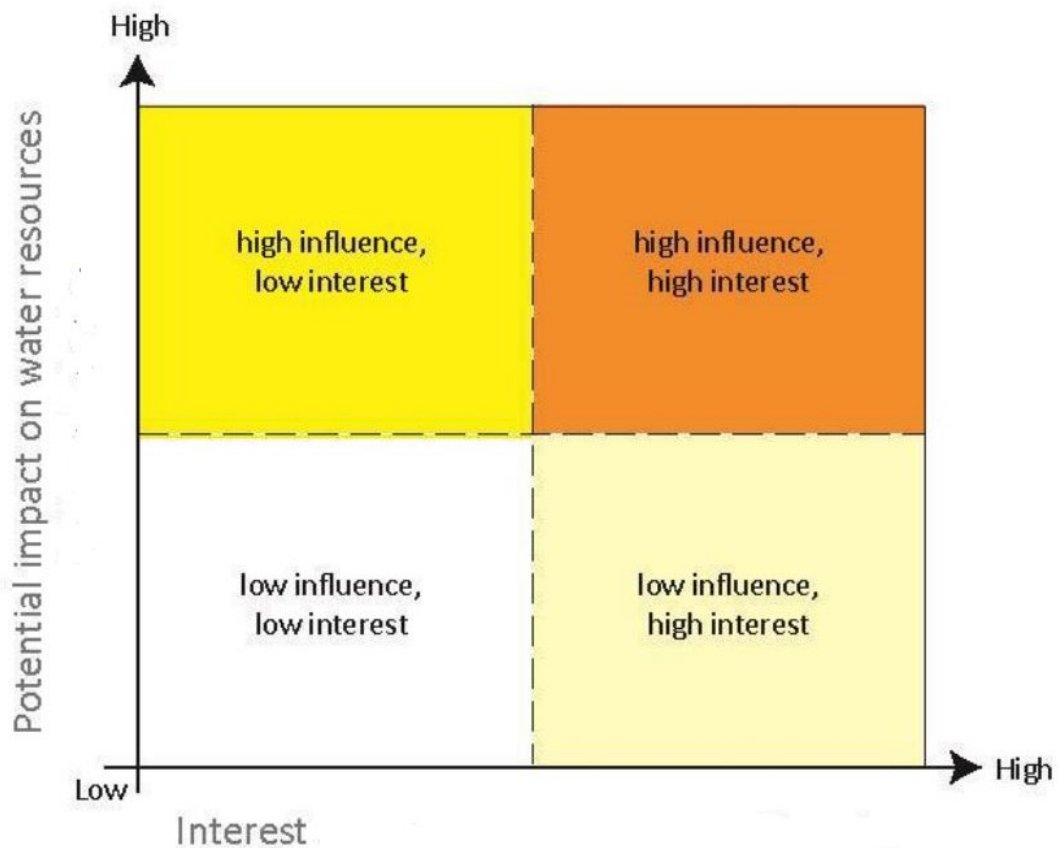
Table (7) summarized actors and its role. Then, they classified in four main groups as shown in figure (10):

Table 7*Actors and its role*

Actors	Role
Palestinian Water Authority (PWA)	These entities are responsible for various tasks, including licensing water resources (treated wastewater, surface water, and groundwater), developing bylaws and water regulations, and formulating overarching water strategies, policies and plans, and ensuring their implementations.
Water Sector Regulatory Council (WSRC)	Monitoring water production, transportation, distribution and consumption. Striving to provide high-quality and efficient services of water and wastewater at affordable rates.
Ministry of Agriculture (MoA)	The drafting of laws and regulations related to agriculture, providing agricultural services, creating agricultural policies, and regulating the utilization of irrigation water.
Municipalities	Acting as water service providers, establishing water tariffs based on the associated costs, and managing regional water resources.
Ministry of Health (MoH)	responsible for issuing water quality standards, providing health guidance on water policies, conducting water sampling, and increasing public awareness of water-related issues.
Private Companies	For the future, institutionalize the desalinated water use projects, desalination of brackish water, operating and maintenance of desalination plants, distribution desalinated water, and collecting and issuing bills.
Public Members	Potential users of desalinated water (individuals, farmers, etc.)

Figure 10

Stakeholder matrix with four main categories [46].



Influential: refers to people who have power (direct or indirect) over the success of the project.

Interest: refers to those who have power over the delivery of project outcomes [47].

Four main groups:

- Stakeholders with high influence but low interest:
Palestinian Water Authority (PWA)
Ministry of Health (MoH)
- Stakeholders with both high influence and interest:
Ministry of Agriculture (MoA)
Water Sector Regulatory Council (WSRC)

- Stakeholders with both low influence and interest:

Municipalities

- Stakeholders with low influence, but high interest:

Public Members (farmers)

Private Companies.

4.1.1.2 Goal Ambitions and Problem Perspectives

Lack of clear criteria for the design of desalinated water use projects in terms of choosing the type of crops. It totally depends on the farmer. As farmers in the Jericho area prefer to grow date palms that is because of palms tolerance to hold out more salinity compared to other crops. Therefore, the availability of desalinated water helps to diversify crops, as the Palestinian market faces a shortage of 50% of fruit products and 80% of fodder crops. Meeting the irrigation needs of fodder crops, such as Alfalfa, can require up to 6 m³ of water per dunum per day. These products are also subject to high prices and Israeli control. The goal is to achieve self-sufficiency and address the market's deficit in these critical products by utilizing desalinated water at a lower, more affordable cost.

4.1.1.3 Strategies and Instruments

No laws can be enacted in Palestine without the consent of the legislative council. However, due to internal political issues, the council is not functioning. To prevent disagreements between various entities, the ministerial council is issuing by-laws. The presence of current water law and its corresponding by-laws have strengthened the legal structure of the water sector, outlining the duties, obligations, and powers of the involved parties.

Till now, there are no special laws for desalination of salt water and the use of desalinated water in Palestine.

Tariff and WUA By-laws

Several water wells are under private ownership, and their owners have the power to dictate prices and sell water to farmers. WSRC oversees this sector, as specified in Article 24 of the Water Law 2014. However, the council of ministers has yet to approve the by-laws governing the pricing system. Once implemented, the tariff by-law will clearly define the pricing structure for licenses to access all water resources, including surface

water, groundwater, treated wastewater, desalinated water, and any potential future sources. It will apply to all users and service providers, such as the private sector, municipalities, the National Water Company, and individuals. Furthermore, this will enable WSRC to monitor well owners according to well-defined criteria, including the necessary licensing procedures for their operations. The by-laws governing Water Users Associations are also awaiting approval from the council of ministers. These by-laws outline the responsibilities and duties of users of water, the licensing process, and the rights and obligations of members. The aim of this law is to enhance the role of WUA in decision-making processes.

License obtaining and Oslo Agreement

Following the signing of the Oslo agreement between Palestine and Israel in 1993, the Joint Water Committee (JWC) was founded to manage water-related issues in the West Bank. The JWC is responsible for handling all matters concerning water and wastewater. As per article 40 and schedule 8 of the agreement, any construction or development of facilities of water and wastewater in areas A, B, and C must obtain prior approval from the JWC. Additionally, the JWC must approve the treatment, reuse, or safe disposal of all domestic, industrial, urban, and agricultural wastewater (Oslo Agreement, 1993). Getting licenses from the Israeli side is a complex and time-consuming process, with even greater difficulty for facilities located in Area C.

4.1.1.4 responsibilities and resources

Responsibilities regarding desalinated water use:

All actors involved in the water sector have now been assigned clear responsibilities, eliminating any overlap. Since the declaration of No14. 2014, there are no longer any ambiguous or overlapping responsibilities (Interviews).

The procedure for obtaining licenses for desalination projects or the use of desalinated water is well-defined, with each actor following a specific checklist to approve such projects. The responsibilities of each actor are complementary and are aimed at achieving the utilization of desalinated water (Interviews). The following description outlines the practical responsibilities of all actor in the use project, and these responsibilities are summarized in Table 8 for easy reference.

Municipality: This party would bear the responsibility of ensuring that the desalinated water quality is monitored and sustained at a level that meets Palestinian standards for use. In addition, they would serve as the provider of reclaimed water. Their primary duties would involve the operation and maintenance of the WWTP, monitoring and delivering effluent, and determining delivery costs in accordance with the Tariff Law.

Water Users Association (WUA): The responsibility of this task involves obtaining essential permits from the MoA for irrigation purposes. Additionally, it encompasses managing the utilization scheme, which includes the day-to-day operations such as controlling the water supply, reading the water meter, selecting crops with the farmers, and resolving any conflicts or payment delays that arise with the farmers.

Apart from managing the operation and maintenance of the irrigation system, which involves monitoring and maintaining all equipment, including daily inspections of the irrigation network such as pipes, leakages, water pressure, and quantities, this task also includes collecting fees and maintaining accounting records, which may involve reading the water meters or recharging the pre-paid meters, and issuing bills. The responsibility also involves paying water bills to the Municipality, preparing annual budgets and balance sheets that document all the WUA's income and expenditures, monitoring the quality of the products, and conducting on-site tests under the Agricultural engineer's supervision and in coordination with the MoA. Additionally, this task includes managing input purchases and promoting agricultural products.

Ministry of Agriculture MoA: The WUA and its farmers receive guidance and advice from the MoA on crop selection and good agricultural practices. The MoA is responsible for providing guidance and support to farmers to ensure they follow the best practices and resolve any unforeseen issues. Furthermore, the MoA conducts regular site visits to monitor the quality of the products. The ministry also provides guidance to the WUA/Farmers on the proper and safe use of pesticides through pesticide usage surveys. Additionally, the MoA is responsible for conducting essential tests on the soil to ensure its quality and also for monitoring the salinity level in the soil.

Palestinian Water Authority (PWA): The PWA is the primary regulatory authority for water and wastewater resources in Palestine. Its main responsibility includes developing and implementing water policies and strategies, managing the restructuring and development of water usage, monitoring and licensing water resources, and assisting in identifying land for reservoirs from farmers.

Water Sector Regulatory Council (WSRC): This role involves an overarching regulatory function concerning the pricing of reclaimed water, the monitoring of new licenses issued for WUA and system operations. Its primary responsibility includes approving water supply and prices costs. The municipality submits the water tariff for approval to the WSRC, which then supervises and inspects compliance with the licenses and permits indicators, requirements, and conditions.

Environmental Quality Authority (EQA): The EQA is responsible for reviewing Environmental Impact Assessments (EIAs) to ensure there are no hazards of environmental. Typically, this is done by approving and preparing the EIA for the project.

Ministry of Health (MoH): The responsibility of this task is to sample water, which, currently, is limited to drinking water only.

Table 8*Responsibilities of actors*

Actor	Responsibility
Municipality	This task involves monitoring the quality and delivery of desalinated water and based on the tariff law, the cost of service was set.
WUA	Gathering invoices from farmers, remitting payments to providers, overseeing the caliber of agricultural goods, and promoting their sale.
MoA	Providing guidance to farmers regarding optimal agricultural methods, conducting surveys on pesticide usage, and monitoring soil conditions.
PWA	Creating strategies and policies for water management, issuing licenses for water resources, and monitoring their usage, as well as identifying land suitable for reservoirs in collaboration with farmers.
WSRC	Sanctioning effluent tariffs, establishing minimum operational standards, overseeing and inspecting adherence to these standards (operational inspections), supervising supply agreements, and resolving grievances of WUA, farmers, and consumers (Water Users Association) regarding suppliers.
EQA	Reviewing environmental monitoring reports and conducting assessments of environmental impact (EIA reviews).
MoH	Collecting water samples.

4.1.1.5 Levels and scale

This dimension is not conspicuous. Some interview does not mention at all.

4.2 Governance Qualities Assessment:

This section addresses the second sub-question of the thesis, evaluating the level of governance support for desalinated water and its usage in the West Bank. The evaluation is based on the five governance dimensions elaborated in section 4.1.1 and assessed through the qualities of flexibility, intensity, extent, and coherence.

4.2.1 Extent

Actors: The assessment of this dimension is moderate, since most of actors are involved in using desalination water matters from making policy to enforcement. Including MoA, PWA, and Local Municipalities (MoLG) and respecting to drinking desalinated water, MoH Contribute in process. Whereas, the Water Sector Regulatory Council said it had nothing to do with policy making.

Goal ambitious and problem perspective: The assessment of this dimension is moderate, since some of problems are considered. The interviews confirmed especially with farmers in Jericho area that there are problems not taken into consideration. Especially the problems related to salinated water. Especially with water scarcity problem which is increased by Israeli policies towards the Palestinians.

Strategies and instruments: The assessment of this dimension is Supportive, the National Water and Wastewater Strategy for Palestine 2013 is considered the foremost critical approach. Its implementation has enhanced collaboration among the primary stakeholders and promoted coordination between them. However, despite the clear definition of legal frameworks, certain instruments remain inactive due to the absence of a legalization council, leading to complications in their execution.

Responsibilities and resources: The assessment of this dimension is moderate, all of the interviewees agreed that the allocation of responsibilities became more apparent following the implementation of the new Water Law in 2014. The law clearly outlined the tasks, duties, and authorities of each party involved. Nevertheless, the private sector's responsibility has yet to be assigned or defined.

Level and scale: The assessment of this dimension is Supportive, since Implementation and design involve participation from all levels of administration using desalinated water policies.

4.2.2 Coherence

Actors: The assessment of this dimension is Supportive, the majority of the interviews disclosed that the actors involved in managing desalinated water use have a robust level of interaction and function as a cohesive team. They also acknowledged the presence of effective coordination between various governmental entities. For instance, the Ministry of Agriculture coordinates with the Palestinian Water Authority, Environmental Quality Authority, and other relevant organizations when devising their strategy.

Problem perspective and goal ambitions: The assessment of this dimension is moderate, since the existing goals of using desalinated water are complementing each other. Furthermore, the strategies from 2013, 2014, and 2016 all endorse the utilization of desalinated water and serve as short-term objectives to achieve long-term goals.

Strategies and instruments: The assessment of this dimension is moderate to high, the governance structure operates through a synergy-based approach to enhance the utilization of desalinated water. As an illustration, the proposed by-laws are anticipated to incentivize various actors in usage projects, like the Water User Association (WUA), to fulfill their responsibility of distributing desalinated water to farmers.

Responsibilities and resources: The assessment of this dimension is moderate to high, prior to the implementation of the Water Law in 2014, the coherence among the various actors involved was poor due to ambiguous responsibilities and overlapping roles. However, after the clarification of responsibilities, roles have become more coherent. The objective is to foster collaboration within and among institutions. The establishment of committees for each project incentivized actors to cooperate rather than compete, as success is attributed to the team rather than individual actors.

Level and scale: The assessment of this dimension is moderate to high, most of levels consider they work together in most Issues related to desalinated water-Whether designing and implementing policies- and recognize each dependency.

4.2.3 Flexibility

Actors: The assessment of this dimension is Supportive, It is effortless to incorporate new actors into the system. Workshops and meetings are open to all new stakeholders who wish to participate in the utilization sector. Additionally, these workshops include social participants and NGOs.

Problem perspective and goal ambitions: The assessment of this dimension is moderate, some aspects of the goals can be reassessed. For example, the objective was reviewed and modified to include not only treatment but also the utilization of the object.

Strategies and instruments: The assessment of this dimension is moderate, the range of instruments utilized is confined to financial and legal means, and the actors may choose to blend these instruments.

Responsibilities and resources: The assessment of this dimension is Supportive, the actors have a considerable amount of flexibility in their responsibilities, but the available resources are limited. Reallocating resources to another purpose or location is not feasible as each resource possesses distinct characteristics that cannot be altered.

Level and scale: The assessment of this dimension is moderate, depending on the issue, it is possible to move up and down levels.

4.2.4 Intensity

Actors: The assessment of this dimension is moderate to high, the majority of diverse actors are exerting pressure to improve the use of desalinated water.

Problem perspective and goal ambitions: The assessment of this dimension is moderate, most of the objectives can be attained through the existing strategies, but the lack of distinct instructions for implementing use projects is hindering the progress of this sector as anticipated.

Strategies and instruments: The assessment of this dimension is moderate, some actors don't impose the licenses for desalinated water use, making it easier to use.

Responsibilities and resources: The assessment of this dimension is restrictive, the construction and operation of desalination water projects in Palestine are primarily supported by grants. However, the sustainability of these projects is crucial for altering the present circumstances. It is imperative that each facility has adequate funds to cover the expenses of ongoing maintenance and operations; otherwise, the project will cease to function once the funding runs out.

Level and scale: The assessment of this dimension is moderate to high, the majority of levels are striving towards achieving behavioral change or implementing management reforms.

4.2.5 Summary of Assessment

Table of GAT Result

This table summarizes the result of interviewees with actors

Table 10*The governance context assessment of using the desalinated water.*

Dimension \ Quality	Extent	Coherence	Flexibility	Intensity
Actors and networks	Moderate	Supportive	Supportive	Moderate+
Problem perspectives and goal ambitions	Moderate	Moderate	Moderate	Moderate
Strategies and instruments	Supportive	Moderate+	Moderate	Moderate
Responsibilities and resources	Moderate+	Moderate+	Supportive	Restrictive
Level and scale	Supportive	Moderate+	Moderate	Moderate+
Overall assessment of the qualities	Supportive	Moderate+	Supportive	Moderate

Summary of Qualities Assessment

Supportive extent: Two dimensions are characterized as supportive while the remaining three are classified as moderate.

Most of actors are involved in use project. Most of problems are considered. All instruments are used. The responsibilities are clearly assigned but some resources are missing and all levels are involved in the use project.

Moderate to supportive coherence: one dimension is characterized as supportive while the remaining dimension range from moderate to high. The interaction between actors are stable and there is trust. Most of goals of actors support each other. There are some conflicts in the instruments. While there are some issues, the actors work to foster collaboration within and across institutions. The various levels acknowledge their interdependence and the existence of some multi-level issues.

Supportive flexibility: two dimensions are characterized as supportive while the remaining dimension are moderate.

It is easy to include new actors. Some aspects of the goals can be reassessed. The law allows for the combination and utilization of various instruments, and it is also possible to consolidate the assigned responsibilities. It is possible to move up and down levels in some cases.

Moderate intensity: one dimension is characterized as restrictive while the other range from moderate to high.

Certain actors are exerting pressure to enhance the utilization sector. The objective can be accomplished by making minor adjustments to the current policy. Only slight deviations from the prevailing practices of the instruments are necessary. Lack of resources to comply with the responsibilities. The majority of levels are working towards bringing about behavioral change or implementing management reforms.

Most Supportive/Restrictive Dimensions

Actors is the most supportive dimension, since most of actors are involved in the use project and the interaction between actors are stable and there is trust. It is easy to include new actors. Some actors are pressuring to improve the use sector. On the other side, 'Problem perspectives and goal ambitions' is the restrictive dimension, especially there is aspects of the goals must be reassessed and some changes to the current policy must be done to achieve the goal.

Chapter Five

Conclusions and Recommendations

5.1 Conclusions

The Palestinians face big problems regarding to accessibility and management of water resources especially farmers in Jericho area. This research confirms the importance of desalination of brackish water as additional unconventional water sources for agricultural irrigation and drinking water purposes.

This research is study governance assessment of brackish water in Palestine. The assessment of governance comprises dimensions such as problem perceptions and goal ambitions, actors, strategies and instruments, level and scale, and responsibilities and resources. The qualities of flexibility, coherence, extent, and intensity were employed to evaluate these dimensions, and the governance assessment matrix was used to answer the related questions. The search results are summarized as follows:

- The qualities of the governance system assessment of desalination of brackish water in West Bank showed that in terms of flexibility and extent, the governance context is supportive. And in terms of intensity and coherence, it's moderately supportive.
- The governance system in terms of actors, it's highly supportive. Since most of actors are involved and the interaction between actors are stable and there is trust. It is simple to include new actors and some actors are pressuring to improve the desalination sector.
- The governance system is restrictive in terms of Problem perspectives and goal ambitions, especially there is aspects of the goals must be reassessed and some changes to the current policy must do to achieve the goal.
- The governance system in terms of strategies and instruments, it's moderate to supportive. All instruments are used but there are some conflicts between them. There is chance to use and combine between various instruments as it's stipulated in law.
- The governance system is moderate in terms of responsibilities and resources, the responsibilities are clearly assigned but some resources are missing. Also actors enhance collaboration within and across foundation. And it is possible to aggregation

the assigned responsibilities but there is Lack of resources to comply the responsibilities.

- The governance system is supportive in terms of level and scale, all levels are involved in the use project but the levels deem little multi-level cases exist and recognize their dependence. It is possible to move up and down levels in some cases. Also most levels are working to make behavioral change or management reform.

5.2 Recommendations

Actors

- Involve all actors in the process of creating and implementing laws, especially privet sector as possible main actor in the future

Problem perspectives and goal ambitions

- Develop practical and appropriate methods for farmers to desalinate brackish water (it could be desalination plants or a small device for every farmer).
- Awareness of farmers about the bad impact of saline water on their crops.

Strategies and instruments

- Require farmers to use desalinated water at a small percentage in the beginning and then gradually increase this percentage.

Responsibilities and resources

- To establish more clarity in policies and strategies, elaborate on the responsibilities of actors.
- To prevent interruptions in operations due to the exhaustion of funds or grants, invest in the expansion of irrigation projects that employ desalinated water. This will create more employment opportunities and boost revenue.

Level and scale

- Increase work on management reform and involve all levels in it.

5.3 Further Research

- Possible reuse options for desalinated brackish water in Palestine
- The impact of private sector involvement on reuse projects.
- Comparison cost of production of desalinated water between large scale and small scale projects.

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Appendices

Appendix A

Table A.1

GAT Interviews set of questions

Governance dimension	Quality of the governance context			
	Extent	Coherence	Flexibility	Intensity
Level and scale	How many administrative levels are involved in implementing and designing using treated desalinated water policies?	Do these administrative levels work together and recognise each dependency?	Is it possible to move up and down levels (up scaling and downscaling)	Is there a strong impact from a certain level towards behavioural change or management reform?
Open Question	In the process of implementing and designing use desalinated water policies is there is a dominant level? What is it and how many levels they are and how it's easy to move between them?			
Actors and networks	Are all relevant stakeholders involved?	What is the strength of interactions between stakeholders?	Is it possible to include new actors and how much it's easy to shift the lead from one actor to another when it's needed?	Is there a strong pressure from an actors or actors coalition towards behavioural change or management reform?
Open Question	Which actors are involved in the process, how it's their relation and the performance of management reform?			
Problem perspectives and goal ambitions	To what extent are the various problem perspectives taken into account?	To what extent do the various perspectives and goals support each other, or are they in competition or conflict?	Are there opportunities to reassess goals?	How different are the goal ambitions from the status quo or business as usual?
Open Question	How does the problem was taken into consideration, the interrelation of goals with each other?			
Strategies and instruments	What types of instruments are included in the policy strategy?	To what extent is the incentive system based on synergy?	Are there opportunities to combine or make use of different types	What is the implied behavioural deviation from current

			of instruments? Is there a choice?	practice and how strongly do the instruments require and enforce this?
Open Question	What are the instruments used, the possibility to combine them and their influence of implying this?			
		To what extent do the assigned responsibilities create competence struggles or cooperation within or across the institutions?	To what extent is it possible to pool the assigned responsibilities and resources as long as accountability and transparency are not compromised?	Is the amount of allocated resources sufficient to implement the measures needed for the intended change?
Responsibilities and resources	Are all responsibilities clearly assigned and facilitated with resources?			
Open Question	How the responsibilities are facilitated with resources and is it possible to measure implement the measures needed for the intended change?			

Governance dimension	Quality of the governance context			
	Extent	Coherence	Flexibility	Intensity
Level and scale	Supportive: All levels are involved in implementing and designing policies of using desalinated water? Moderate: most levels are involved Restrictive: minority of levels are involved	Supportive: The levels consider they all work together and recognise its dependence Moderate: The levels consider few multi-level issues exist and recognise their dependence Restrictive: The levels consider, most levels are missing, but they recognise their dependence	Supportive: It is possible to move up and down levels, depending on the issue in what they could consider a free manner Moderate: It is possible to move up and down levels, depending on the issue, only through certain articles in the policies Restrictive: It is not possible to move up and down levels even when there are certain articles in the policies to do so	Supportive: All levels are working to bring behavioural change or management reform Moderate: Most levels are working to bring behavioural change or management reform Restrictive: The minority of levels are working to bring behavioural change or management reform

<p>Actors and networks Supportive Neutral: Restrictive</p>	<p>Supportive: all relevant stakeholders are involved? Moderate: most of the stakeholders are involved Restrictive: Few stakeholders are involved</p>	<p>Supportive: the interaction is institutionalised, stable and there is trust. Moderate: Most interactions are institutionalised, stable and there are trust issues Restrictive: the institutionalised interaction is not operating, actors report stability and/or trust issues</p>	<p>Supportive: it's easy to include new actors, shift leadership and social capital creation. Moderate: some of the following is possible (include new actors, shift leadership and social capital creation) Restrictive: the choice of (include new actors, shift leadership and social capital creation) is restricted.</p>	<p>Supportive: there is a coalition of different actors who pressuring strongly towards behavioural change or management reform. Moderate: a minority of different actors are pressuring. Restrictive: one or none of the actors are pressuring</p>
<p>Problem perspectives and goal ambitions</p>	<p>Supportive: all problem perspectives are considered Moderate: most of the problem perspectives are considered Restrictive: few of problem perspectives are considered</p>	<p>Supportive: all of the actor's goal support each other Moderate: most of the actor's goal support each other Restrictive: there is conflict/competition the actor's goals</p>	<p>Supportive: it's possible to reassess all aspects of the goals during the implementation process Moderate: some aspects of the goals can be reassessed Restrictive: it's not possible to reassess the goals or could be after the implementation phase.</p>	<p>Supportive: the goals can be achieved with the current policy Moderate: some minor changes to current policy will achieve the intended goals Restrictive: major changes are required to achieve the goals</p>
<p>Strategies and instruments</p>	<p>Supportive: no instruments or strategies are missing Moderate: some are missing Restrictive: significant number is missing</p>	<p>Supportive: the policy allows creations of synergy among the instruments and there are no overlaps or conflict between them. Moderate: some overlaps or conflicts are exist</p>	<p>Supportive: there is opportunity to combine and use different instruments Moderate: there is opportunity to combine and use different instruments as it stated in the policy/law Restrictive: there is/no opportunity</p>	<p>Supportive: no need for behavioural deviation and the instruments are enforced properly Moderate: There is minor need for behavioural deviation from the running practises and the instruments are</p>

		Restrictive: the policy does not allow creations of synergy among the instruments and there are overlaps or conflict	to combine and use different instruments but the actors do not do it.	facing small issues during enforcement Restrictive: there is a major need for behavioural deviation from the running practises and the instruments are facing important issues during enforcement.
Responsibilities and resources	Are all responsibilities clearly assigned and facilitated with resources? Supportive: responsibilities clearly assigned with resources Moderate: responsibilities clearly assigned but some have no resources. Restrictive: responsibilities clearly assigned but there are insufficient resources	Supportive: the actors promote cooperation within and across institutions Moderate: the actors promote cooperation within and across institutions, but some issues were reported Restrictive: the actors promote cooperation within and across institutions. However, actors report significant issues.	To what extent is it possible to pool the assigned responsibilities and resources as long as accountability and transparency are not compromised? Supportive: It is possible to pool the assigned responsibilities Moderate: It is possible to pool partially some of the assigned responsibilities Restrictive: It is not possible to pool the assigned responsibilities	Supportive: there are enough resources needed for the intended changes Moderate: there are resources to attain most of the responsibilities to achieve the intended goals Restrictive: there is a lack of resources to comply the responsibilities to achieve the intended changes

Table A.2*Utilization of the aquifers [31]*

Use	Wells in Western aquifer (MCM/y)	Wells in Eastern aquifer (MCM/y)	Wells in North-Eastern aquifer (MCM/y)
Israel	340	40	-
Palestine	20	24	25
Additional quantities for Palestinian Development	-	78	-
Total	360	142	25

Table A.3*Water Demand for the Jordan Valley Area to the year 2015 [8]*

	Demand MCM/Y	Available MCM/Y	Potential for Development MCM/Y	Deficit
Municipal and Industrial	7.8	27	-	+19.2
Agricultural Water Demand	81	10	15 (recycled Water)+ 28 Flood Water	-28
TOTAL	88.8	37	43	-8.8

Table A.4*Data for Desalination Plants in the Jordan Valley*

Unit	Use	Location	Owner	Treatment Method	Treated water quantity CM/D
Zbeidat	Domestic	Zbeidat	PWA	RO	15
MarjNa'jeh	Agricultural	MarjNa'jeh	MoA	RO	400 ⁶
PARC	Agricultural	Jericho	PARC	RO	400
COPSCO	Domestic + Agricultural	Jericho	COPSCO	RO	50



جامعة النجاح الوطنية
كلية الدراسات العليا

التقييم الحوكمي لتحلية المياه المالحة في الضفة الغربية، فلسطين

إعداد
ولاء أبو صاع

إشراف
د. عبد الفتاح حسن

قدمت هذه الرسالة استكمالاً لمتطلبات الحصول على درجة الماجستير في هندسة المياه و البيئة، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس - فلسطين.

2022

التقييم الحوكمي لتحلية المياه المالحة في الضفة الغربية، فلسطين

إعداد

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إشراف

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المختص

الخلفية: تعتبر المياه المالحة أحد مصادر المياه في فلسطين، نتيجة لنقص المياه العذبة في الضفة الغربية كان من الواجب إيجاد حلول للاستفادة من المياه المحلاة لغرض الشرب والاستخدام الزراعي.

الهدف: الهدف الرئيسي من البحث هو دراسة مدى توافر الأنظمة الصغيرة ومنخفضة التكلفة لتحلية وتنقية المياه في الضفة الغربية.

المنهجية: أداة تقييم الحوكمة هي الإطار الذي تم استخدامه في هذه الرسالة لتقييم استخدام المياه المحلاة، تتكون أداة تقييم الحوكمة من "مصفوفة" كنموذج يحتوي على خمسة عناصر (الجهات والشبكات الفاعلة، تصورات المشكلة وطموحات الأهداف، الاستراتيجيات والأدوات، الموارد والمسؤوليات، المستويات والمقاييس) وأربعة معايير (المرونة، التماسك، المدى، الشدة).

النتائج: تتلخص نتائج البحث كالاتي:

- نظام الحوكمة داعم من حيث الجهات الفاعلة، نظرا إلى أن معظم الجهات الفاعلة مشاركة والتفاعل بين الجهات الفاعلة مستقر وهناك ثقة، من السهل ضم جهات فاعلة جديدة وهناك بعض الجهات الفاعلة تضغط لتحسين قطاع تحلية المياه.
- نظام الحوكمة مقيد من حيث تصورات المشكلة وطموحات الأهداف، خصوصا أن بعض جوانب الأهداف يجب إعادة تقييمها وبعض التغييرات يجب عملها للسياسة الحالية لتحقيق الأهداف.

• نظام الحوكمة معتدل إلى داعم من حيث الاستراتيجيات والأدوات، جميع الأدوات مستخدمة ولكن هناك بعض التعارض بينها، هناك فرصة للاستخدام والجمع بين مختلف الأدوات كما هو منصوص عليه في القانون.

• نظام الحوكمة معتدل من حيث الموارد والمسؤوليات، المسؤوليات محددة بوضوح ولكن بعض الموارد مفقودة، كما أن بعض الجهات الفاعلة تعزز التعاون داخل المؤسسة وعبرها، من الممكن الجمع بين المسؤوليات ولكن هناك نقص في الموارد للامتثال لهذه المسؤوليات.

• نظام الحوكمة داعم من حيث المستويات والمقاييس، كل المستويات مشاركة في مشاريع الاستخدام، ولكن المستويات ترى وجود حالات قليلة من تعدد المستويات وتترك اعتمادها، من الممكن التحرك صعودا وهبوطا في بعض الحالات، كما تقوم معظم المستويات بإجراء تغيير سلوكي واصلاح إداري.

الخاتمة: تقييم معايير نظام الحوكمة لتحلية المياه المالحة في الضفة الغربية يظهر أنه داعم من حيث المرونة والمدى، ومعتدل إلى داعم من حيث التماسك والشدة.

الكلمات المفتاحية: تحلية المياه، حوكمة المياه، أداة تقييم الحوكمة، المياه المالحة، نقص المياه.