PALESTINE

Cost Assessment of Water Resources Degradation

2015

ESCWA

United Nations Economic and Social Commission for Western Asia

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ACRONYMS

BFT.....Benefit Function Transfer
CAWRD……. Cost Assessment Water Resources Degradation
COED .....Cost of Environmental Degradation
CMWU .....Coastal Municipalities Water Utility
CV .....Contingent valuation
DALYs .....Disability-Adjusted Life Years
EPA .....Environmental Protection Agency of the United States
EQA.....Environment Quality Authority
EU.....European Union
FAO .....Food and Agriculture Organization
GDP .....Gross Domestic Product
GEF .....Global Environmental Fund
GIS.....Geographic Information System
JWC.....Joint Water Committee
Kg .....Kilogram
lcd .....liter per capita per day
m^3.....Cubic meter
MCM .....Million of Cubic Meter
MoA……Ministry of Agriculture
NWC.....National Water Council
OIIA.....Oslo II Accords
OMEX .....Operations and maintenance expenditure
PA.....Palestinian Authority
PCBS .....Palestinian Central Bureau of Statistics
PPP .....Purchasing Power Parity
PWA .....Palestinian Water Authority
RWC.....Regulatory Water Council
UNDP .....United Nations Development Programme
UNEP.....United Nations Environment Programme
VSL .....Value of Statistical Life
WHO .....World Health Organization
WSSA.....Water Supply and Sewage Authority
WTP.....Willingness to Pay
WWTPs……..Waste water treatment plants

EXECUTIVE SUMMARY

Introduction

With a total population of 4.55 million in 2014, Palestine consists of the West Bank and the Gaza Strip. Approximately 74.4 percent of the population live in urban areas and 25.6 percent in rural areas. The annual urban population growth is estimated at 3 percent and the population is expected to increase to 5.3 million in 2020 and 6.75 million in 2030. Palestine GDP amounts to US$ 7.45 billion in 2014, of which: the services sector constitutes 76 and 77.4 percent of the West Bank and the Gaza Strip economic activity respectively; followed by the industrial sector with 20.2 and 16.9 percent; and the agriculture sector with 5.7 percent[1].

The area of the West Bank is 5,640 km^2 (excluding the Dead Sea territorial waters) where approximately 2.79 million live. With a population density of 494.7 habitants per km^2, the West Bank has one of the highest population density in the Middle East and North Africa Region. The West Bank is divided into three Zones with different administrative, security and military status under Israeli occupation: A, B, and C consisting of 11 governorates divided in 124 municipalities. The Gaza Strip is a narrow strip of land on the Mediterranean coast. It borders Israel to the east and north and Egypt to the south. It is approximately 41 km long, and between 6 and 12 km wide. The total area of the Gaza Strip is 378 km^2 (excluding the Exclusive Economic Zone) where 1.76 million people live with a population density of 4,656 habitants/km^2, one of the highest population density worldwide. The Gaza Strip consists of 5 governorates divided in 16 municipalities.

Overview of the Water Resources Availability and Water Quality in Palestine

The West Bank and Gaza movement and access and therefore water allocation are extremely dependent on Israel unchallenged military and political will. The Oslo I and II accords have not been implemented as agreed upon. Therefore, Palestinians do not have access to their trans-boundary water resources from the Jordan River as well as the water resources as agreed upon under the Oslo I and II Accords, as Israel control most of them including the groundwater aquifers. Their share of the water is totally inequitable and unreasonable. As a result, the Palestinians have the lowest annual water resources availability in the Middle East and North Africa with less than 75 m^3 per capita in the West Bank and 125 m^3 per capita in Gaza. In the PCBS household survey of 2015, the water consumption is 50 liter per capita (lcd) and 73 lcd in the West Bank and Gaza respectively.

With an estimated annual renewable capacity of about 679 million cubic meters (MCM), the West Bank, groundwater is currently the main source of water derived from the *Mountain Aquifer*, which consists of the following three aquifers: the North-Eastern, Eastern and Western aquifers. These aquifers are recharged mostly from snow melt and rain fall from the Palestinian Side of the Green Line. This volume is in addition to wadis and runoff water with an estimated annual volume of 165 MCM. The water quality is poor in various part of Palestine especially those communities that are not connected to the network and for habitants living in Area C. In these areas, incidence of water-related diseases are high and prevalent, causing substantial health costs and lost opportunities.

[1] Based on the information provided by the Environment Quality Authority, GDP amounts to US$ 7.45 billion in 2014, of which the major sectors include services sector which constitutes 40 percent of the GDP followed by the industrial sector with 14.5 percent and the agriculture sector with 3.8 percent.

The unique fresh water resource of the Gaza Strip is the coastal aquifer, which also runs beneath the coast of Israel and Egypt. Contrary to the aquifers in the West Bank, the coastal aquifer under Gaza flows downstream from the portion of the aquifer in Israel which flow upstream. The Palestinians are also not allowed to transport water from the West Bank to Gaza. Under normal flows, the current yield under the aquifer segment of Gaza is estimated at about 57 MCM, around 15 percent of the total yield of the shared aquifer, which is estimated at 360-420 MCM. Gaza has a water crisis and faces very serious challenges concerning the future access to its water resources. About 89 percent of ground water is facing excessive abstraction for up to 200 MCM per year. The excess of the annual recharge of the reservoir ranges between 55-60 MCM per year by about four times. The Gaza Strip is among the territories that have the scarcest renewable water resources. The over abstraction of the groundwater aquifer has led to the deterioration of water quality and sea water intrusion with very high concentration of nitrates and chlorides. Only 5-10 percent of the aquifer now meets drinking water quality source standards by WHO. Poor water quality is also related to trans-boundary and local pollution from wastewater seepage and infiltration of agricultural fertilizers.

Objective and Scope

The water resources in Palestine have been the subject of economic reports from the impact of the occupation and blockade and were estimated at US$. 6.9 billion by the Palestinian Authority . However qualitative and quantitative assessments of impacts on the environment and its natural resources are not generally understood and, the economic assessments of these impacts are almost non-existent. In view of the lack of economic assessment of water degradation that this present study has been developed, the economic assessment of water degradation will enable an approximate quantification in form of orders of magnitude of the economic costs associated with environmental degradation. This assessment will enable the decision makers at the national and regional levels to develop sectoral priorities based in the cost and benefits of investments and the impact of the environmental externalities on these investments.

The main objective is to assess water resources, the policy, legal and institutional framework, and the cost assessment of water resource degradation (CAWRD) in West Bank and Gaza to assist decision-makers at national and local levels to identify and prioritize specific actions to improve the management of the water sector under the current restrictions.

The present study consists of:

- An overview of the water right and water use as well the assessment of the legal and institutional frameworks of the water sector in the West Bank and Gaza; and
- An assessment of the cost of the environmental degradation to encompass environmental health and ecological degradations.

The CAWRD can be understood as a measure of the lost welfare of a nation due to water resources degradation. For the purpose of this report, a loss in welfare includes but is not necessarily limited to:

- Loss of healthy life and well-being of the population (e.g., burden of disease); and
- Economic losses (e.g., efficiency losses, competitiveness, forgone revenues).

The CAWRD were valued by using available data source that sometimes cannot be entirely reliable. In addition, gaps in the data required to make several assumptions. Nevertheless, the CAWRD is meant to help policymakers make informed and efficient choices to maintain the integrity of the environment and promote conservation based on a common denominator: monetizing the environmental damage and remedial interventions. These results, which should be considered as preliminary order of magnitudes, could nevertheless help highlight the trade-offs between economic development and growth, well being, and the preservation of the commons. Moreover, these results, which should guide further analyses, provide policymakers with a preliminary tool for integrating environment into economic development decisions and comparing damage costs as a percentage of GDP within categories and across countries. The Water subcategories that were assessed were as follows:

- **Water-related Diseases.**
- **Water Quality** which includes water quality of potable water treatment; quality of water resources, water quality due to salinity.
- **Water Quantity** which includes: water supply to supplement domestic needs, water supply network (unaccounted for water); drawdown of the water table due excess pumping.
- **Water Scarcity:** Water needs not fulfilled and valued at replacement cost (desalination cost, waste water treatment cost which used for agriculture).

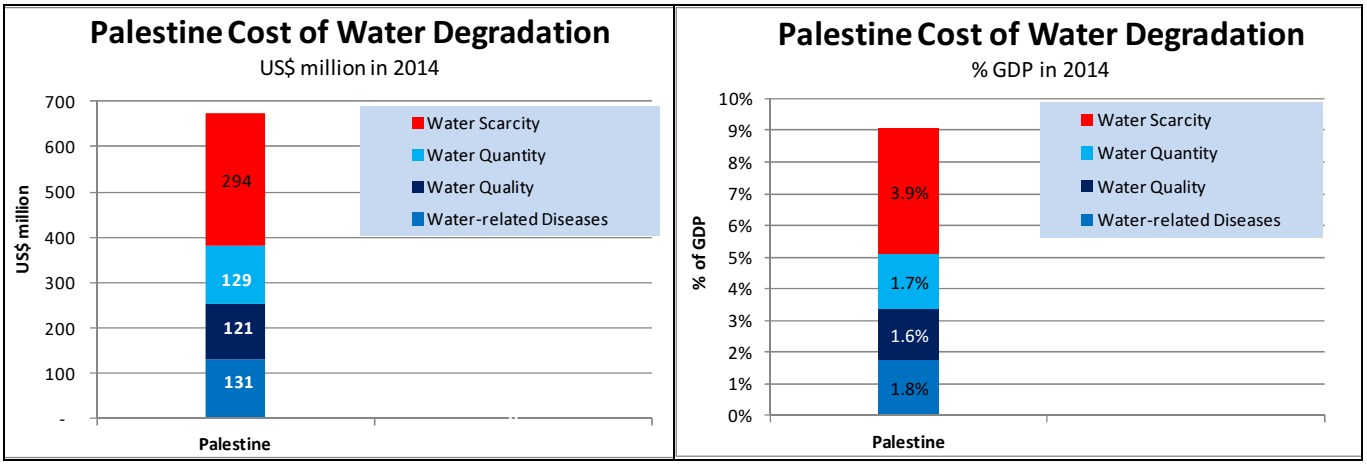
Cost of Environmental Degradation: The Water Sector

The results of the CAWRD are shown in Table 1 and Figure 1. The CAWRD of Palestine reaches US$ 675 million in 2014 equivalent on average to 9.1 percent of GDP in 2014 with a variation between US$ 529 and 875 million. Degradation cost associated to human health reached US$131 million in 2014 or 19.1 percent of the CAWRD with the rest being equivalent to US$ 544 million (Table 1 and Figure 1).

TABLE 1: CAWRD IN PALESTINE, 2014

Category	CAWRD		Lower bound	Upper bound
	US$ million	%	US$ million	US$ million
Water-related diseases	131	19.4%	111.2	150.5
Water quality	121	17.9%	92.7	132.70
Water quantity	129	19.1%	109.3	147.94
Water scarcity	294	43.6%	220.4	455.42
Total	675	100.0%	528.9	875.2
% GDP		**9.1%**	7.1%	11.7%
GDP	**7,449**			

Figure 2: CAWRD in Palestine, 2014



Broken down by the water subcategory (US$ million in 2014): water scarcity represents 44 percent of the degradation costs (US$ 294 million in 2014) due partly to the withhold of Palestine share from the various riparian transboundary resources; followed almost equitably by water quality (US$ 121 million in 2014), water-related diseases (US$131 million in 2014) and water quantity (US$ 129 million in 2014). Water use has a small impact on the global environment but costs were not valued.

In comparison with other MENA countries as shown in table 2 below, Palestine has the highest CAWRD.

TABLE 2: COMPARISON OF CAWRD IN MENA

MENA countries	% of GDP	Year
Palestine	9.1	2014
Iraq	3.4	2008
Morocco	1.2	2000
Lebanon	1.1	2005
Egypt	1.0	1999
Algeria	0.8	1999
Tunisia	0.5	1999

The Way Forward

There is an undisputed conclusion that Palestinians need to seek their water rights for Palestine, including the fair right-of-access, right-of-control and right-of-use to water resources shared with other countries, in line with international law, Although international pressure should continue to enable the Palestinians to have access and control of their water resources, the diagnosis and analysis developed in the previous sections helped reach the following conclusions:

1. **The environment neglect is a serious burden on the Palestinian Economy.**

2. **Palestinians are suffering twice.** First, from the economic costs of the Israeli occupation which, for comparaison purpose only, could reach US$ 4.1 billion in 2014; and second, the evironment cost of

water degradation estimated at US$ 686 million for 2014 although some double counting does exist when adding the former and latter figure.

3. **The environment health bill** is considred to be significant and six times higher the environment health bill estimated at US$ 20 million in the report of the economic costs of Isreali ocupation.

4. **The waterlosses (unaccounted for water) in the West Bank and Gaza are considred high and chronic.** The West Bank and Gaza average municipal water losses are estimated at 28 percent and 48 percent respectively.

5. **It is impossible to predict the future of the water resources and supplies in Palestine** and at present integrated resources management is impossible to achieve. With such serious constraints in the supply management, demand water management can only be considered at that time.

6. **The fragmented resources and responsibilities between the PWA EQA, West Bank Water Department CMWUs in the presence of the "jungle of hundred of small providers"** in terms water access monitoring and enforcement have prevented the efficient development and management of the water and wastewater services.

Based on the above conclusions and the meeting that the Palestinian delegation headed by H.E. Ms. Adala Atira, President of Environment Quality Authority in Palestine held in Beirut on November 26 2015, with senior staff of the Food & Environment Policies Section, Sustainable Development Policies Division in UN ESCWA, the Palestinian delegation recommended that ESCWA facilitates the development for a roadmap for assessing the cost of environmental degradation due to occupation within ESCWA plans for 2016 and to include capacity building component for 12-15 participants from Palestine to ensure that the process can be partially implemented at the national level. The road map would include the cost of environmental degradation due to the Separation Wall built by Israel as the priority and starting point for the assessment. Furthermore, the assessment can be expanded for assessing the COED due to occupation provided data is available from 1967 onwards.

I. INTRODUCTION

A. Background

With a total population of 4.55 million in 2014, Palestine consists of the West Bank and Gaza Strip (Figure 1.1)[2]. Forty three percent of Palestinians living in Palestine are refugees from 1948 (68 percent in Gaza Strip and 27 percent in West Bank).[3] Approximately 74.4 percent of the population live in urban areas and 25.6 percent in rural areas.[4] The annual urban population growth is estimated at 3 percent[5] and the population is expected to increase to 5.3 million in 2020 and 6.75 million in 2030.[6]

The total area of the Palestinian territories occupied by Israel in the Arab-Israeli War of 1967 is 6,238 km^2, including the Palestinian share of the Dead Sea (estimated at less than 220 km^2 as the Dead Sea area is shrinking).

The area of the West Bank is 5,657 km^2 (excluding the Dead Sea territorial waters) where approximately 2.79 million live. With a population density of 456 habitants per km^2, the West Bank has one of the highest population density in the Middle East and North Africa Region.[7] The West Bank is divided into three Zones, A, B, and C consisting of 11 governorates divided in 124 municipalities. The Israeli military authorities impose administrative, political, and technical constraints on these areas. According to the Palestinian Central Bureau of Statistics (PCBS), the divided areas are as follows:

- Zone A is 1,005 km^2 or 17.8 percent of the total West Bank area.
- Zone B is 1,035 km^2 or 18.3 percent of the total West Bank area.
- Zone C is 3,617 km^2, including East Jerusalem, constitutes the remaining 63.9 percent of the West Bank.

Zone A is under Palestinian control, Zone B is under joint Palestinian and Israeli control, and Zone C is under Israeli control. Zone A is administered and policed by the Palestinian Authority (PA); zone B is administered by the Palestinian Authority and policed by Israel; and zone C is administered, policed and military controlled by Israel although more than 150,000 Palestinians live *in situ*. Zones A and B are smaller territorial islands as shown in Figure 1.1 and are themselves divided into 469 distinct areas (171 and 298 respectively).[8] The majority of them being less than two km^2 and separated from each other by Zone C which is more or less a contiguous territory with small islands like Jericho (Figure 1.1). The Zone is fully controlled by Israel and endowed with the bulk of the agricultural and most fertile land, grazing land, water resources and underground reservoirs. The building of the wall separating Israel proper and Israel settlements from Palestinian areas has exacerbated movement and access for Palestinians (Figure 1.1). Moreover, an area denominated as natural reserves extending over the Hebron to Bethlehem districts for its resources is off limits to Palestinians, so are the Dead Sea territorial waters. More importantly, East Jerusalem is not considered in the Palestinian area as Israel

[2] PCBS 2014
[3] World Bank, fact sheet on West Bank and Gaza.
[4] UNDP and Sweden 2013, Water Governance in the Arab Region: Managing Scarcity and Securing the Future.
[5] The World Bank, 2015, World Development Indicators.
[6] UNDP and Sweden 2013, Water Governance in the Arab Region: Managing Scarcity and Securing the Future.
[7] National Water Policy and Strategy, 2013.
[8] The World Bank, 2013 Area C and the Future of the Palestinian Economy.

unilaterally declared it the capital of Israel in 1980 and has carved out areas surrounding East Jerusalem to create a settlement buffer that is administered by the Greater Jerusalem municipality (Figure 1.1).

Figure 1.1: Palestine: West Bank Division and the Gaza Strip

Source: UNCHR, Atlas, 2015 <website: <www.ochaopt.org>.

The Gaza Strip is a narrow strip of land on the Mediterranean coast as shown in Figure 1.1.[9] It borders Israel to the east and north and Egypt to the south. It is approximately 41 km long, and between 6 and 12 km wide. The

[9] UNEP: Environment Impact Assessment of the Gaza Strip.

total area of Gaza is 378 km^2 (excluding the Exclusive Economic Zone) where 1.76 million people live of whom at least one million were UN-registered refugees with a population density of 4,353 habitants/km^2, one of the highest population density worldwide.[10] Gaza consists of 5 governorates divided in 16 municipalities. Gaza has a certain autonomy in terms of administration and policing since the 2005 Israeli evacuation although movement and access have been hampered by the restricted opening of the Rafah crossing to Egypt and the Eretz crossing to Israel and the ban imposed by Israel on Eastern Mediterranean sailing and fishing, especially since the military conflicts in 2008 and 2014.

In short, the West Bank and Gaza movement and access and therefore water allocation are extremely dependent on Israel unchallenged military and political will. For instance, in the West Bank, the Israeli restrictions caused the Palestinian economy to lose US$ 3.4 billion or 35 percent of the annual Gross Domestic Product (GDP).[11]

Palestine GDP amounts to US$ 7.45 billion in 2014,[12] of which Palestine GDP amounts to US$ 7.45 billion in 2014, of which: the services sector constitutes 76 and 77.4 percent of the West Bank and the Gaza Strip economic activity respectively; followed by the industrial sector with 20.2 and 16.9 percent; and the agriculture sector with 3.8 and 5.7 percent.[13]

B. Setting the Stage for Water Resources Allocation Under the Oslo Accords

Under the 1993-95 Oslo I and II Accords, the Agreement on Movement and Access between Israel and the Palestinian Authority was reached in 2005 and relates not only to the movement of people and goods but also to the restrictions on access to resources, including land and water[14] over the Palestinian Territories administered by Jordan in the West Bank and by Egypt in Gaza before the 1967 Israeli-Arab War.

Box 1.1: Palestinian Water Rights and Use Arrangements under the Oslo II Accords of 1996

Although a treaty was reached between Israel and Jordan regarding the Jordan and Yarmuk rivers, a treaty cannot be reached between Israel and Palestine before Palestine become a sovereign state. The Oslo II Accord is therefore an interim accord that is not comprehensive in terms of water sharing as it does not, for instance, cover the allocation of treated wastewater or options for an exchange scheme. Still, under the Oslo II Accord, *Article 40* contained provisions on water and sewage that recognized undefined Palestinian water rights, and returned some of West Bank water resources and services responsibility to the PA:

- Set governance arrangements for a five year interim period, notably, a Joint Water Committee to oversee the management of the aquifers, with decisions to be based on consensus between the two parties. Israel had a veto right under this clause.
- Allocate to either party specific quantities of the three West Bank aquifers underlying both territories. The Palestinian West Bank allocation share was about one fourth of the Israel and her settlement allocation share.
- Provided for interim extra supplies from new wells and from Mekorot, Israel water service provider: an extra 28.6 MCM was to be allocated to Palestinian needs, of which 5 MCM to Gaza and 4.5 to Palestinian living in the West Bank, the rest is being destined to Israeli settlers in the West Bank.
- Estimated "future needs" for the Palestinian West Bank at 70-80 MCM.

[10] National Water Policy and Strategy, 2013.
[11] Idem.
[12] Palestinian Central Bureau of Statistics, Annual report 2014.
[13] CIA Factbook website: <www.cia.gov/library/publications/resources/the-world-factbook/>.
[14] World Bank, 2007.

Under the Oslo II Accords, which stipulated that full Palestinian independence and an end to occupation by Israel would come by 1999, Palestinian water rights and use were considered but remained unfulfilled. Water use and rights were discussed under Oslo II Accords but reached a non-comprehensive and inequitable arrangement whose terms are set under Article 40 (Box 1.1). Given the growing demand on water resources and the deterioration of its quality, shared water resources between Israel and the PA is characterized by decisions to be reached under Article 40 between the two parties with unequal powers leading to asymmetrical overexploitation favoring Israel as water abstraction exceeds the water replenishment balance which could further exacerbate tensions in the future.[15]

C. Water Resources Overview

The water resources available to the Palestinians include springs, major groundwater, and harvested rainwater. About sixteen streams are shared between Israel and Palestine,[16] of which approximately two thirds originate on the Palestinian territory, flowing through Israel and partly discharging into the Mediterranean Sea to the west. The Jordan River is used by Jordanians and Israelis, and Palestinians in the West Bank are banned from using it. Therefore, Palestinians do not have access to their transboundary water resources from the Jordan River as well as the water resources as agreed upon under the Oslo I and II Accords, as Israel control most of them including the groundwater aquifers. Their share of the water is totally inequitable and unreasonable. As a result, the Palestinians have the lowest annual water resources availability in the Middle East and North Africa with 75 m^3 per capita in the West Bank and 125 m^3 per capita in Gaza.[17] In the PCBS household survey of 2015, the water consumption is 50 liter per capita per day (lcd) and 73 lcd in the West Bank and Gaza respectively.[18]

TABLE 1.1: WATER SUPPLY AND NEEDS FOR THE PALESTINIANS

Sectors	Water needs by Palestinians (2010) MCM	Water supplied from wells and springs (2008) MCM
Agriculture	489.9	118.2
Municipal	184.1	132.7
Industry	29.5	-
Total	712.5	250.9
Mekorot (Israel water utility)		52.8
New Total	**712.5**	**303.7**

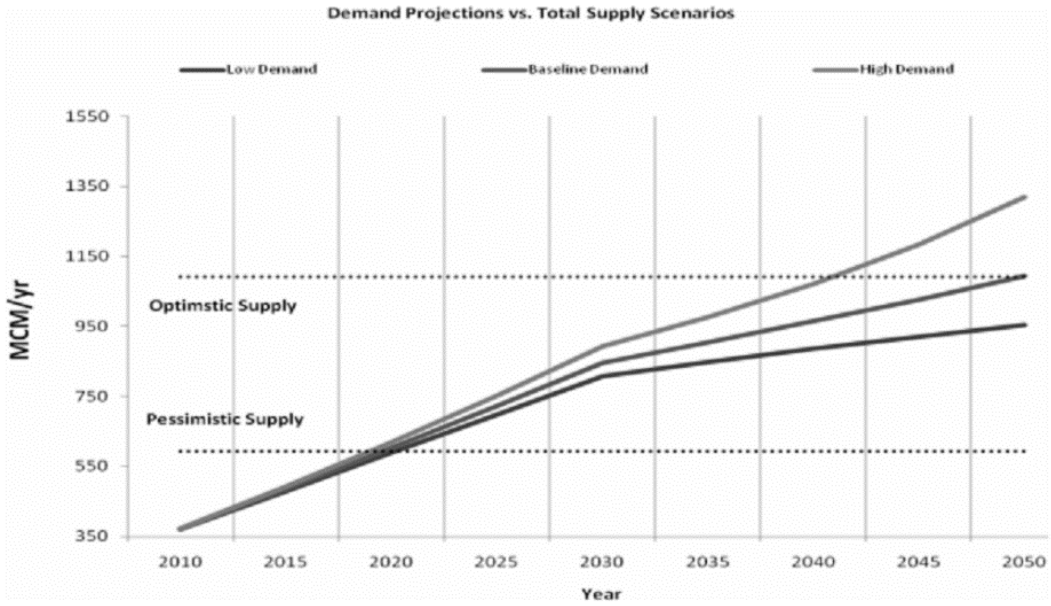
Source: The economic costs of the Israeli occupation for Palestine, Ministry of the National Economy Applied Research Institute-Jerusalem September 2011.

Table 1.1 shows the water needs for West Bank and Gaza which was estimated at 826 MCM in 2014. This demand from water is almost three times the amount supplied from wells and springs controlled by the Israelis which was estimated for the municipal and agriculture sectors in the amount of 250.9 MCM. These volumes are totally insufficient and the Palestinians have no other alternatives than to purchase water in excess of 52.8 MCM from the Israel national water authority, Mekorot which was assigned by the Israeli army to control the water infrastructure. By including the water purchase, the water supply is 42.6 percent of the water demand from the Palestinians.

[15] GWP-Med, 2014.
[16] GWP-Med, 2014.
[17] The World Bank Report No 47657-GZ, Assessment of Restrictions on Palestinian Water Sector Development, April 2009.
[18] PCBS 2015 household survey.

The demand projection versus the supply services were estimated by Glover and Hunter[19] using three scenarios of low, baseline and high demand against pessimistic and optimistic supply by the Israelis authorities. These figures are not definite and are less accurate given the very troubling local and regional, and water political context which is extremely complex and unpredictable. Nevertheless, this figure shows clearly that in about 2017, the demand under any of these three scenarios will exceed the supply and that using the baseline scenario, the water supply will need to increase on average by 3.38 percent in order to meet the projected demand. Furthermore, as stated in the study, the water resources allocated to the municipal sector will far exceed the water resources allocated to the agricultural sector. The water supply increase was underestimated as the water deficit quoted by PCBS is 473.9 MCM in 2014.

Figure 1.2: The projections of water demand and supply in Palestine



Source: Steven Glover and Andrew Hunter. 2010. Meeting future Palestinian water needs.

[19] Steven Glover and Andrew Hunter. 2010. Meeting future Palestinian water needs.

II. OBJECTIVE OF THE STUDY

The main objective is to value the cost assessment of water resource degradation (CAWRD) in West Bank and Gaza to assist decision-makers at national and local levels to identify and prioritize specific actions to improve the management of the water sector under the current restrictions of the Israeli occupation of the West Bank and the Israeli blockade of the Gaza Strip leading to the full control by Israel of the Palestinian water resources.

The present study consists of:

a) An overview of the water right and water use as well the assessment of the legal and institutional frameworks of the water sector in the West Bank and Gaza; and

b) An assessment of the cost of the environmental degradation to encompass environmental health and ecological degradations.

The CAWRD can be understood as a measure of the lost welfare of a nation due to water resources degradation. For the purpose of this report, a loss in welfare includes but is not necessarily limited to:

- Loss of healthy life and well-being of the population (e.g., burden of disease);
- Economic losses (e.g., efficiency losses, competitiveness, forgone revenues)

The CAWRD can be understood as a measure of the lost welfare of a nation due to water resources degradation. For the purpose of this study, a loss in welfare includes but is not necessarily limited to:

- Loss of healthy life and well-being of the population (e.g., burden of disease); and
- Economic losses (e.g., efficiency losses, competitiveness, forgone revenues).

III. PALESTINE WATER RESOURCES

A. Overall Water Resources Assessment

Palestine Water resources are difficult to assess due to the overlaps of the surface and underground between Israel, the West Bank and Gaza as well as other riparian countries. The West Bank and Gaza water and fishing rights, and water use are bound by hydro-strategic concerns due to the unresolved regional conflict: the Jordan River shared by Lebanon, Syria, Jordan, Israel and Palestine; the Dead Sea shared between Palestine, Jordan and Israel, and recharged by the Lower Jordan River and a number of non-perennial rivers; a number of interconnected aquifers shared with Palestine, Israel and Egypt and recharged by rainfall; the Hebron-Besor watershed; and the Mediterranean Sea with Gaza's coast stretching northward to Israel and southward to Egypt's Sinai (Figure 3.1).

B. The West Bank Water Resources

With an estimated annual renewable capacity of about 679 million cubic meters (MCM), the West Bank, groundwater[20] is currently the main source of water derived from the *Mountain Aquifer*, which consists of the following three aquifers: the Northeastern, Eastern and Western aquifers. These aquifers are recharged mostly from snow melt and rain fall from the Palestinian Side of the Green Line.[21] This volume is in addition to wadis and runoff water with an estimated annual volume of 215 MCM (Figure 3.1). More specifically, the West Bank water resources are as follows.

1. West Bank Water Resources Available

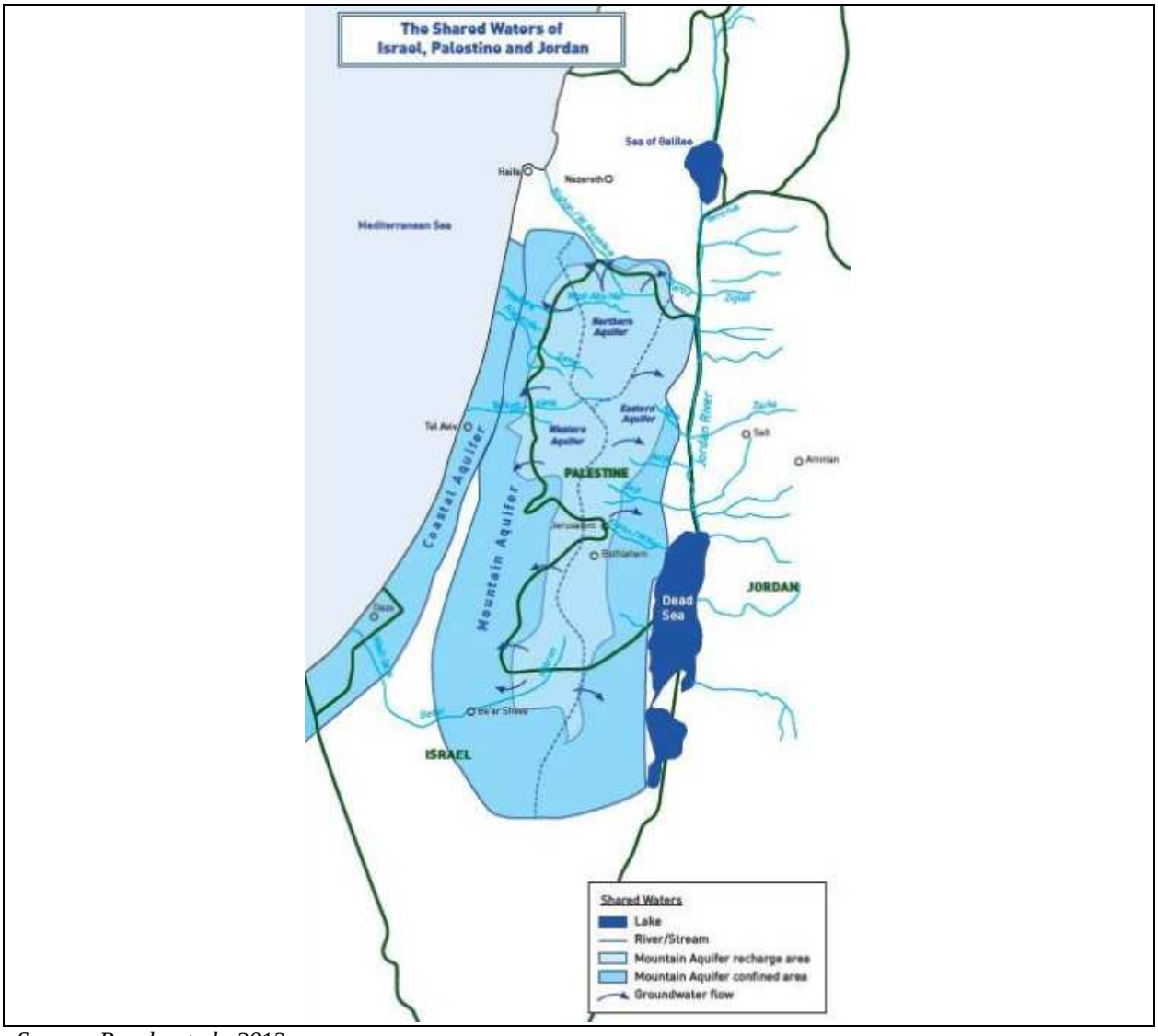
Mountain Aquifer Basin shared between Palestine (West Bank) and Israel. The Mountain Aquifer Basin includes the **recharge area** including the Northeastern, the Eastern and Western aquifers mainly overlapping with the West Bank territories and the **storage area** that is mainly located in Israel proper (Figure 3.1). The Mountain Aquifer Basin lies in a semi-arid climate, has an area ranging from 9,000 to 14,167 km^2 depending on the studies with the hydrologically most active area.[22] The Mountain Aquifer Basin is recharged from precipitation from October-March ranging between 550 to 700 mm on average and snowmelt. The recharge and water quality of the 3 aquifers is as follows (Figure 3.1):[23]

- The **North-eastern Aquifer** estimated recharge range between 130 to 200 MCM (of which 70 MCM are brackish) depending on precipitation and other meteorological factors. The aquifer is 80 percent and is within the Palestinian territories and almost 100 percent of its water comes from precipitation falling within the West Bank area, but then flows underground in a northerly direction towards the Tiberias basin and drains into the Bisan (Bet She'an) and Jezreel valley, and towards the Lower Jordan River to the northeast and east. The water has natural high salt content.[24]
- The **Eastern Aquifer** estimated recharge range between 155 to 237 MCM (of which 70-80 MCM are brackish) depending on precipitation and other meteorological factors, drains to the Lower Jordan River and the Dead Sea. This aquifer, which is mainly brakish, lies entirely within the West

[20] Environment Quality Authority.2010. Environment Sector Strategy.
[21] World Bank. 2009. "Assessment of Restrictions on Palestinian Water Sector Development," Sector Note.
[22] GWP-Med, 2014.
[23] World Bank, 2009.
[24] World Bank, 2009.

Bank with no inflows or outflows to or from Israel, and is mainly drained by springs and contains saline water. Nevertheless, it is being pumped nearly dry by Israeli settlers living in the West Bank every year.[25]

Figure 3.1: West Bank and Gaza Transboundary Water Resources



Source: Brooks et al., 2013.

- The **Western Aquifer** is the largest aquifer and its estimated recharge range between 335 to 450 MCM (of which 40 MCM are brackish) depending on precipitation and other meteorological factors. An additional 75 MCM needs to be included in the potential recharge but were not allocated under Article 40 of the Oslo II Accords. Limited agricultural development and water use in the West Bank

[25] EWASH website: <www.ewash.org/files/library/2%20Fact%20sheet-%20Water%20Resources%20In%20the%20West%20Bank.pdf>.

seldom contribute to the return flow. Still, water flow is transboundary from the West Bank hills to Israel coastal plains and 80 percent of the recharge area of this basin is within the West Bank, whereas 80 percent of the storage area is located within Israeli borders. Israelis pumps the aquifers of this basin by means of 300 deep groundwater wells to the west of the Green Line, as well as by deep wells within the West Bank boundary. The water is of very high quality where the groundwater salinity is below 250 mg/l (recommended maximum level of chloride in USA drinking water) in the West Bank but gradually increases westward in Israel to reach more than 1,000 mg/l due notably to salt intrusion from the Mediterranean when the Western Aquifer merges with the Coastal Aquifer (Figure 3.1). Israel exceeds the Oslo II Accords allocated shares by pumping on average 175 MCM in excess of the yearly sustainable yield.[26]

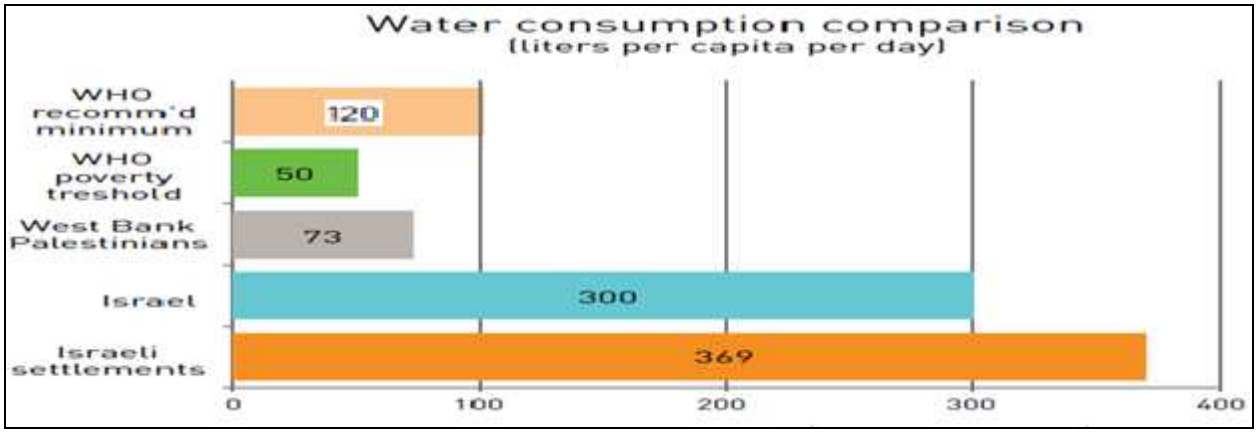
2. West Bank Water Demand and Consumption

Most of the West Bank's aquifers and spring water is located in Area C. Palestinians were not able to draw their agreed allocation of 138.5 MCM per annum,[27] and only 91.4 MCM was abstracted in 2008[28] which decreased further to 87 MCM during 2011. The estimated public demand for water is expected to increase from 105 MCM in 2012 to 146 MCM in 2017 to reach 219 MCM in 2022.[29] This sharp decrease in abstraction from the agreed allocation under the Oslo Accords resulted in the drying up of half the Palestinian wells over the last 20 years from 774 wells in 1967 to 325 in 2009. These restrictions on water availability limit Palestinian irrigation possibilities and thereby constrain potential agricultural production. Although no water quality database exists, individual studies and monitoring projects indicate severe contamination and water quality problems in all major aquifers.[30] Moreover, according to the Israeli Ministry of Environment, "the overexploitation of the Mountain aquifer may lead to a rapid rate of saline water infiltration from surrounding saline water source"[31] which will further exacerbate the complexity of water availability and use.

Furthermore the water quality is poor in various part of Palestine especially those communities that are not connected to the network and for habitants living in Area C. In these areas, incidence of water related diseases are high and prevalent, causing substantial costs and losses. The annual cost of the health impacts of poor water and sanitation on children under 5-year old, was estimated at US$ 20 million, equivalent to 0.37 percent of GDP.[32] ***On average,*** Palestinians in the West Bank consume 73 lcd compared to 300 lcd for Israelis in Israel and 369 lcd for Israeli settlers as shown in Figure 3.2. Still, the water consumption per capita varies according to different sources:[33] In accordance with the PCBS household survey of 2015 in Table 3.1 below, the domestic water use decreased to 50 lcd.

[26] World Bank, 2009.
[27] Palestinian Water Authority, 2012, National Water Strategy for Palestine.
[28] The economic costs of the Israeli occupation for Palestine, Ministry of the National Economy Applied Research Institute- Jerusalem September 2011.
[29] PCBS, 2014 State of Palestine Strategic Water Resources and Transmission Plan.
[30] UNDP and Sweden 2013, Water Governance in the Arab Region: Managing Scarcity and Securing the Future,
[31] <http://sviva.gov.il>
[32] World Bank, 2009. "Assessment of Restrictions on Palestinian Water Sector Development," Sector Note.
[33] Different consumption are mentioned in the report with its specific source.

Figure 3.2: Water Consumption Comparison



Source: GWP-Med, 2014.

At present, in accordance with household environmental survey conducted by PCBS in 2015, the following parameters on water, and wastewater access and solid waste generation are illustrated in Table 3.1.[34]

TABLE 3.1: HOUSEHOLD ENVIRONMENT SURVEY PARAMETERS IN THE WEST BANK

Item	Data
GDP in US$ million	5,742.5
Population in million	2.79
Agriculture percentage of GDP	3.5
Industry as percentage of GDP	23.9
Water supply for municipal sector in MCM	48.5
Percentage of households which live in houses which connect to the public water network	93.4
Monthly water consumption of the household sector in MCM	10.46
Monthly water consumption per household in m^3	18.3
Domestic water use in liter/capita/day	50
Unaccounted for water in percentage	60
Percentage of household that are connected to a wastewater network	38.4
Percentage of household that dispose of cesspits	61
Household daily generation of waste in Kg	3.2
Daily generation of municipal waste in tons	1,835

Source: PCBS, 2015; and UNDP and Sweden 2013, Water Governance in the Arab Region: Managing Scarcity and Securing the Future.

[34] PCBS, 2015, Household Environmental survey: Main findings (in Arabic) and PCBS report (2009) and (2014).

3. West Bank Sectoral Water Allocation

Agricultural Sector and Irrigation

Agriculture is an important traditional sector in the economy of the West Bank and consumes 43 MCM of water resources in 2008.[35] Although its added value is only 3.5 percent of the GDP, it is a source of employment for 12 percent of the labor force.[36] Due to the low quantities of water, 6.8 percent of the cultivated land is irrigated though half of the agricultural production is from irrigated land.[37] Nearly 63 percent of the agricultural land is in Area C in most in the Jordan valley, and Palestinians famers need special permits for construction and repair of infrastructure such as wells, water reservoirs and irrigation networks. These permits are rarely issued. Out of the total 611,000 dunums (1 dunum is 1,000 m^2),[38] only 247,000 are irrigated due to land closed affecting 60,000 dunums where 8,920 dunums of irrigated lands were destroyed for building the Separation Wall, and irrigated land became inaccessible because of the Separation Wall. Nevertheless, the agriculture sector continues to be an important source of income for the West Bank and the irrigation sector continues to be characterized by inadequate water storage capacity, lack of proper maintenance and a heavy reliance on the Israelis authorities to control and provide permits. The major crops in the West Bank are olives, citrus and stone fruits, grapes, vegetables, herbs, and wheat. Most farms are small: 50 percent are less than 2.5 acres. With the exception of wheat, all crops are harvested manually.[39] It is expected that 150 MCM will be needed in 2017 in order to satisfy the agricultural demands.[40] There are very few activities for wastewater reuse in agriculture but these are small community level a projects that are implemented such as Anza, Attil, Kharas.[41]

Industrial Sector

The industrial sector is also a consumer of water and is also a source of pollution. The industries are mostly small and medium scale and are complemented by handicraft. The sector consists of cement, quarrying, textiles, soap, olive-wood carvings, mother-of-pearl souvenirs and food processing. Stone cutting, which is the traditional source of income in the West Bank, consists of 650 outlets. The Palestinian cities of Bethlehem, Hebron and Nablus are known for specializing in handicraft, with the sale and export of such items forming a key part of each city's economy. Major exports includes olives, fruit, vegetables, limestone, citrus, flowers, and textiles.[42] It is expected that 29.5 MCM of water is needed to satisfy the industrial demand. In addition, many Israelis industries were transferred to the West Bank without Palestinian consent and causing also pollution. These include manufacturing of aluminum, cement, canned food, fiberglass, rubber, alcohol, ceramics, marble, cleaning chemicals, paints, metal formation and painting, batteries, pesticides and chemical fertilizers, gas industry, plastics, leather tanning, textile dyeing, military industries, and others.[43]

[35] The Economic Costs of the Israeli Occupation for the occupied Palestinian territory. 2011. Ministry of the National Economy. Applied Research Institute, Jerusalem.
[36] ANERA, Agriculture in the West Bank and Gaza.
[37] EWASH, 2013, Water for Agriculture in the West Bank.
[38] World Bank, 2009. "Assessment of Restrictions on Palestinian Water Sector Development," Sector Note.
[39] ANERA, Agriculture in the West Bank and Gaza.
[40] PWA, 2014 State of Palestine Water Resources and Transmission Plan.
[41] National Water Strategy 2013.
[42] Idem.
[43] Environment Quality Authority.

4. West Bank Pollution

The major sources of pollution in the West Bank consist of:

- Municipal and Industrial Wastewater
- Municipal, Industrial and Hazardous Waste
- Agricultural Runoff
- Pollution resulting from the Israeli settlements

Municipal and Industrial Wastewater

The disposal of untreated municipal and industrial wastewater in the West Bank[44] is considered one of the most critical pollution problems. Domestic wastewater is either collected by main sewerage networks or in cesspits. About 38.4 percent of the household are connected to the sewage network which is linked to a primary treatment plant in several cities in the West Bank such as Ramallah, Jenin, Tulkarm, etc. whereas the only full treatment plant is located in Al Bireh and Nablus Cities. Almost 61 percent of the household liquid waste is stored in cesspits which are unaligned. It percolates into the groundwater when it is not emptied with vacuum tankers that dump untreated sewage in open areas or wadis. The annual volume of wastewater discharged into the environment was estimated by PWA to be about 62.51 MCM[45]per year, in addition to the quantities discharged by Israeli settlements in the West Bank, which were estimated about 39 MCM per year,[46] due to the transfer of Israelis chemicals and plants which were transferred to the West Bank without Palestinian consent. Wastewater treatment plants needs to be upgraded because most of them are obsolete and not to desirable standards, exceed their capacity and have a limited coverage in the West Bank areas. Along the Hebron/Besor water stream monitoring site on the outskirts of Hebron showed Chemical Oxygen Demand levels of the order of 1,210 mg/liter and total suspended solids of 260 mg/liter,[47] far exceeding the discharge standards in the streams. Nitrate concentrations in some domestic wells have also reached 40 milligram per liter.

In addition, 59 percent of the factories discharge their industrial wastewater into the sewage network, adversely affecting these networks by the chemicals found in the effluents. Also, 29.9 percent of factories dispose of their wastewater in cesspits, increasing the risk of groundwater pollution. Hazardous wastewater from health institutions are also discharged untreated to the sewage network.[48] Another source of pollution is the chemicals and hazardous materials and industries which were transferred by Israel to the West Bank without Palestinian consent.[49]

Municipal, Industrial and Hazardous Waste

The Municipal, industrial and medical solid waste are also a major source of pollution. Industrial, municipal and hazardous wastes are mixed with wastes and thrown in open dump sites or in controlled dumpsites in which the leachate containing heavy metals, organic and hazardous chemicals could either percolate the soil and the groundwater and be discharged in the water streams. The number of dump sites in the West Bank and Gaza was

[44] ESCHR, 2014 Environment, Social and Cultural Heritage Assessment report to support additional financing for the Hebron Wastewater Management Project.
[45] PWA , 2014
[46] Environment Quality Authority, Environment Strategy note, 2010
[47] GWP-Med, 2014.
[48] Environment Quality Authority, 2010 Environment Sector Strategy.
[49] Idem.

estimated at 147. Sanitary landfill was constructed in Jenin and Tubas governorates named Zahret Al Finjan sanitary landfill which was constructed and operated in 2007. The same was done in Hebron and Bethlehem governorates where a new sanitary landfill was constructed and operated in 2013 named Mina sanitary landfill. It is worth mentioning that about 22 percent of the solid waste in Palestine is being disposed in sanitary landfills namely Zahret Al Finjan in Jenin, Mina sanitary landfill in Hebron and Bethlehem, Dir El-Balah in Gaza Strip, and Jericho landfill in Jericho Governorate. Industrial waste represents approximately 15-20 percent from the total produced waste. Part of that waste is considered to be hazardous waste. The latest estimates of the hazardous wastes were about 62,621 ton/year in the West Bank and Gaza. Industrial waste is being collected transported and disposed of and mixed other kind of wastes in the dumpsites, as there is no separation at source or special handling for such waste. Similarly, there is no proper handling of industrial hazardous waste,[50] no separation or sorting, no proper treatment, and no proper disposal.

The generation of the medical waste in the West Bank and Gaza was estimated at about 1,202 tons/month, which is estimated at 14,424 tons/year,[51] resulting from the health care facilities and units both in the West Bank and Gaza. About 77 percent of the health centers disposes their medical waste in dump sites and 19 percent disposes in special dumps belonging to health centers. The rest is either disposed randomly in dumps, released in the sewer network or burnt.

Agricultural Runoff

Agricultural runoff is also an important source of pollution due to primarily the overuse of fertilizers and pesticides. Agricultural runoffs do not only pollute the surface water but also percolate into the ground water, reducing agricultural productivity. The land in Palestine was estimated to be at least 20 percent less productive due to the use of inappropriate fertilizers by Palestinian farmers following the Israeli banning of certain fertilizers. Most of the agricultural practices are neither regulated nor monitored and the famers do not receive technical support as to the proper use of the pesticides and fertilizers. Overuse of fertilizers, poor water quality and quantity needed for agricultural uses, and emerging zoonotic diseases are affecting water resources. Collectively, they are negatively affecting the environment in terms of biodiversity, soil pollution or salinity, land uses, desertification and groundwater contamination.[52]

Pollution from the Israelis Settlements

Jewish settlers are adding also pressure on the environment as solid and liquid waste are discharged without any treatment.[53,54] There are approximately 160 Israeli owed installations in the West Bank. The problems is exacerbated by the fact that the settlements are located on hills above pre-existing Palestinian towns. Many of these installations have taken advantage of the relaxed and poorly enforced environmental regulations to discharge their waste water and municipal waste untreated posing a threat to ground water quality in the region. Factories using wet process in food manufacturing, metal coating and textiles poses a serious environmental

[50] Industrial Hazardous Waste Management in occupied Palestinian territory- Case Study: Ramallah Industrial Zone. Samhan Z., AbuShanab Y., Abu-Rmeileh NME., Musleh R. 2008.
[51] Environmental Survey for Health Care Centers, Palestinian Central Bureau of Statistics, 2009.
[52] Environment Quality Authority, 2010, Environment Sector Strategy.
[53] Applied Research Institute (ARIJ) 1995, and the Monde Diplomatique (the socio economic impact of settlements on Land, Water and the Palestinian Economy), 1998.
[54] Juan Cole : Informed comments 2015: <www.juancole.com>.

risks So far no study was undertaken to assess the overall economic and environmental effects that these settlements have on the Palestinians.

C. The Gaza Strip Water Resources

The unique fresh water resource of Gaza (Figure 3.1) is the coastal aquifer, which also runs beneath the coast of Israel and Egypt. Contrary to the aquifers in the West Bank, the coastal aquifer under Gaza flows downstream from the portion of the aquifer in Israel which flow upstream. This means that the water in the aquifer flows from Israel upstream to Gaza downstream and therefore has no effect on the water quality of the Israeli side. On the other hand, Israel has installed upstream numerous deep wells along the Gaza border and extracts much of the groundwater before it can reach Gaza.[23, 24] The Palestinians are also not allowed to transport water from the West Bank to Gaza. Under normal flows, the current yield under the aquifer segment of Gaza is estimated at about 57 MCM, around 15 percent of the total yield of the shared aquifer, which is estimated at 360-420 MCM. More specifically, the Gaza water resources include the following.

1. Gaza Water Resources Available

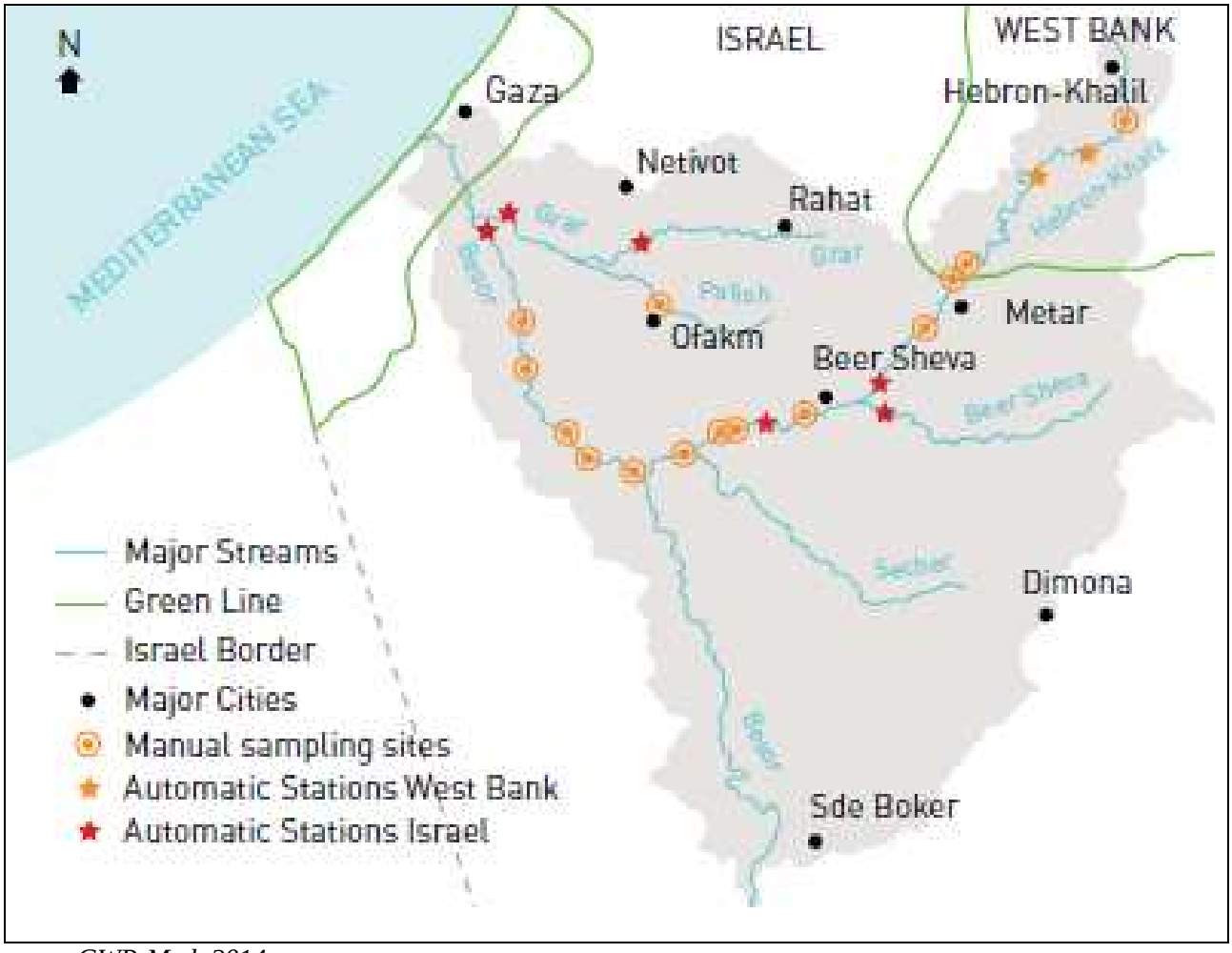
The Hebron-Besor watershed (3,500 Km^2) **shared between Palestine and Israel.** The Hebron-Besor is a non-perennial river and has a main affluent originating in the West Bank that flows into Gaza. The Hebron-Besor has one small dam, the Yeruham Dam on a tributary of the HaBesor (Figure 3.2) and other diversion schemes built by Israel. The Hebron-Besor, which is dry most of the year, is responsible for flash floods during the raining season and that has its source in the southern West Bank where about 5 MCM of untreated municipal, industrial and agricultural effluents are released into the stream. Stone-cutting, leather tanning and olive-oil industries are the major polluters leading to parameters significantly exceeding international watercourse standards such as sodium, Chemical Oxygen Demand (used to measure the organic compounds in water), Total Suspended Solids and fluorine. The watercourse then runs through the Negev desert and Gaza before reaching the Mediterranean. Also, flash floods have been occurring over the years with increased damages in Gaza.[55] The 2013 Storm Alexa produced an exceptionally devastating flash flood following 4 days of torrential rain where large swathes of northern Gaza were under water for few days.

The Coastal Aquifer Basin shared between Palestine (2 percent of total aquifer area), Israel (27 percent) and Egypt (71 percent). The Western Aquifer Basin has an area of 18,370 km^2. The Wadi Gaza Basin that is part of the Gaza aquifer recharges inland with very irregular flow patterns and discharges towards Gaza's eastern Mediterranean coast and the Sinai. Gaza benefits from an average precipitation ranging between 200 to 400 mm. The average annual recharge of the Coastal Aquifer Basin varies from 360 to 420 MCM and include return flows from agricultural runoff and wastewater (40 to 55 MCM). Gaza depends on this strategic water resource that is highly polluted and affected by high levels of salinity due to over-abstraction leading to drawdown, salt intrusion and lateral inflow of saline groundwater and seawater. Only 10 percent of the aquifer that is below Gaza is considered fresh water. About 1.6 million Palestinians live in Gaza and Palestine abstraction amounts to an annual average of 165 MCM (135-180 MCM) against 440 MCM for Israel and 75 MCM for Egypt. Currently, there are 2,700 unlicensed by registered wells and 2,000 unlicensed and unregistered well in Gaza, mainly for agricultural purposes that covers 11,000 ha of which 7,524 are cultivated. The water table is dropping by 1 m per

[55] GWP-Med, 2014; and UN-ESCWA and BGR, 2013.

year. Under the Oslo II Accords, Israel's Mekerot is transferring 4-5 MCM per year for drinking purposes. As for the sewage, wastewater is mainly untreated and released in wastewater lagoons, wadis, cesspits or into the sea. Agricultural fertilizer runoff and leachates from solid waste dumps contribute to the contamination of ground water. As a result, 90 percent of the Gaza underground water is unfit for domestic use when international standards are considered: chlorides range between 500 and 3,000 mg/l and are much higher than WHO 250 mg/l standards for drinking water; nitrates range between 100 and 800 mg/l and are much higher than WHO 50 mg/l standards for drinking water; and TDS can reach up to 5,000 mg/l.[56]

Figure 3.2: The Hebron-Besor Watershed



Source: GWP-Med, 2014.

Gaza Coast. Gaza stretches over 41 km and most of the wastewater is untreated and most of it is released into the Mediterranean if it is not released into cesspools. Moreover, leachate from dumpsites pollute both underground water and sea water. Sea fishing activity is banned and the only fishing activities are carried out along the coast.

[56] GWP-Med, 2014; and UN-ESCWA and BGR, 2013.

2. Gaza Water Demand and Consumption

Gaza has a water crisis and faces very serious challenges concerning the future access to its water resources. About 89 percent of ground water is facing excessive abstraction for up to 200 MCM per year. The excess of the annual recharge of the reservoir ranges between 55-60 MCM per year by about four times. The Gaza Strip is among the territories that have the scarcest renewable water resources with average water consumption in 2015 to be 73 lcd.[57] This is far below the water resources consumption of 100 lcd available in other countries in the Middle East and in the world, constraining therefore economic development, and creating negative health impacts. Still, the water consumption per capita varies according to different sources.[58]

The groundwater is being pumped through more than 4,600 wells all over the Gaza Strip and water is available for only a few hours a day. More than half of the available groundwater is used for irrigation (52 percent),[59] while the remaining is used for domestic water supply and industry. Due to the increasing extraction of underground reservoir, the aquifer is threatened to become totally unusable by about 2016.[60] If the current rates of extraction from the aquifer continues without considering different alternatives, it will become impossible to restore it by 2020.

Since Gaza could not completely supply itself with water, consumption is covered through the purchase of water from Mekorot in the amount of 4.8 MCM as well as from large and local small scale desalination plants from sea water and brakish water.[61] There is only one sea water desalination plant located in the middle area of Gaza Strip (Deir El Balah) with a capacity of 600 m^3/day (0.22 MCM/year)[62] and was expected to be expanded to about 2,600 m^3 per day (0.95 MCM/year) by the year 2014. Also, four public desalination plants using brackish water are run by the Coastal Municipalities Water Utility (CMWU) and produce 1,000 m^3/day[63] or about 0.37 MCM per year. There are at least 40 private desalination plants, which provide both wholesale water by tanker and water retail by jerry can, could produce about 2,000 m^3 per day.[64] Also, it is estimated that more than 20,000 private home desalination plants operate by using brackish water from wells. Now, most of the population can depend on brackish water desalination for drinking.[65] With no-revenue water reaching 32 percent in Gaza (2003), the total water supplied for domestic and drinking use is 103.34 MCM/year with the following breakdown:

- 94.1 MCM from municipal groundwater wells.
- 2.44 MCM from UN groundwater wells.
- 2.8 MCM from private groundwater desalination vendors resulting from 4.80 MCM abstracted from the aquifer.

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[57] PCBS 2015, household survey
[58] Different consumption are mentioned in the report with its specific source.
[59] Idem.
[60] PWA, 2014, Fact Sheet in Gaza (in Arabic).
61 The Economic Costs of the Israeli Occupation for the occupied Palestinian territory. 2011. Ministry of the National Economy Applied Research Institute, Jerusalem.
[62] National Water Policy and Strategy, 2013.
[63] Source: PWA and CMWU databases.
[64] PWA Gaza commented: "About 20 of these plants are licensed by PWA although there is no capacity to monitor the distribution system of such small scale plants. Hundreds of trucks are transporting and distributing this desalinated water and thousands of small tanks exist at the small shops and supermarkets. Importantly, this water lacks the basic minerals since the majority of minerals are removed by the reverse osmosis process. Unfortunately, this approach of reducing minerals became the competitive criterion among the private sector desalination plants."
[65] See also Gaza Private Water Supply Case Study, Annex 11.

3. Gaza Sectoral Water Allocation

In 2014, the proportion of water consumption for agricultural purposes exceeded 48 percent of the amount of ground water or more than 95 MCM including the livestock (92.7 for agriculture and 2.64 for livestock (according to MoA). There is an annual increase in the agricultural water consumption of about 9.5 percent compared to 2012.

With the increase of Gaza population estimated to reach 2.1 million in 2020, the amount of water needs was estimated to reach 250 MCM.[66] A study carried out at the request of the PWA by an international consulting firm (Phillips Robinson & Associates)[67] concluded that the Gaza Coastal Aquifer will no long be more productive and new water resources need to be found. A new regional sea water desalination plant is planned to be constructed in the central part of Gaza that will also serve its southern part. The first phase with a capacity of 50 MCM was planned to be constructed in 2017 with a possibility of enlargement to a capacity of 129 MCM/year by 2035.[68] This project is to be financed from international financing institutions. Feasibility studies as well as environment and social impact studies were carried out however co-financing of the plant is still being worked out.

TABLE 3.2: HOUSEHOLD ENVIRONMENT SURVEY PARAMETERS IN GAZA STRIP

Item	Data
GDP in US$ million	1,706.5
Population in million	1.76
Agriculture percentage of GDP	4.7
Industry as percentage of GDP	13.7
Water supply for municipal sector in MCM	84.2
Percentage of households which live in houses which connect to the public water network	93
Monthly water consumption of the household sector in MCM	5.86
Monthly water consumption per household in m^3	19.7
Domestic water use in liter/capita/day	73
Percentage of household that are connected to a wastewater network	83.5
Percentage of household that dispose of cesspits	16.5
Household daily generation of waste in kg	2.4
Daily generation of municipal waste in tons	716

Source: PCBS, 2015; and UNDP and Sweden 2013, Water Governance in the Arab Region: Managing Scarcity and Securing the Future.

There are also small demonstration activities of wastewater reuse as scattered pilot projects with total reuse quantities of around 1 MCM/year, however, standards of wastewater reuse need to be ascertained.[69] At present, in accordance with household environmental survey conducted by PCBS in 2015, the following parameters[70] on water, and wastewater access and solid waste generation are illustrated in Table 3.2.

Agricultural Sector and Irrigation

[66] PWA, 2014, Fact Sheet in Gaza (in Arabic).
[67] PWA / CMWU, Environmental and Social Impact Assessment (ESIA) & Environmental and Social Management Plan (ESMP) for Gaza Water Supply and Sewage Systems Improvement Project (WSSSIP**).**
[68] National Water Policy and Strategy, 2013.
[69] Idem.
[70] PCBS, 2015, Household Environmental survey: Main findings (in Arabic) and PCBS report (2009) and (2014).

Although Gaza is urbanized, it has an active and potentially profitable irrigated agriculture sector. The major crops are citrus, strawberries, olives and vegetables. Halal beef and dairy products are also processed in Gaza. Primary exports are citrus, and flowers, and primary imports are food, consumer goods and construction materials. Irrigation is efficient in Gaza and the amount of water use is about 400-500 m^3/dunum. Protected agriculture with green houses is used.[71] Agriculture activities shrank since 2000 due to military activities which uprooted lands and established buffer zones and border lands: in accordance with the Ministry of Agriculture, the total irrigated areas decreased from 167,016 dunums in 2002/2003 to 157,000 dunums in 2007/2008 with a corresponding water demand of 75 MCM. The labor force employed by farming dropped from 12.7 percent in 2007 to 7.1 percent in 2009.[72] Table 3.3 shows the irrigated areas and water demands. Since the closure of Gaza in 2007, agricultural product that was exported to Israel was reduced to zero from 22,318 tons in the two years before the closing. About 574 tons are now exported to the West Bank compared to 6,466 tons in the two years before the closure and only 2,053 tons was exported abroad compared to 12,531 in the two years before the closure.[73]

TABLE 3.3: CULTIVATED AREAS AND WATER DEMAND IN GAZA STRIP

Hydrological Year	Total Cultivated Area (Dunums)	Total Estimated Agricultural Water Demand (MCM)
2002/2003	167,016	79.5
2003/2004	158,055	77.5
2004/2005	154,000	73.5
2005/2006	167,861	80.0
2006/2007	175,755	85.5
2007/2008	156,945	74.0

Source: Ministry of Agriculture records, 2002-2008.

Industrial Sector

Industrial sites are localized primarily in northern and center of Gaza. Industries are small and medium scale family businesses and include textiles, fishing, soap, olive wood carvings, wood furniture, mother of pearl souvenirs, leather products and information communication technology. Many of these products are for the local market and were exported to the West Bank. The fishing industry of which 30,000 people depend is almost blocked.[74] Also due to the blockade, the number of workers in the following industries were substantially reduced,[75] as shown in Table 3.4.

TABLE 3.4: LOSS OF EMPLOYMENT IN GAZA STRIP

Industry	Before closure in 2007	After closure	Reduction
Food Processing	1,672	570	66%
Furniture	289	49	83%
Textile	390	55	86%

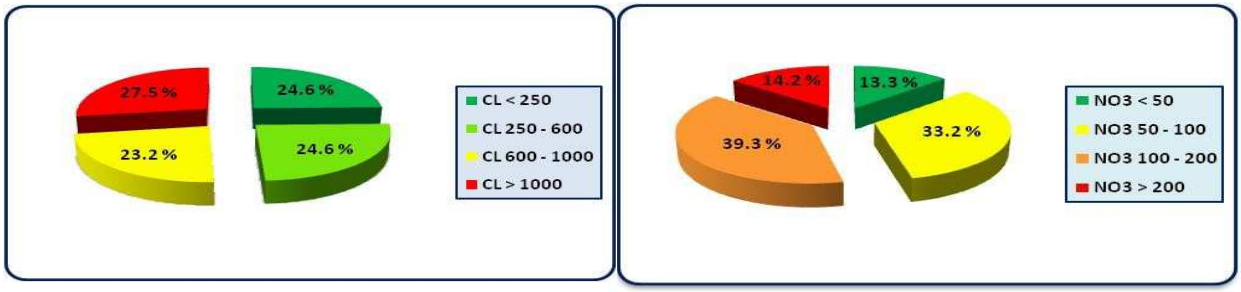
Source: GISHA website: <www.gisha.org>.

[71] World Bank, 2009. "Assessment of Restrictions on Palestinian Water Sector Development," Sector Note
[72] ANERA, Agriculture in the West Bank and Gaza
[73] Leaders of the Gaza's strip manufacturing industries: gisha.org/User files/File/publications/made_in_gaza_en.pdf
[74] https/electronicintifada.net/content/gaza-fishing industry, 2007.
[75] Leaders of the Gaza's strip manufacturing industries: <gisha.org/User files/File/publications/made_in_gaza_en.pdf>.

Groundwater Quality

The over abstraction of the groundwater aquifer has led to the deterioration of water quality and sea water intrusion with very high concentration of nitrates and chlorides (Figure 3.3). These salts are difficult to extract and remove from drinkable water. Only 5-10 percent of the aquifer now meets drinking water quality source standards by WHO. Poor water quality is also related to transboundary and local pollution from wastewater seepage and infiltration of agricultural fertilizers. [76, 77]

Figure 3.3: Chlorine and Nitrate Ions Concentration



The monitoring of ground water quality of selected municipal and agricultural wells are illustrated in Figure 3.3. The chloride ion concentration, which is used as a reflection of water salinity that can be tasted when drinking, varies from less than 250 mg/l in the sand dune areas to about more than 10,000 mg/l in the northern and south-western area of Gaza where the seawater intrusion has occurred. The major parts of the aquifer have a Cl concentration ranging between 600-2,000 mg/l, while along the coastal line, Cl concentration exceeds 2,000 mg/l and can reach more than 10,000 mg/l at some spots due to seawater intrusion. The nitrate ion concentration shows also a very high range in different areas of the Gaza Strip, while the WHO standard recommended nitrate concentration less than 50 mg/l. Nitrate causes methemoglobinemia (blue baby syndrome), a cause of death or developmental disability (Annex I).

The source of the nitrate is due to intensive use of agricultural pesticides in addition to the existence of septic tanks to dispose the domestic wastewater in the areas where there is no wastewater collection system. On the basis of these measurements, 3 percent of the domestic water meets the WHO standard, while 96.2 percent is far from the limits.

Major Source of Pollution

The major sources of pollution in the Gaza Strip consist of:

- Municipal and Industrial Wastewater
- Municipal, Industrial and Hazardous Waste
- Agricultural runoff
- Sea Water Intrusion Pollution caused by the wars on the Gaza Strip.

[76] United Nations Relief and Works Agency (UNRWA) in Gaza.
[77] PWA and Austrian Development Agency.

Municipal and Industrial Wastewater

Wadi Gaza is obstructed with sewage. About 35 MCM untreated or partly untreated wastewater are discharged yearly into 16 outfalls going the sea in addition to 12 MCM of untreated wastewater and partly wastewater percolate into the groundwater, and the wadis. About 83.5 percent of the population have access to sewage networks while 16.5 percent are using septic tanks.[78] Four wastewater treatment plants are functioning intermittently and a partially treated sewage overflowed its banks killing 6 people from Beit Lahya in 2007. Untreated wastewater is presenting very serious health risks: bacteria of fecal coliform are clustered around the sea outfalls, the coastal line are contaminated and the fishes infected.[79]

The municipal brackish water desalination plants, where about 40 percent is rejected as brine, is resulting in increased loading on the Coastal Aquifer which is against PWA regulations and strategies.

The major sources of industrial hazardous waste are: (a) oil, grease and acids from batteries and from mechanical workshops; (b) fuels, chemicals and from the textile industries; (c) bleaching, chemicals, dyes and glues from the paper factories; and (d) chemicals and printer toners from print and photography shops. Other industries producing hazardous waste include construction materials, woodwork, plastics, leather tanning, metalwork, and food processing. As in the West Bank, industrial wastewater are discharged untreated either into the network or in wadis.

Municipal, Industrial and Hazardous Waste

In 2011, Gaza generated 1,500 tons of solid waste per day or 550,000 tons per year. With the expected population of 2.08 million expected by 2020, waste generation is expected to reach 2,100 tons of per day. As with other public services, solid waste management is under extreme duress in Gaza. Waste is disposed in seven dump sites that are overflowing and three legally designated landfills that have reached maximum capacity: Johr Al-Deek in the north, Deir El-Balah in the middle area, and Al-Fukhari (Sofa) in the south,[80] operated by Rafah municipality. Of the three, the landfill in Deir El-Balah built in 1995 (with German assistance) is considered a sanitary landfill. A new sanitary landfill and associated transfer stations is being built with World Bank assistance to serve a population of 860,000 residents in the middle and southern Gaza.[81] Lack of disposal of municipal waste is a serious risk of environmental hazard for the waste pickers and for the communities living around the dump sites and landfills. As for the case in the West Bank, industrial waste is not separated from municipal waste and therefore there is no proper handling of industrial hazardous waste,[82] no separation or sorting, no proper treatment, and no proper disposal. A trial was conducted to dispose of the medical waste by establishing a special storage cell in the Gaza city dumpsite in 1998 with EU financing.

[78] PCBS, 2015, Household Environmental survey: Main findings (in Arabic)
[79] World Bank, 2009. "Assessment of Restrictions on Palestinian Water Sector Development," Sector Note.
[80] Gaza municipality operates Johr Al-Deek, the Deir El-Balah is managed by its Joint Services Council and the Rafah municipality manages Al-Fukhari (Sofa) in the south.
[81] The World Bank, 2014, Gaza Solid Waste Management Project.
[82] Industrial Hazardous Waste Management in occupied Palestinian territory- Case Study: Ramallah Industrial Zone. Samhan Z., AbuShanab Y., Abu-Rmeileh NME., Musleh R. 2008.

Agricultural Runoff

Chemicals are being used to produce fertilizers and pesticides in Gaza. These fertilizers and pesticides also percolate into the groundwater.[83]

Sea Water Intrusion

Groundwater quality in the Gaza Strip is being deteriorated as a result of sea water intrusion into the aquifer due to the lowering of fresh water level in relation to excessive groundwater abstraction.[84] Agricultural activities has been associated with uncontrolled use of pesticides, and the pumping locations near the shore line also deepens the problem of sea water intrusion.[85] As stated in para 41 above, the chloride ion concentration reaches about more than 10,000 mg/l in the northern and south-western area of Gaza where the seawater intrusion has occurred. The major parts of the aquifer along the coastal line, have a Cl concentration exceeds 2,000 mg/l and can reach more than 10,000 mg/l at some spots due to seawater intrusion.

Pollution Caused by the Wars on the Gaza Strip

The Israeli war in 2008-2009 and 2014 had a serious environmental repercussions on water, air, and soil pollution resulting from the use of internationally prescribed weapons.[86] In the norther area of the Gaza Strip where the aggression was more concentrated on wells water systems and waste water treatment plans were destroyed. It is estimated that the direct damage to the water sector was about US$ 6.0 million. About 20,000 cubic meters of wastewater leaked into the aquifer as well as 3,000 liters of diesel fuel. In addition about half a million cubic meter were sipped as result of the damage of the water filtration basins.

[83] World Bank, 2009. "Assessment of Restrictions on Palestinian Water Sector Development," Sector Note.
[84] Qhman K and Zhou Y, 2011 Monitoring sea water intrusion in the Gaza Strip ; First International conference on Sea water Intrusion and Coastal Aquifers, Essaouira, Morocco
[85] Saleh abdelhaleem , 2007, M.Sc thesis on impact of pumping on saltwater intrusion in Gaza Coastal Aquifer , Palestine
[86] Ramhi, S, 2013, the health risks posed by water pollution in the Gaza Strip , Middle East Monitor

IV. THE WATER SECTOR POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

A. The Policy Framework

The Palestinian Authority has prepared very comprehensive documents related to the policies strategies and sector plan in the water sector. These can be summarized as follows:

The National Water Policy and Strategy of 2013

The National Water and Wastewater Strategy for Palestine – Toward Building a Palestinian State from Water Perspective – by Palestinian Water Authority (July 2013) was prepared by the Palestinian Water Authority (PWA).[87] The document provides " the planning and management framework necessary for the protection, conservation, sustainable management and development of water resources and for the improvement and sustainable management and provision of water supply and wastewater services and related standards in Palestine. The policy and the strategy aim to:

1. Reinforce the Palestinian Authority's approach to sustainable water resources management by ensuring that all arms of government work together in the pursuit of shared water resources management goals;
2. Establish a framework for the coordinated development, regulation and financial sustainability of water supply and wastewater services to ensure concerted efforts towards improved water systems management, rehabilitation and maintenance."

This document established strategies and objectives till 2032. It provides a short term strategy from 2013-2017, based on the management efficiency water resources, and drilling new wells based on Israel agreement. The long term strategy aims to" completely transform the water and wastewater sector in Palestine, bringing sector performances to the level of a developed country in 20 years only." [88]

The Strategic Water Sector Plan for 2016-2018

PWA has also prepared a water sector plan for 2016-2018 with the following vision, message and four strategic goals, as well as their level of intervention, responsibilities and indicators:[89] The strategic vision is: to have a sustainable and integrated water resources to meet the needs and the development of the State of Palestine. Its strategic message is to have an authority that manages, improves and protect the water sources and its infrastructure in an equitable, integrated and sustainable manner in order to provide safe water uses as to endure the protection of the environment and the achievement of the development goals of the Palestinian Community:

5. To improve and protect the water sources in accordance with the principles of integrated water management;
6. To achieve equity in the distribution of water and waste water services;
7. To achieve effective management and consolidation of good governance in the water sector; and
8. To invest in institutional building and achieving operational excellence in the PWA.

[87] National Water Policy and Strategy: <http://procurement-notices.undp.org/view_file.cfm?doc_id=27192>.
[88] Idem.
[89] PWA, 2015, Strategic Plan for PWA: <www.pwa.pd>.

The Environment Sector Strategy of 2010

The Environment Quality Authority[90] (EQA) has developed the environment sector strategy with the following vision: "A protected, maintained and safe Palestinian environment, that achieves sustainability of natural resources, meeting the current needs of the Palestinian society, while ensuring the rights of future generations to enjoy a healthy and safe environment and social welfare under an independent Palestinian sovereignty."

In order to reach such vision, the following requirements were proposed:

1. A fully sovereign and independent Palestinian State which is an active member in all international and regional environmental treaties.
2. Principles of environment protection are mainstreamed in national, regional and local development plans and strategies, so that environment be a priority at all levels.
3. The Environment institution is strong, and capable to implement its plans and directions for environment protection in close partnership with other government institutions, NGOs, the private sector aiming at the protection of the Palestinian environment, supported by a real partnership with other government institutions at the national and local levels and with the NGO and private sectors.

B. The Legal Framework

The Legal framework for the water sector consists of the following laws.

The Water Law No. 3/2012

´The aim of this law is the sustainable development and the management for the existing water resources, increasing their capacity, improve their quality, protect them from pollution and depletion and provide and satisfy social and individual needs in an optimal and equitable way". The law defines the roles and responsibility of the PWA as well as the National Water Council It also give the jurisdiction to the PWA for water provision and wastewater services.

The New Water Law of 2014

The new water law[91] has proposed a series of reform in the water sector. It separates the ministerial functions from the regulatory functions, establishes the West Bank Water Department into a government own company and allows the PWA which becomes the central body for water resource management, to establish regional water utilities and users associations.

[90] Environment Quality Authority, 2010, Environment Sector Strategy.
[91] Italian development cooperation. WASH report, June 2014.

The Environmental Law No. 7/1999

The aim of this law is" to protect the environment and public health from pollution, promote sustainable development of water resources, increase public awareness of environmental problems. It states that the Ministry of Environmental Affairs, in coordination with competent agencies, shall set standards and norms for collecting, treating, reusing, or disposing wastewater and storm water in a sound manner."[92]

Subsequent to this law, the Presidential decree No. 6/2002 has established the EQA as the successor to the Ministry of Environmental Affairs during the administrative reforms. Its main activities are to protect the environment and natural resources, protect public health from adverse environment issues.

The Local Government Law No. 1/1997

The Law defines and regulates the work of the local Government units, determines the nature of the work of local units and their relationship with the Ministry of Local Government. The Ministry of the Local Government is the central authority for local affairs. It sets up policies and oversees the functions and responsibilities of the local councils, regulates projects, budgets and maintain control over the financial and administrative functions of the Councils while the local councils which are elected are responsible for the construction and management of water and wastewater services at the local level.

C. The Institutional Framework

The Institutional Framework consists of:

-At the policy level:	The Joint Water Committee (JWC) and the National Water Council (NWC).
-At the national level:	PWA, EQA, Ministries of Finance and Planning, Local Government, Health, Public Works and Housing and the Palestinian Standard Institute.
-At the local level:	The local councils, the West Bank water department, the Coastal Municipalities Water Utility (CMWU) in Gaza, and the service providers.

1 At the Policy Level

The Joint Water Committee

The JWC consists of equal representatives of Israelis and Palestinians where decisions are supposed to be unanimous. Its functions is to:

- Joint manage the water and waste water resources;
- Protect the water resources;
- Cooperate and exchange information and resolve outstanding water issues; and
- Regulate the water supply.

The JWC has formed four sub-committees: The hydrological committee to discuss and provide authorization for drilling; the committee on water projects for laying pipes and construction of reservoirs and pumping stations;

[92] Idem.

the committee on sewage for the establishment of waste water treatment plants; and the committee on water pricing for the setting selling prices of water by the Israelis to the Palestinians.

The JWC does not operate as joint management committee, and there is an asymmetry[93] between Israelis and Palestinians in terms of information, decision power and capacity, the Palestinian side being the weakest. In addition there is no mechanism for solving disputes.

The National Water Council

The National Water Council[94] (NWC), was established by By-Law no. 2/1996 and was supposed to be the policy making body for the water and wastewater sector. It is supposed to review and approve the water policies and support the work of the PWA. It only met once and is not functionally at present.

The Regulatory Water Council

As required in the new water law of 2014, a Regulatory Water Council[95] (RWC) is to be established by the Cabinet. The Council's role will be to set water prices, monitoring the performance of Water and Wastewater service providers from economical, technical and environmental point of view, issue licenses for water, wastewater and desalination infrastructure, establish water quality assurance services and manage citizens' complaints.

2. At the National Level

The Palestinian Water Authority

Established by President order No. 5/1995, PWA was the regulator body for water and wastewater, as well for planning, assessing, monitoring and managing water and wastewater projects. Some of its functions will be transferred to the Regulatory Water Council: PWA will maintain its ministerial functions whereas the RWC will be in charge of regulatory functions. Until now, PWA is in charge of the overall regulation of water producers and service providers and manage water resources, including:[96] (a) the Allocation of water abstraction rights; (b) the regulation of the right of water resources; (c) the establishment of water service providers; and (d) the setting of water tariff, and the support to the Palestinian Standards Institute for developing standards.

The Environment Quality Authority

As the environment policy maker and regulator, EQA is responsible for defining environmental regulations related to water quality, including standards for the discharge of treated wastewater into natural water courses.

[93] World Bank, 2009. "Assessment of Restrictions on Palestinian Water Sector Development," Sector Note.
[94] Development of an Institutional Framework and Organizational Structures for Water and Sanitation Service Providers in the West Bank – Palestine", Dalia Zakarya Daifi.
[95] National Water Policy and Strategy; http://procurement-notices.undp.org/view_file.cfm?doc_id=27192.
[96] Idem.

The Ministry of Finance Planning

The Ministry of Finance and Planning[97] is responsible for the strategic planning process at the national level. It seeks the participation of all ministries in the preparation of the 3-5 year development plan (taking availability of water resources into account) and coordinate the development and the projects in the water sector in a sustainable manner.

The Ministry of Agriculture

The Ministry of Agriculture[98] is responsible for managing the agricultural resources in Palestine. Its responsibilities include: Establishing policy and regulation of irrigation and promotion and organization of farmers' associations; working closely with the PWA for the rehabilitation of water resources, protecting of water resources from pollution and promoting ~~and promotion of~~ their rational and economic use for agricultural production.

The Ministry of Local Government

As indicated earlier, the Ministry of Local Government[99] is considered to be the cornerstone of local governance. The Ministry supports the Joint Service Councils, oversees the local council units and provide the infrastructure services to all areas, both within and outside municipal boundaries.

The Ministry of Health

The Ministry of Health[100] has an important role in the water sector. This includes setting the standards, related to the public health such as: drinking water quality; discharge of treated sewage in bathing water; disposal of treated sewage in the natural environment and in the sea which could affect fisheries. Treated wastewater reuse for irrigation, which may affect the agricultural products, and the disinfection of and drinking from water storage.

The Ministry of Public Works and Housing

The main responsibilities of the Ministry of Public Works and Housing[101] in the water sector include the improvement of housing standards related to health, safety and housing services such water and sanitation facilities, and wastewater disposal.

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[97] Environment Sector Strategy.
[98] National Water Policy and Strategy; http://procurement-notices.undp.org/view_file.cfm?doc_id=27192, and the Environment Sector Strategy, 2010.
[99] Idem.
[100] Environment Sector Strategy, 2010.
[101] Idem.

The Palestinian Standard Institute

The Palestinian Standard Institute[102] is responsible for ensuring the standardization of rules for water facilities, sewerage and on-site sanitation.

3. At the Regional and Local Level

The Local Councils

The local councils are elected by their communities. They manage the local units which have a legal personality with financial autonomy, managed by an elected local councils. These are responsible for providing clean drinkable water, defining water requirements, fixing fees and connection tariffs, causing to prevent pollution and water contamination, as well constructing, managing, and controlling the sewerage network.

The West Bank Water Department

The West Bank Water Department is an executive body of the PWA for supplying bulk water supply to the utilities, municipalities and villages in the West Bank. It acts as a liaison between the Israeli Civil Administration and Palestinians. It also assumes the monitoring of the water systems. According to the new Water Law, the West Bank Water Department will be transformed into a governmental company which will be owned by the State of Palestine.

The Coastal Municipalities Water Utility in Gaza

The PWA in Gaza has been suspended since 2008. The Coastal Municipalities Water Utility (CMWU) is now responsible for the delivery of water and wastewater services for the entire population of Gaza. The CMWU was supported by the World Bank. Under the Emergency Water Project II (GEWP),[103] it had has operated effectively despite the emergencies and the severe damages that occurred in the water sector in Gaza.

The Service Providers

The bulk water supplier does not serve the customers themselves, but sell water to local service providers. There are also sanitation service providers. In the West Bank, there are two semi-public water supplier: Jerusalem Water Undertaking and Bethlehem Water Supply and Sewage Authority (WSSA), while the others are departments or divisions of large municipalities (in urban centers) or Village Councils or Joint Service Councils (in rural areas).

[102] National Water Policy and Strategy.
[103] The World Bank, 2012, Gaza Water Supply and Sewage Systems Improvement Project (WSSSIP).

D. General Conclusions

The above diagnosis and analysis of the water resources showed the following five conclusions:

1. The complex political situation, the blockade, and the control of Israel of all the water and ground water resources constitute the major insurmountable stumbling block for ensuring a decent quality of life of the Palestinian citizens that are entitled to live with dignity.
2. Water pollution is the major issue in the West Bank and Gaza and is responsible for the degradation of natural resources and is affecting public health.
3. Given the blockade and the separation of the West Bank and Gaza, institutions and agencies each works on programs in their well-defined areas; however, coordination and exchange of information and experience are low and horizontal reinforcement among these institutions should be considered. Moreover, there is an urgent need to address the missing link that exists between the comprehensive policies and strategies that were prepared over the years and the mainstreaming and application of the results.
4. Qualitative and quantitative assessments of impacts on the environment and its natural resources are not generally understood and, the economic assessments of these impacts are almost non-existent. Moreover, despite the unjustified control of water resources, changes in land use patterns, demographic trends, economic drivers, environmental pressures and climate vulnerability, water is a vital natural resource that is not valued and costed according to well established general principles and therefore is not allocated efficiently.

In view of the lack of economic assessment of water degradation that this present study has been developed, the economic assessment of water degradation will enable an approximate quantification in form of orders of magnitude of the economic costs associated with environmental degradation. This assessment will enable the decision makers the national and regional levels to develop sectoral priorities based in the cost and benefits of investments and the impact of the environmental externalities on these investments.

V. TAKING STOCK OF PALESTINE COST OF ENVIRONMENTAL DEGRADATION

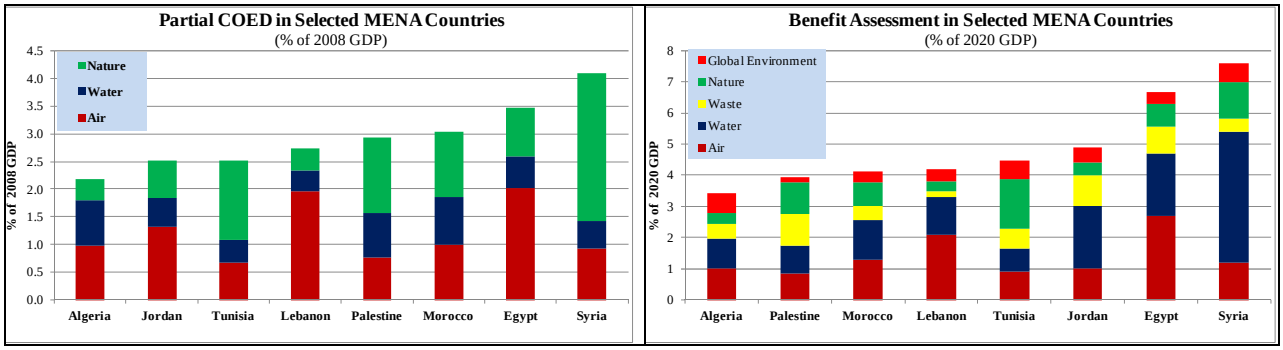
The Palestinian Authority is fully conscious of the water challenges in Palestine. Despite the unfair and unjustified occupation, the blockade, the fully control of its water resources by Israel, its overall political instability, the very bleak landscape and sluggish economic performance, there have been significant efforts in the past five years to initiate a series of reform in the water and wastewater sectors as shown in the previous chapter.

Many studies on the COED and economic losses were carried out in the Middle East and North Africa countries since 2000. METAP Project/World Bank, Economic Research Forum in Egypt and the European Commission estimated national, partial or sectoral cost assessment of environmental degradation, each using different methodologies. Yet, no report was produced to assess the COED in Palestine *per se*. In addition to technical reports that were also referenced above, the water resources has been the subject of economic reports from the impact of the occupation and blockade.

A. The Economic Research Forum

In 2011, the **Economic Research Forum** has estimated a partial cost of damage covering three categories: air, water (only waterborne diseases) and agricultural land degradation. The costs for Palestine were estimated at about US$ 171 million equivalent to 2.93 percent of total GDP in 2011, the impact on the water was around 0.8 percent of GDP or US$ 47 million for waterborne diseases in 2008 (Figure 5.1).

Figure 5.1: Partial Costs of Environmental Degradation and Environmental Benefits in MENA



Source: adapted from ERF (2011); and compiled from EU Benefit Assessment (2011) <www.environment-benefits.eu>.

B. The European Union

In 2011, the **European Commission** estimated the increased environmental benefits at the national level covering 5 categories: air, water, nature, waste, and global environment. The benefits for Palestine were estimated at 3.9 percent of GDP including global environment of Purchasing Power Parity (PPP)€ 314.2 million in 2020 in 2008 prices if pollution were to be reduced by ± 50 percent in 2020 compared to 2008. The proportion of water in these benefits has been estimated at 0.9 percent of GDP in 2020 equivalent to PPP€ 72 million including water-related diseases and water resources degradation. In other words, in the

case where pollution could not be reduced by 50 percent in 2020, the cost of degradation considered could reach at least twice the 3.9 percent of GDP estimates in 2020 (Figure 5.1).[104]

C. The Palestinian and World Bank Report on the Economic Cost of Occupation

The economic implication due to the Israeli occupation has been assessed in 2011 to be US$ 3.0 billion or 37.1 percent of GDP of Palestine due to direct costs, and US$ 3.9 billion or 47.9 percent of GDP as indirect costs totaling US$ 6.9 billion excluding the fiscal cost of US$ 1.8 billion[105] as shown in Table 5.1. Direct utilities costs and indirect costs due to water restrictions amounted to US$ 1.955 billion. The health impacts which was assessed by the incidence of diarrhea in children below the year of five, due to lack of clean water and sanitation was estimated in 2009 at US$ 20 million or 0.37 percent of GDP. The loss of opportunity cost in irrigated agriculture because of the Separation Wall, was estimated to be US$ 1.2 billion or 15 percent of GDP in 2009.[106]

TABLE 5.1: ECONOMIC COSTS OF ISRAELI'S OCCUPATION OF PALESTINIAN TERRITORY, 2009

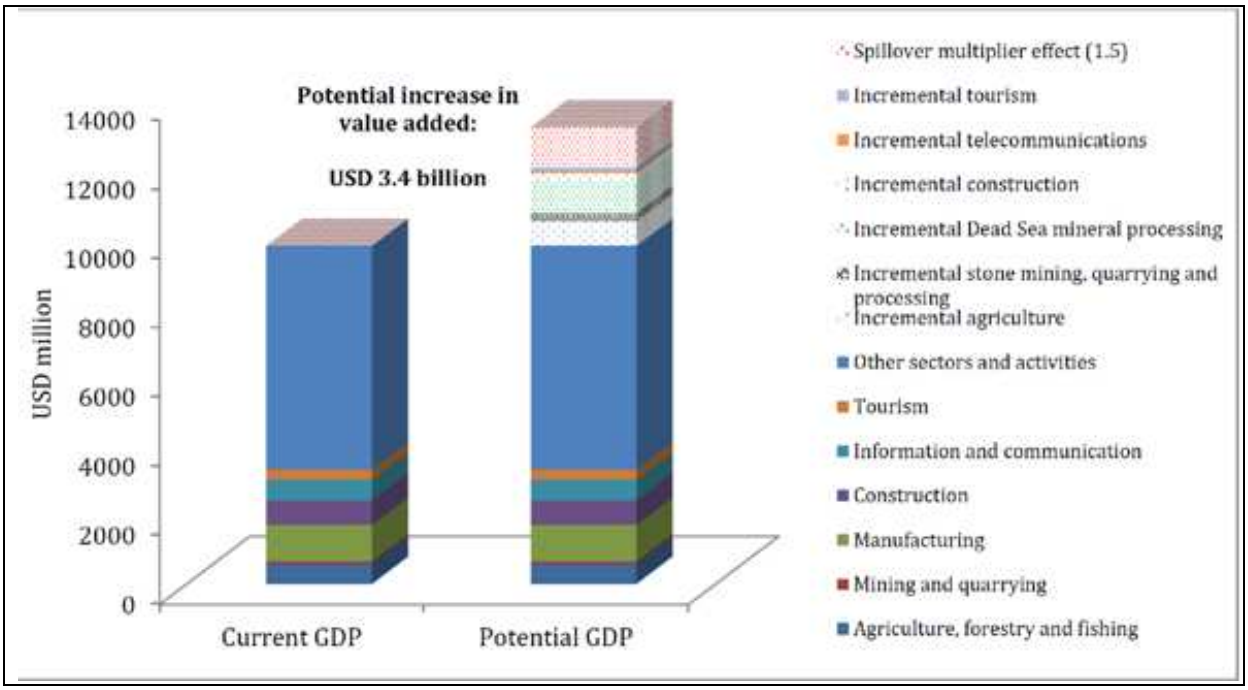
Item	Cost US$ million	% of GDP
Gaza Blockade	1,908.8	23.5
Indirect costs of water restrictions	1,903.1	23.4
Value added from Irrigation	1,219.7	15.0
Jordan Valley Agriculture	663.4	8.2
Health Cost from water	20.0	0.2
Natural Resources	1,837.7	22.6
Dead Sea Salt and Minerals	1,102.9	13.6
Value added from Quarries	574.9	7.1
Gas Marine Reserve	160.0	2.0
Direct utility cost	492.8	6.1
Direct Electricity costs	440.9	5.4
Direct water costs	51.9	0.6
International Trade restrictions	288.4	3.5
Dual use (excl. agr.)	120.0	1.5
Dual use agriculture	142.0	1.7
Cost of trading	26.4	0.3
Movement restrictions	184.5	2.3
Dead Sea Tourism	143.6	1.8
Uprooted trees	138.0	1.7
Direct cost	3,015.5	37.1
Indirect cost	3,884.4	47.8
Total	6,896.8	84.9
Fiscal cost	1,795.7	

Source: World Bank, 2013, Area C and the Future of the Palestinian Economy.

[104] Görlach, B., Möller-Gulland, J., Bar-On, H. and Atrash, I. 2011. EU Benefit Assessment, occupied Palestinian territories Report. Brussels. <www.environment-benefits.eu>.
[105] Palestinian Ministry of the National Economy and the Applied Research Institute 2011, The economic costs of the Israel
[106] World Bank, 2009. "Assessment of Restrictions on Palestinian Water Sector Development," Sector Note.

Furthermore, the potential benefits lost as a result of the restriction on access to and activity made in Area C which constitutes 61 percent of the West Bank, is key to the Palestinian economy and is endowed with rich natural resources was estimated to US$ 3.4 billion or 35 percent of GDP in 2010 (Figure 5.2) From this estimated amount US$ 2.2 billion is considered to be a loss of direct benefits related to agriculture, tourism, telecommunications, construction, stone mining and quarrying, and Dead Sea mineral exploitation.[107] Growth generated through the lifting of restrictions in selected sectors could increase potential Palestinian value added by US$ 3.4 billion.

Figure 5.2: Economic costs of Israeli's occupation of Palestinian Territory, 2010



Source: PCBS National Accounts, 2011 and World Bank Staff calculations.

Whereas all the above figures represent loss of economic opportunities, they do not reflect which he exception of the health costs due to water pollution of US$ 20 million), the cost of degradation for water resources due to pollution and natural resources depletions. These costs are real costs that have not been estimated yet and should be additional and over and above the loss of opportunity costs. It is within this context that the cost of water resources degradation was assessed as the first phase of the cost of environmental degradation that is planned to be conducted in 2016.

[107] World Bank, 2013, Area C and the Future of the Palestinian Economy.

VI. METHODOLOGY, CALIBRATION AND LIMITATIONS OF THE VALUATION, AND CATEGORIES CONSIDERED IN THE ANALYSIS

The CAWRD were valued by using available data source that cannot be entirely reliable. In addition, gaps in the data required to make several assumptions. Nevertheless, the CAWRD is meant to help policymakers make informed and efficient choices to maintain the integrity of the environment and promote conservation based on a common denominator: monetizing the environmental damage and remedial interventions. These results, which should be considered as preliminary order of magnitudes, could nevertheless help highlight the trade-offs between economic development and growth, well being, and the preservation of the commons. Moreover, these results, which should guide further analyses, provide policymakers with a preliminary tool for integrating environment into economic development decisions and comparing damage costs as a percentage of GDP within categories and across countries.

Moreover, it is difficult to accurately define the environmental degradation that is strictly natural and the one that is strictly anthropogenic. In some cases, there is overlap between the two causes of degradation that could lead to mutual reinforcement such as natural soil salinity and water that is exacerbated by human practices by adding fertilizers.

A. Valuation Methodology

The economic valuation of environmental projects including water projects are proven methods that are summarized in the Handbook of the World Bank on the Cost Assessment of Environmental Degradation,[108] the European Commission's Manual on the Benefit Assessment[109] and other reference sources such as The Economics of Ecosystems and Biodiversity (TEEB), also funded by the European Commission in cooperation with the German Government.[110]

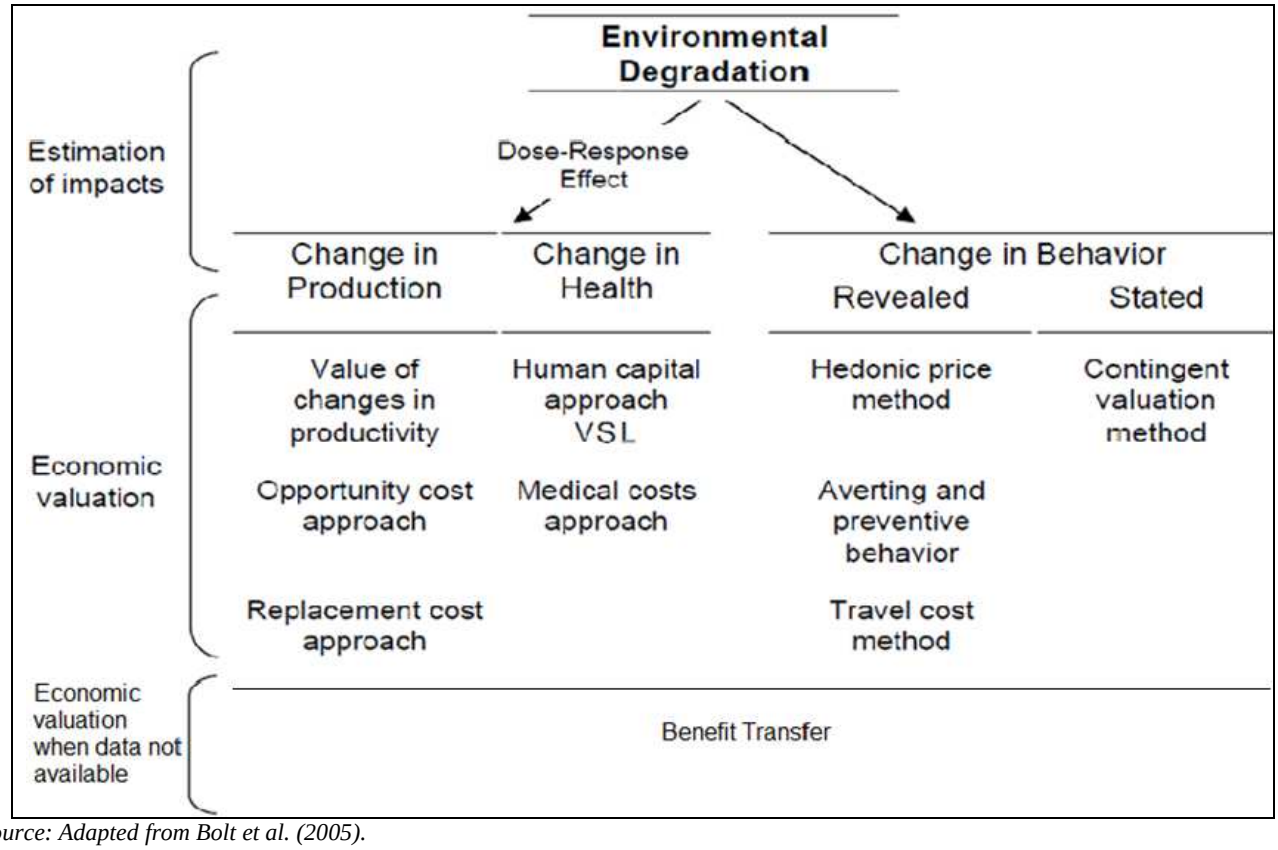
The main methods for estimating impacts are grouped around three pillars with specific techniques under each pillar (Figure 6.1):

- Change in production.
    - Value of changes in productivity such as reduced agricultural productivity due to salinity and / or loss of nutrients in the soil;
    - Approach the opportunity cost of such shortfall of not re-selling the recycled waste;
    - Market Price method makes use of observed market prices for environmental goods and services. It values changes in quantity and/or quality of a good or service such as drinking water;
    - Approach replacement cost when for example the cost of construction of a dam to be replaced by a dam that was silted.

[108] Website of the World Bank: <www.worlddbank.org>.
[109] Website of the EU ENPI BA: <www.environment-benefits.eu>.
[110] Website of TEEB: <www.teebtest.org>.

- Change in condition with the dose-response function to establish between pollutant (inhalation, ingestion, absorption or exposure) and disease.
    - The value associated with mortality through two methods: the future shortfall due to premature death, and the willingness to pay to reduce the risk of premature death. Only the latter method is used in this study.
    - The approach to medical costs such as the costs when a child under 5 years is taken to the hospital to be cured of diarrhea.
- Changing behavior with two sub-techniques: revealed preferences, and stated preferences.
    - Revealed preferences by deriving the costs associated with behavior: e.g., hedonic method where for instance the lower value of land around a landfill is derived; trying to derive travel costs to visit a specific place like Lake Titicaca; and preventive behavior as when a household buys a filter for drinking water.
    - Stated preference where a contingent valuation is used to derive willingness to pay through a survey for example, improve the quality of water resources.

Figure 6.1: Estimation of Impacts and Associated Economic Valuation Techniques



Source: Adapted from Bolt et al. (2005).

In cases where data are not available, a benefit transfer can be based on studies made in other countries by adjusting the results for the differential income, education, preference, etc. The original results that are used for

the benefit transfer are based on one of the economic valuation methods under the three pillars as illustrated in Figure 6.1.

B. Valuation Methodology Retained for the Study

Over the last 2 decades, Israel did not carry through the Oslo I and II Accords which stipulated the creation of Palestinian sovereign state by 1999. On September 30, 2015, the Palestinian Authority announced at the UN General Assembly that it is no longer bound by the Oslo I and II Accords (as far as Israel is not obeying them) which could further affect Palestinian water rights and use in the future. Still, the following analysis relies on the never ratified by authoritative Johnston Plan (see Section 3) and Oslo II Accords premise.

The valuation will hence be subdivided into 2 major groups: the CAWRD proper that will value the degradation using the techniques cited above; and the replacement cost of the unfulfilled water demand due to the inequitable allocation of water as Israel prohibits Palestinian from exploiting their equitable and reasonable shares of transboundary surface and underground waters in Palestine irrespective of the partial water allocation agreed under Oslo II Accords or the fact that the PA is not allowed to using its Jordan River share or the fact that the Israeli settlers are illegally tapping the Mountainous Aquifer. However, it is difficult to have a clean breakdown of the Palestinian CAWRD due to Israel. Still, the lost opportunities are not considered in this respect and will need further analysis in the future based on data and information on water allocation trends between Israel and Palestine Nevertheless, Israeli premeditated exactions are definitely leading to poor water and sanitation services, water pollution due to wastewater treatment prevented by Israel that otherwise, could have translated into better quality of life, growth and the commons in Palestine. Incidentally, the base year 2014 was chosen to estimate both groups.

C. Calibration and Limitations of the Valuation

In addition to resource constraints and binding time, the techniques used have their own methodological limitations. In the process of fact finding it became clear that availability, accessibility and topicality of information relevant for the assignment posed problems. Information has been very scattered, not up-to-date and sometimes inconsistent. Inconsistencies have been experienced with similar types of information from different sources. Approaching local authorities helped generate response, feedback and clarifications in terms of facts and figures.

The results allow for a margin of error through sensitivity ranges (lower bound, upper bound) that were taken into account. In addition, marginal analysis has been attempted in some cases to assess the benefits (reducing the CAWRD) and investment costs.

Most valuation techniques used have inherent limitations in terms of bias, hypothetical premise, uncertainty especially when it comes to non-tradable goods. Moreover, the results are of course sensitive to the context. The use of benefits transfer could therefore exacerbate the results and uncertainties. Therefore, some results are described in the text and should be subject to further analysis when investments will be considered.

D. Categories Considered in the Analysis

Categories, sub-categories, impacts and methods to assess the CAWRD and remediation are developed in Table 6.1. The general description of the methods and specific sub-categories can be found in Annex I.

TABLE 6.1: WATER SUB-CATEGORIES, IMPACTS AND METHODS USED FOR THE VALUATION OF DEGRADATION

Category	Sub-category	Impact	CAWRD: Method used	Cost of Remediation: Possible intervention
Water	**Water-borne diseases:** improved drinking water supply and sanitation and change in behavior with regards to hygiene	Illness associated with drinking water supply quality and quantity as well as sanitation and poor hygiene	HCA/VSL and COI	Coverage rate of improved drinking water supply and sanitation, and hygiene awareness campaign
	Quality and treatment: drinking water in urban and rural areas	Consumer preference (tap water vs. bottled water); filter use or chlorine addition; boiling water; etc.	CR and CB (additional cost of treatment)	Desalination for dilution with potable water and upstream investments; water treatment improvement and improvement of potable water; and tariff/charge adjustments
	Quality of services: drinking water in urban and rural areas, and irrigation	Costs of alternative sources of water (bottle, tank, wells, etc.); technical losses (financial losses are not considered as services are provided but tariff/charges are not collected) while considering the opportunity cost and economic externalities (subsidies); lost time hauling water	CR and CO	Improved delivery, service effectiveness; and tariff/charge adjustments
	Quality of the resource (mainly anthropogenic and possibly natural such as arsenic): effluents and seepage	Surface water quality affecting: water use (domestic, agricultural, fisheries, industrial et mining); basin ecosystem and (eutrophication, etc.) coastal zones; territories; and eco-tourism	CV (restoration of water quality)	Wastewater investments, reduction of industrial effluents) and reduction of pesticide and nitrate use; and tariff/charge adjustments
		Underground water quality affecting: water use (domestic, agricultural and industrial); basin ecosystem and coastal zones; territories; and eco-tourism	CV and RC (restoration of water quality)	Artificial recharge for dilution; substitution wells or water desalination/transport
	Salinity (anthropogenic and natural): surface and underground water, marine environment and soil	Salinity of soils, effects on health **(see Quality and treatment**), reduction of agricultural and fishery productivity and effects on ecosystems	CP (agricultural productivity)	Fertilizer increase (shor term measures) and lan use planning (long term measures to reduce salinity)
	Quantity (anthropogenic and natural):surface water flow reduction and underground water drawdown	Surface: treated and untreated water use that could cause contamination of the food chain; and in extreme cases, substitution effects through desalination	CP (agricultural productivity and additional cost of pumping/substitution)	Opportunity cost of treated and reused water; and of desalination and water transportation; and tariff/charge adjustments
		Underground: deeper pumping, substitution wells or desalination (rapid drawdown or fossil water)	CP (agricultural productivity and additional cost of	Opportunity cost of pumped/substitution water; and

Category	Sub-category	Impact	CAWRD: Method used	Cost of Remediation: Possible intervention
		to overcome domestic needs and/or agricultural productivity	pumping/substitution)	tariff/charge adjustments
	Erosion and Storage: soil management is affected by erosion and exacerbated by climate change	Soil nutritional losses and sedimentation of dams, hill lakes, river beds and coastal zones exacerbated upstream by poor land use management due notably to deforestation, wind and water erosion, etc.	CP et RC (dredging; increase the dam height or construction of new dams/hill lakes)	Costs: Land use planning to prevent and reduce erosion, e.g., reforestation, terraces, etc.
	Water Scarcity (anthropogenic and natural)**:** water needs are not fulfilled due to the Israeli occupation	Water-related diseases; socioeconomic, environmental and biodiversity effects; opportunity losses	RC in terms of desalination and/or CO	Rightful and equitable transboundary water allocation and supplementing water supply through desalination

Note: CB: change in behavior; COI: cost of illness; CO: Opportunity cost; CP: change in production; CR: cost of remediation; DR: dose-response; HA: hedonic approach; CV: Contingent valuation; HCA: human capital approach; RA: risk analysis; RC: replacement cost; VSL: Value of Statistical Life; and CC: Carbon credits. Source: adapted from EU SWIM Program: <www.swim-sm.eu/>; and Authors.

VII. PALESTINE COST ASSESSMENT OF WATER RESOURCES DEGRADATION

A. Dataset

The dataset used to calculate the CAWRD in Palestine is illustrated in Tables 7.1-7-4 and is based on the previous sections.

TABLE 7.1: AREA AND POPULATION DATASET IN PALESTINE, 2014

Input	Unit	Year	West Bank		Gaza	Comments and Sources
			PA	Israel	PA	
Area	Km^2	2014	5,655+220		365	1949 Armistice Line
-Zone A	Km^2	2014	1,005			1995 Oslo II Accords, Article 40 (OIIA)
-Zone B	Km^2	2014	1,035			Ibid.
-Zone C	Km^2	2014		3,455		Ibid. and tbd upon final peace settlement
-Natural Reserves	Km^2	2014		160		Ibid.
-Dead Sea territorial waters	Km^2	2014		≈220		Ibid.
Population	Million	2014	2.79	0.6	1.76	Palestinian Central Bureau of Statistics
-Zone A	Million	2014	2.31			Palestinian Central Bureau of Statistics
-Zone B	Million	2014				Palestinian Central Bureau of Statistics
-Zone C	Million	2014	0.15	0.25		Palestinian Central Bureau of Statistics
Jerusalem	Million	2014	0.33	0.35		Palestinian Central Bureau of Statistics

Note: Gaza territorial waters and Economic Exclusive Zone are not included in the Table.
Source: Oslo II Accords, 1995; PCBS; and Israel Ministry of Housing (for Israel figures).

TABLE 7.2: WATER RESOURCE ALLOCATION UNDER JOHNSTON PLAN AND OSLO II ACCORDS IN PALESTINE

Water Sources	Palestinian Authority		Israel	Potential	Source
	West Bank	Gaza			
	MCM	MCM	MCM	MCM	
Jordan River Basin	**≈250**	**0**	**616**	**NA**	**1955 Johnston Plan sharing**
Coastal Aquifer	**0**	**57**	**NA**	**390 [360-420]**	**Cited in World Bank, 2009**
Mountain Aquifer	**118**	**0**	**483**	**679 [620-887]**	**1995 OIIA**
-North-eastern	*42*	*0*	*103*	*145 [130-200]*	1995 OIIA
-Eastern	*54*	*0*	*40*	*172 [155-237]*	1995 OIIA
-Western	*22*	*0*	*340*	*362 [335-450]*	1995 OIIA
Western, Other	**0**	**0**	**0**	**78**	**1995 OIIA unallocated**
East Jerusalem	**NA**	**NA**	**NA**	**NA**	**Supplied by Israel's Mekorot**
Wastewater Reuse	0	0	NA	NA	OIIA Not considered
Memo: Transfer to PT	*4.5*	*5*	*19.1*	*28.6*	*OIIA From Israel's Mekorot*

Note: Transfer to PT under Israel is for Israeli settlers in Palestine.
Source: Johnston Plan, 1955; Oslo II Accords, Article 40, 1995; and World Bank, 2009.

TABLE 7.3: WATER RESOURCE ESTIMATED ALLOCATION IN PALESTINE, 2014

Water Sources	Palestinian Authority		Israel	Total Use	Avg. Annual Recharge	
	West Bank	Gaza				
	MCM	MCM	MCM	MCM	MCM	% Salinity
Jordan River Basin	0	0	700	700	565	>WHO std.
Coastal Aquifer	0	125.0	430	555	360-420	>WHO std.
Mountain Aquifer	115	0	485	600	550-620	
-North-eastern	*30*	*0*	*105*	*135*	*131-145*	*10%*
-Eastern	*23*	*0*	*40*	*63*	*95-172*	*28%*
-Western	*62*	*0*	*340*	*402*	*320-362*	*12%*
Desalination	0	0.6	300	300.6	Not applicable	
Wastewater Reuse	7.7	3.7	220	231.4	220	
Total	122.7	129.3	2,135	2,387	2,300	

Source: cited in Brooks et al., 2013.

TABLE 7.4: WATER RESOURCE COVERAGE IN PALESTINE, 2014

Water Sources	Unit	Palestinian Authority	
		West Bank	Gaza
Water Coverage	%		
-Household	%	93.4	93.0
-Economic Establishments	%	83.4	NA
Wastewater Network	%		
-Household	%	38.4	83.5
-Economic Establishments	%	71.3	NA
Wastewater Treatment	m^3/day	13,000 out of 85,000	10,000 out of 80,000
UfW	%	28	48
Water Consumption	lcd	50	73
Water Demand	MCM	826	
Water Supply	MCM	352.1	
Water Deficit	MCM	473.9	

Note: Water deficit is based on the figures illustrated in Table 1.1 that were projected till 2014 by using the demographic growth rate.
Source: World Bank, 2009; and PCBS, 2015.

B. Cost Assessment of Aggregate Results

The socioeconomic dataset used in the analysis is derived from a number of official Palestinian sources where the population reached 4.55 million in 2014.

The results of the CAWRD are shown in Table 7.5 and Figure 7.1. The CAWRD of Palestine reaches US$ 675 million in 2014 equivalent on average to 9.1 percent of GDP in 2014 with a variation between US$ 529 and 875 million. Degradation cost associated to human health reached US$ 131 million in 2014 or 19.4 percent of the CAWRD with the rest being equivalent to US$ 544 million (Table 7.5 and Figure 7.2).

Broken down by the water subcategory (US$ million in 2014): water scarcity represents 44 percent of the degradation costs (US$ 294 million in 2014) due partly to the withhold of Palestine share from the various riparian transboundary resources; followed almost equitably by water quality (US$ 121 million in 2014), water-

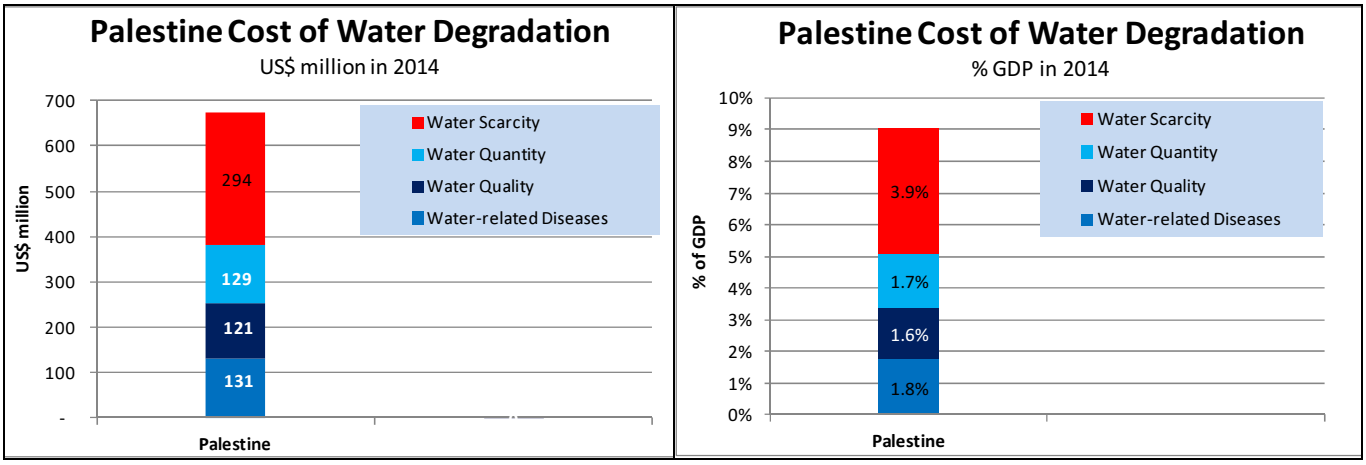
related diseases (US$131 million in 2014) and water quantity (US$ 129 million in 2014). Water use has a small impact on the global environment but costs were not valued.

TABLE 7.5: CAWRD IN PALESTINE, 2014

Category	CAWRD		Lower bound	Upper bound
	US$ million	%	US$ million	US$ million
Water-related diseases	131	19.4%	111.2	150.5
Water quality	121	17.9%	92.7	132.70
Water quantity	129	19.1%	109.3	147.94
Water scarcity	294	43.6%	220.4	455.42
Total	675	100.0%	528.9	875.2
% GDP		**9.1%**	7.1%	11.7%
GDP	**7,449**			

Source: Authors.

Figure 7.2: CAWRD in Palestine, 2014



Source: Authors.

In comparison with other MENA countries as shown in Table 7.6, Palestine has the highest.

TABLE 7.6: COMPARISON OF CAWRD IN MENA

MENA countries	% of GDP	Year
Palestine	9.1	2014
Iraq	3.4	2008
Morocco	1.2	2000
Lebanon	1.1	2005
Egypt	1.0	1999
Algeria	0.8	1999
Tunisia	0.5	1999

Source : World Bank (2004); and World Bank (2011).

C. Water Category and Sub-categories

The Water subcategories are as follows:

-Water-related Diseases

-Water Quality which includes:

Water quality of potable water

Water quality of water resources

Water quality due to salinity although part of it is due to natural causes

-Water Quantity which includes:

Water supply to supplement domestic needs

Water supply network (unaccounted for water)

Drawdown of the water table due excess pumping

-Water Scarcity

Water needs not fulfilled and valued at replacement cost (desalination cost)

1. Water-related Diseases Associated to Water and Sanitation Services

The 2014 UNICEF/WHO progress on drinking water and sanitation has high scores for coverage in the West Bank and Gaza with improved drinking water and sanitation (Box 7.1) reaching 92 and 94 percent respectively in 2012. The PCBS reports provides an even better picture with a potable network coverage of 93.4 and 98.8 percent respectively in West Bank and 93 and 100 percent respectively in Gaza (Table 7.7). Incidentally, both tight and porous cesspits were considered as improved sanitation at the household level although porous cesspits are environmentally unsound. Services to empty the cesspits is however irregular leading to overflowing. Still, these indicators are providing a skewed picture as the quality of drinking water and to a lesser extent irregular cesspit clean up and poor hygiene are burdening Palestinian health.

The prevalence of diarrhea and mortality due to diarrhea in the West Bank and Gaza due to poor water quality, water quantity, sanitation services and hygiene was derived by using the burden of water-related diseases risk factors in terms of diarrheal and intestinal diseases as calculated by the IHME in terms of DALY lost in 2013.[111] The Disability-Adjusted Life Year (DALY) is the burden of disease metric or a currency that allows to quantify the burden of morbidity (Years Lived with Disability or YLD) and mortality (Year Lost Life or YLL). The DALY is defined as "one year lost of healthy life." The same burden of water-related diseases was considered for 2014.

[111] Institute for Health Metrics and Evaluation, 2013: <www.healthdata.org>.

TABLE 7.7: WATER ACCESS AND SANITATION TYPOLOGY, % OF CONSIDERED POPULATION IN PALESTINE, 2012-2015

Access Typology	Source	Year	Total	Source	Year	Total
Palestine						
Improved Water Sources	WHO/UNICEF	2012	92%	PCBS	2015	93.3%
Unimproved Water Sources	WHO/UNICEF	2012	8%	PCBS	2015	6.7%
Improved Sanitation	WHO/UNICEF	2012	94%	PCBS	2015	99.5%
Unimproved Sanitation	WHO/UNICEF	2012	6%	PCBS	2015	0.5%
West Bank						
Improved Water Sources				PCBS	2015	93.4%
Unimproved Water Sources				PCBS	2015	6.6%
Improved Sanitation				PCBS	2015	98.8%
Unimproved Sanitation				PCBS	2015	1.2%
Gaza						
Improved Water Sources				PCBS	2015	93.0%
Unimproved Water Sources				PCBS	2015	7.0%
Improved Sanitation				PCBS	2015	100.0%
Unimproved Sanitation				PCBS	2015	0.0%

Source: WHO/UNICEF. 2014. Progress on Drinking Water and Sanitation; and PCBS, 2015.

The total burden of water-related diseases in terms of DALY lost associated with unsafe water and unsafe sanitation and poor hygiene amounts to 27,012 DALY lost in Palestine in 2014 (Table 7.8). The valuation associated with morbidity uses the GDP per capita in 2014 for each DALY lost whereas the valuation associated with mortality uses the value of statistical life after performing a benefit transfer function (See Annex II) and dividing it by 20 (average discounted years lost). The CAWRD ranges between US$ 111.2 million and US$ 150.5 million with a mean US$ 130.9 million in 2014 (Table 7.8).

Box 7.1: UNICEF Definition of Improved Water Supply and Sanitation

UNICEF defines Improved Water Supply and Sanitation as follows: improved drinking water sources include water points, by construction or active intervention, are protected against outside contamination, particularly faeces, i.e., running water at home (household connection to a network, supply of water in the house of the household, or on his plot in his yard) and public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs and rainwater; and improved sanitation facilities are sanitary facilities that can prevent the user and their immediate surroundings to come into contact with excreta (flush to a piped sewer system/septic tank/pit latrine, ventilated improved pit latrine, toilet with lid, composting toilet).

Source: UNICEF website: <www.unicef.org>.

TABLE 7.8: BURDEN OF WATER-RELATED DISEASES IN PALESTINE, 2014

Risk Factor and Burden of Disease	Water-related Diseases	Value per DALY Lower Bound US$	Value per DALY Upper Bound US$	CAWRD US$
Years Lived with Disability (YLD)				
Unsafe water sources	6,249	2,966		18,533,932
Unsafe sanitation	1,445	2,966		4,285,731
Hand washing	1,397	2,966		4,143,367
Year Lost Life (YLL) equivalent to mortality				
Unsafe water sources	1,981	2,966	24,756	49,040,679
Unsafe sanitation	457	2,966	24,756	11,313,271
Hand washing	1,759	2,966	24,756	43,544,954
Disability-Adjusted Life Year (DALY) Lost				
Unsafe water sources	16,711			67,574,611
Unsafe sanitation	3,864			15,599,002
Hand washing	6,437			47,688,322
Total	27,012			130,861,935
Lower Bound				*111,232,645*
Upper Bound				*150,491,226*

Note: the IHME 2013 figures were considered for 2014. See Annex III for valuation.
Source: Institute for Health Metrics and Evaluation, 2013: <www.healthdata.org>; and Authors calculation.

2. Quality: Potable Water Treatment

The water and sanitation sector provides poor services to both dwellers and the business community, and is increasing the distortionary effects that translates into competitiveness losses and dweller additional time and expenses. Moreover, water supply is inadequate in terms of both quality and quantity and the prevalence of connected households that tend to purchase water from alternate sources reaches more than 90 percent. According to the household evaluation of water quality conducted in 2014, 78.2 percent of household in the West Bank and 28.2 percent in Gaza consider the water of good quality whereas only 3.5 percent and 31.6 percent respectively consider it as bad.[112] Also, 50.9 percent of households in the West Bank and 30.5 percent in Gaza are supplied daily with water from the network. It is estimated that 191,238 Palestinians living in the West Bank are without running water network whereas 190,000 Palestinians have limited access to water where water truck cost reached an average of US$ 5 per m^3 in the West Bank and US$ 9 per m^3 in Gaza. In addition, a growing number of households is relying on small scale desalination (capacity of 20 liters per day) at a prohibitive cost of 13 per m^3 whereas a number of private companies are selling desalinated water in bottles in Gaza. A recent study showed total coliform bacteria was detectable in 75 percent of locally bottled water and 45.4 percent of imported brands.[113] Reverse osmosis is usually used for small desalination devices which is producing good water quality results. However, it is mostly during bottling and processing that the contamination occurs while there is no capacity to enforce water bottling and handling at production sites and during transportation.

[112] PCBS, 2015.
[113] Bashir, Abdallah and Adnan Aish. 2013. Bacteriological Quality Evaluation of Bottled Water Sold in the Gaza Strip, Palestine. International Water Technology Journal Vol. 3-No.1 March 2013.

Irrespective whether households have access to the network or not, they have to replace it with better sources due to poor quality (bottled/containers) and to supplement it with other sources such as wells, trucks, springs, small desalination small devices, etc. due to inadequate quantities.

So, most households complement their initial source of water with 2 to 4 water supply sources through additional water sources to offset poor quality, low quantity and irregularity of provision. An attempt is made to derive the forgone consumer surplus that is deducted from the West Bank and Gaza average water tariffs although these tariffs do not reflect the real costs of water especially desalinated water as they are subsidized. For the West Bank and Gaza, data on bottled water, trucks, household and private desalination is available from the PCBS.

TABLE 7.9: HOUSEHOLD WATER DEFENSIVE AND COMPLEMENTARY EXPENDITURES IN PALESTINE, 2014

Item	**West Bank**	**Gaza**	**West Bank**	**Gaza**	**West Bank**	**Gaza**	**West Bank**	**Gaza**	**CAWRD**
	Million	Million	lcd	lcd	US$/l	US$/l	US$ million		
Population	2.46	1.76							
Water Consumption			50	70					
Public Network					0.0010	0.0003			
Mineral Water and Gallons	6.70%	24.90%	0.50	0.50	0.830	0.830	24.94	66.38	91.32
Private desalination	0.50%	11%	4.00	4.00	0.009	0.009	0.14	2.54	2.69
Total Quality							**25.08**	**68.93**	**94.01**
Lower Bound									*79.91*
Upper Bound									*108.11*
Water Tanks	19.40%	65.40%	25.00	17.5	0.005	0.009	17.40	63.46	80.86
Total Quantity							**17.40**	**63.46**	**80.86**
Lower Bound									68.74
Upper Bound									92.99

Note: The population of the West Bank does not include the Palestinian population of Jerusalem. Water tanks are assumed to supplement water consumption 50 percent of the time in the West Bank and 25 percent of the time in Gaza. Bottled water consumption are based on an average consumption of 0.5 lcd. Private desalination household device is based on a maximum production capacity of 4 lcd as its daily capacity is 20 liters per day.
Source: Palestinian Water Authority. Gaza Strip: No Clean Drinking Water, No Enough Energy, and Threatened Future. Gaza, occupied Palestinian territory.

The cost of damage was derived from the incremental use of alternative sources to complement or substitute (when water quality is perceived to be below standards) the initial water sources. Moreover, it is important to note that people and namely the poor without network coverage tend to spend a higher share of their disposable income (in cash or kind in terms of time and effort fetching water) to secure their household water needs. Hence, incremental expenditures as illustrated in Table 7.9 allowed to derive the CAWRD associated with inadequate potable that is supplemented by bottles and household reverse osmosis devices. The cost of the damage is estimated at US$ 94 million in 2014 with a bracket ranging between US$ 80 and 108 million.

3. Quality: Water Resources

A simple attempt at calculating the cost of reducing the release of effluents from domestic sources was attempted by just assigning a figure of US$ 0.11 per m^3 on the overall wastewater release as the treated wastewater is not

considered adequate. The partial degradation amounts to US$ 6.6 million as hazardous and medical waste, agricultural runoff and solid waste leachate are not considered because of the lack of data.

Hence, given the multiplicity of sources of pollution and the number of pollutants affecting water resources in Palestine, the valuation is based on a contingent valuation carried out in the United Kingdom and where a benefit transfer was used. The degradation is equal to the estimated amount of money that households in Palestine would be willing to pay for improved surface water quality over 20 years (see Annex II for details).

TABLE 7.10: RESTORING WATER RESOURCE QUALITY IN PALESTINE, 2014

Area	Population	Willingness to Pay US$/Capita/Year			WTP to Improve Water Resources US$ Million		
	Million	*Lower Bound*	*Middle Bound*	*Upper Bound*	Total	*Lower Bound*	*Upper Bound*
West Bank	2.79	1.69	2.26	2.82	**6.3**	**4.7**	**7.9**
Gaza	1.76	1.69	2.26	2.82	**4.0**	**3.0**	**5.0**
Total					**10.3**	**7.7**	**12.8**

Note: See Annex III for valuation.
Source: Baker et al. (2007); Annex II; and Authors.

Table 7.10 illustrates the results of the transfer of estimated economic values of water for the United Kingdom in Baker et al. (2007) to Palestine. Mean willingness to pay (WTP) values for 33 percent Successive Improvement after 9 years, 15 years and 20 years overall water quality improvement scenario in Palestine ranges between US$ 1.69 and US$ 2.82 per year per capita depending on the two payment mechanisms used in the original contingent valuation method employed in Baker et al. (2007). Results are shown in a range to illustrate the degree of uncertainty associated with the benefits estimates that were elicited through a survey that used the Contingent Valuation methodology using both payment card and dichotomous choice as payment mechanisms. The benefit transfer provides "order of magnitude" results, in order to communicate the scale and significance of the potential benefits arising from improved surface water quality.

Multiplying WTP values by the current population gives a total benefit figure for WFD related water quality improvements in Palestine in the range of US$ 7.7 million – US$ 12.8 million with a mean US$ 10.3 million (Table 7.10).

4. Quality: Salinity

The mismanagement of fertilizer and water application results in salt build up in the soil and groundwater systems. For instance, potatoes could use less water and less fertilizers should modern cropping techniques are used. Overall soil salinity is usually positively correlated with irrigation water and can therefore produce lower yields. Salinity levels and reductions in productivity were developed by Kotuby-Amacher et al. (2003) and Evans (2006) for all crops and are based on the electrical conductivity of saturated soil (ECs) expressed in dS/m. However, other factors could affect the tolerance of crops (variety, climate, level of precipitation, etc.), and therefore the thresholds are merely suggestive. The reduced productivity due to salinity affecting agricultural production affects a number of crops in the West Bank and Gaza. However, the additional use of fertilizer should offset the loss of productivity while creating a vicious cycle, but it is not possible to determine the cost of preventive behavior in this particular case.

Although water salinity data from various aquifers exists, soil salinity and its effects on yields are not readily available in the West Bank and Gaza and would need in the future attention. The CAWRD associated with yield loss due to soil salinity was therefore not valued.

5. Quantity: Water Supply to Supplement Domestic Needs

The cost of damage was derived from the incremental use of alternative sources to complement the initial water sources. Hence, incremental expenditures as illustrated in Table 7.5 allowed to derive the CAWRD associated with inadequate potable that is supplemented by water trucks. The cost of the damage is estimated at US$ 80.1 million in 2014 with a bracket ranging between US$ 69 and 93 million.

6. Quantity: the Water Supply Network Efficiency Losses

For water supplies: The *American Water Works Association*[114] suggests a benchmark of 10 percent for acceptable water service providers losses. A range of more than 10 percent to 25 percent is considered intermediate, and should be given special attention to reduce the losses to less than 10 percent. Water losses above 25 percent are considered chronic and require immediate attention. The West Bank and Gaza average municipal water losses are estimated at 28 percent and 48 percent respectively.[115] Water companies produced about 200 MCM in 2014 of which 39 percent were unaccounted for. This amount includes the water provided to business and industries. Thus, these losses could be seen as a cost borne by taxpayers with no return on investment while, from an environmental point of view, these losses are usually recharging the aquifers. However, these positive externalities are not taken into account in the analysis.

Should the technical losses were to be reduced by 20 percent in the West Bank and 40 percent in Gaza, efficiency losses in terms of residual production and financial losses would amount to 8 percent. The bulk water produced and consumed is illustrated in Table 7.11. The average tariff is used although a better approach would be to use the opportunity cost of water as water is subsidized in Palestine and operations and maintenance costs are barely covered by tariffs.

TABLE 7.11: UNACCOUNTED FOR WATER IN PALESTINE, 2014

Region	Population	Supplied MCM	Consumed MCM	Unaccounted for Water %	Capita Consumption lcd	Average Tariff US$/m^3	CAWRD US$ million
West Bank [1)]	2,435,338	93.9 [2)]	67.9 [2)]	28.0	76.4 [2)]	0.97	18.2
Gaza Strip	1,672,865	106.0	54.7	48.0	89.5	0.33	14.0
Total	**4,108,203**	**199.9**	**122.6**	**39.0**	**81.7**	**0.77**	**47.1**
Lower Bound							*40.0*
Upper Bound							*54.2*

1) excluding East Jerusalem that is covered by Mekorot.

[2)] including commercial and industrial uses; hence, the actual supply and consumption rates per capita are less than the indicated numbers; 93.9 MCM =105.6 lcd and 67.9 MCM =76.4 lcd (for given population over 365 days).

Source: PCBS, 2014.

[114] Website of AWWA: <www.awwa.org>.
[115] PCBS, 2015.

The value associated with the non-revenue domestic water based on average water tariffs by household as a defensive measure to augment domestic water supply and ensure the quality of drinking water amounts to US$ 47.1 million with a lower bound of US$ 40 million and an upper bound of US$ 54.2 million (Table 7.11).

For irrigation water a benchmark of 10 percent for acceptable losses is also suggested where losses are not only associated with leaks in the system but also irrigation techniques, cropping patterns, surfacing soil, drainage systems, etc. However, there is no estimates on irrigation losses in Palestine.

7. Quantity: Drawdown of the Water Table

The development of formal and informal wells is accompanied by significant withdrawals and poorly compliance and controls regarding groundwater resources. Due to groundwater drawdown, source spring waters to the aquifers function briefly over the winter months when water tables are raised sufficiently. However, the rate of pumping exceeds the natural recharge rate where an average drawdown in water table was reported as 1 m per year. This drawdown is more accentuated during summertime which could exceed the meter.

TABLE 7.12: ADDITIONAL COST OF PUMPING IN PALESTINE, 2014

Pumping Cost	Unit	Underground Water Volume	Underground Water
West Bank Groundwater Extraction	MCM	87	87
Gaza Groundwater Extraction	MCM	180	180
Total Extraction	MCM		267
Average Consumption of diesel	liter/meter of depth/m^3		0.004
Annual drawdown	meter		-1
Market price	US$/liter of diesel		1.35
Total	US$ million/year		1.1
Lower bound	US$ million/year		*0.9*
Upper bound	US$ million/year		*1.2*

Source: Arif and Doumani, 2013.

Hence, for groundwater resources, the water is affected by a lowering of the water table and deep resources of an average 1 m per year, which requires additional pumping. Thus, the change of production is considered to derive the additional cost of pumping equivalent to the CAWRD.[116] The damage cost amounts to US$ 1.1 million in 2014 with a variation of US$ 0.9 to 1.2 million (Table 7.12).

8. Scarcity: Deficit between Water Needs and Water Use

Water needs are not fulfilled in Palestine due to a number of reasons as developed in Section 3. And water scarcity is the deficit between water needs and water use which is the water available in this particular case. The water deficit is valued at the water replacement cost, i.e., desalination cost although the transport cost is not included in this case but should ideally be added when supply sources are determined. The cost for desalination for a 270,000 m^3 day capacity varies between US$ 0.5 and 0.74 per m^3.[117] A mid point is considered: US$ 0.62 per m^3. The CAWRD associated with scarcity amounts to 293.8 million in 2014 with a variation of US$ 220.4 to 455.4 million (Table 7.13). This amount should definitely decrease if Israel shares equitably the resources of the aquifers and the surface water.

[116] Arif and Doumani, 2013.
[117] Abazza, 2012.

TABLE 7.13: DEFICIT BETWEEN NEEDS AND AVAILABILITY IN PALESTINE, 2014

Palestine	Water Demand	Water Supply	Deficit	Replacement cost per m^3	CAWRD
	MCM	MCM	MCM	US$/$m^3$	US$ million
Total	826.0	352.1	473.9	0.62	293.8
Lower bound					220.4
Upper bound					455.4

Note: Table 1.1 figures are used and annually increased by 3% until 2014.
Source: Abazza, 2012 for average cost of desalination.

VIII. THE WAY FORWARD: CONCLUSIONS AND RECOMMANDATIONS

There is an indisputable conclusion that Palestinians need to seek their water rights for Palestine, including the fair right-of-access, right-of-control and right-of-use to water resources shared with other countries, in line with international law where shared water management need to be sought along these 4 building blocks:[118]

- Economically efficient water management;
- Socially and politically equitable water management;
- Ecologically sustainable water management; and
- Peaceful settlement of disputes.

Although international pressure should continue to enable the Palestinians to have access and control of their water resources, the diagnosis and analysis developed in the previous sections helped reach the following conclusions:

- **The environment neglect is a serious burden on the Palestinian Economy.** The cost assessment of water resources degradation was estimated at US$ 686 million corresponding to 9.1% of the GDP of Palestine in 2014.

- **Palestinians are suffering twice**. First, from the economic costs of the Israeli occupation related to direct utilities costs and indirect costs of to water restriction estimated in 2009 to be US$ 3.9 billion which, for comparison purpose only, could reach US$ 4.1 billion in 2014; and second, the environment cost of water degradation which is mainly caused by the Israeli occupation as well as by the Palestinians living in Palestine which was estimated at US$ 686 million for 2014 although some overlap does exist between the former and latter figure if they are added.

- **Water scarcity represents 43 percent of the degradation costs** (US$ 294 million in 2014) due partly to the withhold of Palestine share from the various riparian transboundary resources; followed almost equitably by water quality (US$ 133 million in 2014), water-related diseases (US$131 million in 2014) and water quantity (US$ 129 million in 2014).

- **The Environment health bill** is considered to be significant and six times higher the environment health bill estimated at US$ 20 million in the report of the economic costs of Israeli occupation.

- **The Unaccounted Water losses in the West Bank and Gaza are considered high and chronic.** The West Bank and Gaza average municipal water losses are estimated at 28 percent and 48 percent respectively.[119] Thus, these losses could be seen as a cost borne by taxpayers with no return on investment while, from an environmental point of view, these losses are usually recharging the aquifers.

- **It is impossible to predict the future of the water resources and supplies in Palestine,** given the complexities of the regional and national politics exacerbated by the change in demographics as well as by the effects of climate change on water resources in the region. At present integrated resources

[118] Rahaman, M. M. 2009.Shared Water-Shared Opportunities: Associated Management Principles, International Water Resources Update, 22, 15-19.
[119] PSBS, 2015.

management is impossible to achieve.[120] With such serious constraints in the supply management, demand water management can only be considered at that time, by using the existing water resources more efficiently and reallocating water resource among sectors of the economy (domestic, industrial and agricultural) while maintaining that the domestic per capita consumption should not be less than 100 to 150 lcd.

- **The fragmented resources and responsibilities between the PWA, EQA, West Bank Water Department, CMWUs in the presence of the "jungle of hundreds of small providers"[121]** in terms water access monitoring and enforcement have prevented the efficient development and management of the water and wastewater services. Major sector studies and notes stressed the importance of speeding up the process of a transparent governance in the water and the wastewater sectors. The World Bank has recommended institutional reform[122] to re-engineer the sector architecture, and to strengthen the capacities of the agencies involved from the PWA to the Joint Service Councils down to the small and large service providers. UNDP[123] has defined the principles of such good governance; and a recommendation was made to reform the JWC and the Civil Administration.[124]

- Based on the above conclusions and the meeting that the Palestinian delegation headed by H.E. Ms. Adala Atira, President of Environment Quality Authority in Palestine held in Beirut on November 26 2015, with senior staff of the Food & Environment Policies Section, Sustainable Development Policies Division in UN ESCWA, the Palestinian delegation recommended that ESCWA facilitates the development for a roadmap for assessing the cost of environmental degradation due to occupation within ESCWA plans for 2016 and to include capacity building component for 12-15 participants from Palestine to ensure that the process can be partially implemented at the national level. The road map would include the cost of environmental degradation due to the Separation Wall built by Israel as the priority and starting point for the assessment. Furthermore, the assessment can be expanded for assessing the COED due to occupation provided data is available from 1967 onwards.

[120] World Bank, 2009. "Assessment of Restrictions on Palestinian Water Sector Development," Sector Note.
[121] Ibid.
[122] Ibid.
[123] UNDP and Sweden, 2013, Water Governance in the Arab Region; Managing scarcity and securing the future.
[124] Mimi and Samhan. 2011. background paper for the report; ADA and ADC, 2007; Isaac, 2004; PWA 2009; World Bank 2009.

REFERENCES

Abazza, Hussein. 2012. *Economic Considerations for Supplying Water through Desalination in South Mediterranean Countries.* Sustainable Water Integrated Management (SWIM) financed by the European Commission and implemented by a consortium including LDK Consultants Engineers & Planners SA (Leader of the Consortium), Arab Countries Water Utilities Association (ACWUA), Arab Network for Environment and Development (RAED), DHV B.V., Global Water Partnership - Mediterranean (GWP-Med), Greek Ministry of Environment, Energy & Climate Change, Department of International, Lebanese Ministry of Energy and Water, General Directorate of Hydraulic and Electrical Resources, Tunisian Ministry of Agriculture and Environment, Bureau de l'Inventaire et des Recherches Hydrauliques/Direction Générale des Ressources en Eau, and Environment Agency, Austria (Umweltbundesamt GmbH). Brussels.

Arif, Sherif and Fadi Doumani. 2013. *Lebanon, Cost Assessment of Water Resources Degradation of the Litani Basin.* Sustainable Water Integrated Management (SWIM) financed by the European Commission and implemented by a consortium including LDK Consultants Engineers & Planners SA (Leader of the Consortium), Arab Countries Water Utilities Association (ACWUA), Arab Network for Environment and Development (RAED), DHV B.V., Global Water Partnership - Mediterranean (GWP-Med), Greek Ministry of Environment, Energy & Climate Change, Department of International, Lebanese Ministry of Energy and Water, General Directorate of Hydraulic and Electrical Resources, Tunisian Ministry of Agriculture and Environment, Bureau de l'Inventaire et des Recherches Hydrauliques/Direction Générale des Ressources en Eau, and Environment Agency, Austria (Umweltbundesamt GmbH). Brussels.

Arnold, B. and Colford, JM. 2007. "Treating water with chlorine at point-of-use to improve water quality and reduce child diarrhea in developing countries: a systematic review and meta-analysis." American Journal of Tropical Medicine and Hygiene, vol. 76(2): 354-364.

Baker, B., Metcalfe, P. Butler, S., Gueron, Y., Sheldon, R., and J,. East. 2007. *The benefits of the Water Framework Directive Programme of Measures in England and Wales.* Sponsored by Defra, Welsh Assembly Government, Scottish Executive, Department of Environment Northern Ireland, Environment Agency, Scottish Environment Protection Agency, Department of Business, Enterprise and Regulatory Reform, Scotland and Northern Ireland Forum for Environmental Research, UK Water Industry Research, the Joint Environmental Programme, UK Major Ports Group, British Ports Association, CC Water, Royal Society for the Protection of Birds, National Farmers' Union and Country Land and Business Association (the "Collaborative Partners").

Bassi, S. (IEEP), P. ten Brink (IEEP), A. Farmer (IEEP), G. Tucker (IEEP), S. Gardner (IEEP), L. Mazza (IEEP), W. Van Breusegem (Arcadis), A. Hunt (Metroeconomica), M. Lago (Ecologic), J. Spurgeon (ERM), M. Van Acoleyen (Arcadis), B. Larsen and, F. Doumani. 2011. *Benefit Assessment Manual for Policy Makers: Assessment of Social and Economic Benefits of Enhanced Environmental Protection in the ENPI countries. A guiding document for the project 'Analysis for European Neighbourhood Policy (ENP) Countries and the Russian Federation on social and economic benefits of enhanced environmental protection'*. Brussels.

Brooks, David, Julie Trottier and Laura Doliner. 2013. *Changing the Nature of Transboundary Water Agreements: the Israeli-Palestinian Case.* 38.6, 671-686.

Centre for Development and Environment (CDE). 2009. *Benefits of sustainable land management*. University of Bern. UNCCD, WOCAD, and others. Bern.

Commission of the European Communities (CEC). 1991. Council Directive of 21 May 1991 concerning urban waste water treatment (91/271/EEC). OJ L135, 30.5.1991.

Clasen, T., Schmidt, W-P., Rabie, T., Roberts, I., and Cairncross, S. 2007. "Interventions to improve water quality for preventing diarrhoea: systematic review and meta-analysis." British Medical Journal, 334:782-91.

Curtis, V. and Cairncross, S., 2003. "Effect of Washing Hands with Soap on Diarrhoea Risk in the Community: A Systematic Review." Lancet Infectious Diseases, vol. 3:275-81.

European Environment Agency (EEA). Undated: glossary.eea.europa.eu

European Environment Agency (EEA). 2009. Water resources across Europe — confronting water scarcity and drought.

Fewtrell, L., Kaufmann, R., Kay, D., Enanoria, W., Haller, L., and Colford, JM. 2005. "Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis." Lancet Infectious Diseases, vol. 5:42-52.

Global Water Partnership Mediterranean and Cornell University and the Atkinson Center for a Sustainable Future (GWP-Med, 2014). 2014. *Water Scarcity. Security and Democracy: A Mediterranean Mosaic*. Edited by Francesca de Châtel, Gail Holst-Warhaft and Tammo Steenhuis. Athens.

IFH. 2001. *Recommendations for Selection of Suitable Hygiene Procedures for the Use in the Domestic Environment*. International Scientific Forum on Home Hygiene. United Kingdom.

Kotuby-Amacher, Janice, Boyd Kitchen and Rich Koenig. 2003. *Salinity and Plant Tolerance.* Utah State University. Utah.

Larsen, Bjorn. 2011. *Cost of Environmental Degradation Degradation in the Middle East and North Africa Region: Selected Issues*. Working Paper 583. Cairo.

Lindhjem and Navrud. 2010. *Meta-analysis of stated preference VSL studies: Further model sensitivity and benefit transfer issues*. Prepared by Henrik Lindhjem, Vista Analyse, Norway, and Ståle Navrud, Department of Economics and Resource Management, Norwegian University of Life Sciences, Working Party on National Environmental Policies, OECD.

Luby, S., Agboatwalla, M., Feikin, D., Painter, J., Ward Billheimer, MS., Altaf, A., and Hoekstra, R. 2005. "Effect of hand washing on child health: a randomised controlled trial." Lancet, 366: 225-33.

MA - Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-being: Biodiversity Synthesis*. World Resources Institute, Washington, D.C. www.millenniumassessment.org/documents/document.354.aspx.pdf

Pimentel. D., Harvey. C., et al. 1995. "Environmental and economic costs of soil erosion and conservation benefits." Science. 267: 1117-23.

Rabie, T. and Curtis, V. 2006. "Handwashing and risk of respiratory infections: a quantitative systematic review." Tropical Medicine and International Health, vol. 11(3): 258-67.

Raskin, P., Gleick, P.H., Kirshen, P., Pontius, R. G. Jr and Strzepek, K., 1997. *Comprehensive assessment of the freshwater resources of the world*. Stockholm Environmental Institute, Sweden. Document prepared for UN Commission for Sustainable Development 5th Session 1997.

Sonneveld, B.G.J.S. and Dent, D.L. 2007. "How good is GLASOD?" Journal of Environmental Management, 1-10.

TEEB. 2009. *The economics of ecosystems and biodiversity for national and international policy makers - summary: responding to the value of nature*. European Commission, Brussels.

TEEB. 2010. *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*. Edited by Pushpam Kumar, Earthscan, London.

TEEB. 2011. *The Economics of Ecosystems and Biodiversity in National and International Policy Making*. Edited by Patrick ten Brink. Earthscan, London.

ten Brink, P. and S. Bassi. 2008. *Benefits of Environmental Improvements in the European Neighbourhood Policy (ENP) Countries – A Methodology*. A project working document for DGENV.

United Nations Economic and Social Commission for Western Asia and Federal Institute for Geosciences and Natural Resources (UN-ESCWA and BGR). 2013. *Inventory of Shared Water Resources in Western Asia.* Beirut.

World Health Organisation (WHO). 2002. *Environmental Health Indicators for the WHO European region. Update of Methodology*. Geneva.

WHO. 2010. *World Health Statistics 2010*. Geneva.

World Bank. 2015. *World Development Indicators*. Washington, D.C.

ANNEX I: QUANTIFICATION AND VALUATION

Water Category and Subcategories

Quality and treatment of drinking water. The treatment of drinking water can occur at two levels: at the drinking water treating station; and at the household level. The CAWRD is calculated by determining the change in production and thus, deriving the additional cost of treatment required at stations (for example, when the effluents discharged into the watershed without treatment) and determining revealed or stated preferences revealed at the household level (e.g., when a household incur additional cost to supplement water sources, buy bottle to ensure water quality, uses a filter, boil water, etc.). For the cost of the remediation, the benefits can be derived from water dilution (production change) when desalinated water is sought to be mixed with water for domestic consumption and other investments that cover all other sub categories in order to reduce the pollution of natural resource.

Quality of drinking and domestic water and sanitation in urban and rural areas as well as irrigation systems. The stated benefit is considered in this case and derived from the replacement costs associated with alternative sources of domestic water (bottles, wells, tanks, etc.). Or production costs associated with cleaning/scouring septic systems in the absence of services.

Quality of water resources. In this subcategory, it is exclusively anthropogenic origin and is affected by the discharge of domestic sewage, industrial effluents, mining and fisheries (fish in fresh water) as well as runoff due to nitrates and pesticides used in agriculture. The reduction of leachate is however covered under waste. Pollution of surface water and underground water affect water use (domestic, agricultural and industrial) ecosystem (eutrophication effects on direct, indirect and option values, etc.). Watershed and coastal areas, the cost of land, housing and apartments (hedonic) along the polluted areas, and eco-tourism (loss of opportunity especially along the river banks and polluted coasts). However, it is very difficult to assess the degradation of water quality by impact. Thus, using a contingent valuation surveys to derive the revealed preference (willingness to pay) of users to gauge the restoration of desired resource. This method is based on a transfer of benefits (see Annex III). Moreover, to restore the quality of the resource, investments usually include: a choice ranging from the use of simple and inexpensive WWTP processes such as natural ponds (common in wetland ecosystems) with primary treatment to secondary or tertiary treatments; industrial effluents treatment based on the polluter pay principle and a campaign to raise awareness among farmers is to optimize the use of pesticides and nitrates and promoting organic farming. In an extreme case where the resource is unrecoverable, a substitution of the resource by a remote water supply, and desalination and transportation of the water resources should be considered.

Salinity. The salinity of the surface water and groundwater is of natural and anthropogenic origin (soil erosion due to human activity), and effects on health if the water is used for domestic purposes (see above Drinking Water Quality), agricultural productivity and ecosystems. Only the effects on agriculture are taken into account in this case with the use of a production change to derive the CAWRD. The cost of remediation may include several alternatives: the salinity compensation using more fertilizer (however this is perverse because it pollutes water resources); dilution of groundwater resources by injecting normal wastewater treated; better land use by implementing a planning strategy that includes reforestation, responsible land management, prevention or mitigation of water and wind erosion soil etc. And in an extreme case where the resource is unrecoverable, a substitution of the resource by a remote water supply, and desalination and transportation of the water resources should be considered.

Water-related diseases. The change in health status is considered in this subcategory. Some parameters of water quality do not affect the taste of water such as the excess of dissolved solids and sulfates. However, the bacteriological quality of the water can cause diseases such as typhoid, hepatitis A, trachoma and nematodes. In addition, the physico-chemical quality of the water can cause high blood levels of methemoglobin, high blood pressure and Blue baby syndrome which are respectively due to the excess of chlorides, sodium and nitrates. However, the causality between water quality and diseases is very difficult to establish definitively especially when it comes to cases of cancer associated with the ingestion of pesticides that contaminate drinking water or the food chain. Thus, the most reliable causality is that between the diarrhea that is transmitted through biological contamination on the one hand and the lack of water quality including water drinking water, inadequate sanitation status within the household and lack of hygiene (proper use of soap) by household members. Thus, a dose-response function, which has largely been established by a large number of studies, was used to value water-borne diseases, including premature mortality and morbidity from diarrhea affecting children under 5 years and morbidity affecting the 5 year and more age group. Thus, the prevalence of diarrhea in the region and the coverage of drinking water and sanitation were considered in the dose-response function to derive the results. Regarding mortality, it is difficult to assign a value on premature death and this is usually controversial. Yet the value of a human statistical life (VSL), which represents the reduction of risk of premature death, was used. Also, the cost of illness was considered for morbidity (hospitals, doctors, nursing assistants, medication, number of days of inactivity, etc.). The cost of remediation includes investments to increase the coverage of water supply and sanitation. This should be accompanied by a good performance in terms of operations and maintenance that are accounted in the analysis and the launch of an awareness campaign for a change in behavior with regard to hygiene in the households. Effectiveness of services. Opportunity costs can also be calculated for the technical losses in the distribution network, which are considered in this study, or lost time to carry water or clean / disgorge septic tanks. Furthermore, an increase in the efficiency of irrigation systems is done using the change in productivity.

Quantity. The scarcity of water resources could be a natural phenomena and/or anthropogenic, and it manifests itself by reducing the flow or runoff, which is exacerbated by the increased use of the resource to sustain population growth and economic activities. Moreover, the lengthening and disruption of cycles of drought (frequencies and intensities) affect surface water and drawdown groundwater. The lack of flow is usually offset: in an emergency, by the spontaneous use of wastewater treated or untreated, which could cause contamination of the food chain, in an intermediate case, by in-depth pumping (rapid drawdown or use of non-renewable fossil water) underground resources necessary to address domestic needs and/or maintain agricultural productivity. In an extreme case, a substitution of the resource requires a water supply augmentation via transfers or desalination that increase the transport cost. The change in production, opportunity costs (foregone) and replacement costs are considered when calculating the CAWRD while the cost of the remediation depends on the chosen alternative.

Erosion and Storage. Management of water resources is affected by erosion and exacerbated by climate changes that reduce storage capacity. The siltation and sedimentation of dams, hill lakes, riverbeds and coasts are compounded by inadequate land use upstream (such as deforestation, irresponsible management of soil, water and wind erosion of soils, etc.) and exacerbated by climate change through the increased frequency and intensity of floods sometimes during wet seasons. Replacement costs can be calculated by considering the reduction of the nutritional value of the soil that must be compensated by fertilizer, the opportunity costs (releases required to drain overflows) of water loss and damage to the ecosystem, defensive expenditures (dredging, construction of small lakes to absorb excess sedimentation), replacement costs (higher dams or building new dams), opportunity costs (loss of income) due to the reduction the volume of water stored and

reducing the life of dams and hill lakes, and reduction of ecosystem services. Moreover, the costs of remediation are in some cases the same costs used to value the degradation such as investments for the construction of new dams. But the remediation costs might also include the implementation of a land use strategy that can include instruments such as reforestation, construction of terraces, responsible land management, prevention or mitigation of water and wind soil erosion, etc.

Scarcity. Water scarcity is defined as the difference between water needs and water use.

ANNEX II: SPECIFIC METHOD FOR WATER RESOURCES

The total economic value (TEV) of water is a combination of use and non-use type of values (Table A2.1). Use values include direct use and indirect use values. Non-use values include existence values, option and bequest values. An example based on hypothetical improvements in river water quality has been chosen to explain each category:

*Use Value*s arise from the actual and/or planned use of the service by an individual, and be direct or indirect:

- Direct, such as when an individual makes actual use of the environmental asset improved, for example, fishing where it was not possible to catch a fish before the improvements in water quality took place;
- Indirect use values are the benefits derived from ecosystem functions gained, for example, where recreational activities are created or enhanced due to water quality improvements, individuals can benefit in the form of increased recreational opportunities without having to make a direct use of the resource (e.g., walking alongside the river bank).

Non-use values are often divided into:

- Existence values, which arise from knowledge that the service exists and will continue to exist, independently of any actual or prospective use by the individual. This type of use refers to the economic value people place on improvements to the quality of a river due to some moral and/or altruistic reasons, or for the mere pleasure of knowing that the river's water has been enhanced;
- Option values refer to the value place on resource's future use. Because individuals are not sure whether they will use the resource in the future, they are willing to pay to maintain the ability to use it;
- Bequest value is the value an individual places on the ability to preserve a resource so that it can be used by future generations.

TABLE A2.1 TYPES OF BENEFITS COVERED WITH THE PROPOSED METHOD

Benefit	**Types of water uses**			**Example**
Potential water quality benefits	Current use benefits	Direct use	In stream	Recreational activities: Fishing, swimming, boating
		Indirect use	Near stream	Recreational activities: Hiking, trekking
				Relaxation, enjoyment of peace and quiet
				Aesthetics, enjoyment of natural beauty
	Non use		Option	Preferences for future personal use of the resource
			Existence	Maintaining a good environment for all to enjoy
			Bequest	Enjoyment from knowledge that future generations will be able to make use of the resource in the future

Source: Adapted from Baker et al. (2007).

The achievement of GES for water resources in Palestine is important because of the current trends in water pollution and availability. These are in most cases beyond the assimilative capacity of the aquatic ecosystems, which make freshwater quality a principal limitation for sustainable development.

In order to transfer the benefit functions from Baker et al. (2007), the following variables have been adjusted from the original model:

- Current fresh water quality levels in Palestine (below standards);
- Average income levels per household in Palestine (World Bank);

- Other socio-economic data: GDP in local currency and PPP conversion factors in Palestine (World Bank).

These parameters are used in the WTP formulae to directly calculate the annual Willingness to Pay (WTP) for set improvements in freshwater quality per household per year.

Considering the benefits derived from water quality improvements is essential for making sound decisions regarding the country's aquatic ecosystems and habitats. Decisions could for example relate to efficient and equitable infrastructure investment in the water sector, to the efficient degree of waste water treatment and to the design of policy measures, including economic instruments such water pricing or taxes on water depletion and pollution.

Society's preferences for environmental improvements do not have a market value and have to be estimated in monetary terms by using valuation techniques. 'Non-market valuation' techniques must be applied to establish this portion of the TEV of water use. Valuation techniques are based either on revealed preference (based on observed market values that can be used as substitutes for the improved environmental resource) or on stated preferences (based on surveys of willingness to pay, especially for household water use and recreational services).

Determining the value of an individual's or community's use of water is very difficult, because water values are highly site-specific, dependent on type of uses, as well as season, water quality, availability and reliability. As for types of uses, people make different uses of water resources, which translate into different values. For example, the value of water for cooling purposes in hydropower is different to that of water used for irrigation in agriculture or for fishing in a lake.

Due to the lack of regional valuation studies on the topic, and the **impracticability, due to time and budget constraints,** to conduct an original valuation study, the Benefits Function Transfer (BFT) approach has been applied to estimate the TEV of cleaner water. This method allows for the incorporation of differing socio-economic and site quality characteristics between the original study site for which the original benefits estimates were obtained and the policy site under evaluation. Under this approach, typically only one original valuation study is selected. The main assumption made is that the statistical relationship between WTP values for improvements and independent variables are the same for both the study and policy site. In other words, the method assumes that preferences/tastes are the same for both locations and differences in WTP are only related to differences in socio-economic and/or environmental context variables.

For this report, the benefit functions from Baker et al. (2007) have been transferred to Palestine. This study has recently estimated the economic value placed by English and Welsh households for water quality improvements at local and national level as a result of implementing the Water Framework Directive (WFD) in the UK. This study is one of few studies that employed a standard WFD ecological-based water quality metrics for description of baseline levels and improvements. As an additional feature, Baker et al. (2007) offers detailed results for two different WTP elicitation methods in the same survey instrument, i.e., Contingent Valuation (CV) using both payment card (PCCV) and dichotomous choice (DCCV) as payment mechanisms. The advantage behind the use of two different elicitation methods for the transfer exercise (the PCCV and the DCCV results) is the need to offer ranges of WTP estimates that are representative for policy purposes and illustrate the uncertainty surrounding the results (i.e., sensitivity analysis).

The following are important aspects to take into consideration when making use of the results reported below: 1) only people resident in Palestine are considered. any possible value that visitors to the country may have on the

overall quality of water resources is not accounted for in this method; 2) values have not been separated by types of uses of water, although the types of values outlined in Annex II Surface Water Benefit Transfer in A2.1 are all covered in the analysis; 3) the analysis illustrates a portion of the TEV of water quality improvements in Palestine, only valuation of people's preferences for changes in quality are included here; and 4) it has been assumed that all water bodies of Palestine have the same value. This assumption becomes important when considering that values for some water bodies may be higher if they are of significant importance (for example for cultural reasons) or if water resources are scarce. Values may also decrease when overall water quality in the country increases as a result of the improvements.

The benefits from water quality improvements covered in this section by the application of the BFT method are related with the quantifiable portion of the TEV of particular use and non-use types derived from the enjoyment of good water quality by local residents of the country. The specific types of water uses covered in the model are highlighted with examples in Table A2.1. It is important to note that it is not possible to disaggregate values for the different types of uses outlined and that other types of water uses are valued and assessed in other sections of this report.

The three scenarios retained in the Baker et al. (2007) study are as follows:

- Scenario 1: 33 percent Successive Improvement after 9 years, 15 years and 20 years;
- Scenario 2: 50% Improvement after 9 years, 30% after 15 years and 20% after 20 years; and
- Scenario 3: 100 percent Improvement after 9 years.

TABLE A2.2 WTP PER HOUSEHOLD BASED ON PAYMENT CARD AND DICHOTOMOUS CHOICE BENEFIT TRANSFER, 2014

WTP per capita		**Scenario 1 33% Successive Improvement after 9 years, 15 years and 20 years (CL: 95%; CI ±2.5%)**		
	Million	US$/year		
	2014	2012		
		Low	**Mid**	High
Total	4.76	1.69	2.26	2.82

Note: $PPP GDP per capita was used to adjust income differential between the UK and Palestine and the income elasticity is considered at 0.4.
Source: Baker et al. (2007); World Bank (2015); and Authors.

Mean WTP values for scenario 1 in Palestine ranges between US$ 1.7 and US$ 2.8 per year per capita (Table A2.2) depending on the two payment mechanisms used in the original contingent valuation method employed in Baker et al. (2007). Results are shown in a range to illustrate the degree of uncertainty associated with the benefits estimates that were elicited through a survey that used the Contingent Valuation (CV) methodology using both payment card (PCCV) and dichotomous choice (DCCV) as payment mechanisms. The lower end of the range represents mean values of the PCCV format and the upper-bound range is derived from the DCCV model. The benefit transfer provides "order of magnitude" results, in order to communicate the scale and significance of the potential benefits arising from improved surface water quality.

Considering the benefits derived from water quality improvements is essential for making sound decisions regarding the country's aquatic ecosystems and habitats. Decisions could for example relate to efficient and equitable infrastructure investment in the water sector, to the efficient degree of waste water treatment and to the

design of policy measures, including economic instruments such water pricing or taxes on water depletion and pollution.

Society's preferences for environmental improvements do not have a market value and have to be estimated in monetary terms by using valuation techniques. 'Non-market valuation' techniques must be applied to establish this portion of the TEV of water use. Valuation techniques are based either on revealed preference (based on observed market values that can be used as substitutes for the improved environmental resource) or on stated preferences (based on surveys of willingness to pay, especially for household water use and recreational services).

Determining the value of an individual's or community's use of water is very difficult, because water values are highly site-specific, dependent on type of uses, as well as season, water quality, availability and reliability. As for types of uses, people make different uses of water resources, which translate into different values. For example, the value of water for cooling purposes in hydropower is different to that of water used for irrigation in agriculture or for fishing in a lake.

Due to the lack of regional valuation studies on the topic, and the **impracticability, due to time and budget constraints,** to conduct an original valuation study, the Benefits Function Transfer (BFT) approach has been applied to estimate the TEV of cleaner water. This method allows for the incorporation of differing socio-economic and site quality characteristics between the original study site for which the original benefits estimates were obtained and the policy site under evaluation. Under this approach, typically only one original valuation study is selected. The main assumption made is that the statistical relationship between willingness-to-pay (WTP) values for improvements and independent variables are the same for both the study and policy site. In other words, the method assumes that preferences/tastes are the same for both locations and differences in WTP are only related to differences in socio-economic and/or environmental context variables.

ANNEX III: BENEFIT TRANSFER METHODOLOGY

Given the complexity and costliness of performing a CV, the next best alternative was to use a benefit transfer for CV performed for the DALY lost in terms of Value of Statistical Life, which is a WTP to reduce the risk of dying prematurely, and the WTP to improve water resource quality.[125] The benefit transfer involves transposing existing monetary environmental values estimated at one site (study site) to another (policy site), usually with similar context or physical characteristics.[126] There are two approaches for the benefit transfer: the unit value transfer; and the transfer function. In this particular case, we will rely on the unit value transfer and more specifically on the transfer of the unit to adjust for differences in income value as described in Navrud (2009).

The transfer of the unit to adjust for differences in income value is as follows:

$$WPp = WPs \times (Yp / Ys)^{ß}$$

Where :

WPp = willingness to pay by household in policy country
WPs = willingness to pay by household in study country
Yp = income in the country policy denominated in purchasing power parity dollar (PPP$)
Ys = income in the country of study denominated in purchasing power parity dollar (PPP$)
ß = income elasticity for different environmental goods and services, which are considered normal goods,[127] are typically greater than 0 (perfectly inelastic which would have meant that the WPp = WPs only adjusted by income where ß = 0) and smaller than 1 (inelastic), and often range between 0.7 and 0.4.

In this particular case, the lower and upper income elasticity is assumed to be conservatively set between 0.7 (more inelastic) and 0.4 (less inelastic), which means that the percentage responsiveness of quantity demanded (in this case the resource) is significantly and slightly lower to the percentage change in income respectively. For Palestine, the 0.4 elasticity is used.

[125] Per Capita GDP Adjustment for Transnational Transfer: this implies that people spend a smaller proportion of their disposable income on environmental impacts when income decreases. The underlying implication is that environmental goods and services are neither necessities nor luxury goods but normal goods, since the poor spend more of their income on necessities than the rich.
[126] Navrud (1996); and USDA website: <www.csrees.usda.gov/nea/nre/in_focus/ere_if_environmental.html>.
[127] Pearce (2003).