STATUS OF THE ENVIRONMENT IN THE STATE OF PALESTINE 2015




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LIST OF ABBREVIATIONS

Abbreviation	Full Name
AECID	Spanish Agency for International Cooperation and Development
ARIJ	Applied Research Institute - Jerusalem
BIE	Bethlehem Industrial Estate
BOD	Biological Oxygen Demand
CBD	Convention of Biological Diversity
CESCR	Committee on Economic, Social and Cultural Rights
CO_2	Carbon Dioxide
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
COMSC	Cabinet of Ministers Steering Committee
CM	Cubic Meter
CMIP5	Coordinated Modelling Intercomparison Project Phase 5
CMWU	Coastal Municipalities Water Utility
EIA	Environmental Impact Assessment
EM	Eastern Mediterranean
EMT	Eastern Mediterranean Transient
EQA	Environmental Quality Authority
ETC	Extra Tropical Cyclones
EWASH	The Emergency, Water, Sanitation and Hygiene Group
FAN	Freshwater Action Network
FAO	United Nations Food and Agriculture Organization
FOME	Friends of the Earth Middle East
FS	Feasibility Study
GEF	Global Environment Facility
GHG	Green House Gases
GIS	Geographic Information System
GIE	Gaza Industrial Estate
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HC	Hydrocarbons
ICA	Israeli Civil Administration
ICRC	International Committee of the Red Cross
IDF	Israel Defense Forces
IPCC	Intergovernmental Panel on Climate Change
ISIC	International Standard Industrial Classification
IUCN	International Union for the Conservation of Nature
IWRMP	Integrated Water Resources Management Plan
IWSR	Institutional Water Sector Review
JAIP	Jericho Agro – Industrial Park
JSC for SWM	Joint Services Councils for Solid Waste Management
JIE	Jenin Industrial Estate

JSC	Joint Services Councils
JSCPD	Joint Services Councils for Planning and Development
JWC	Joint Water Committee
KBA	Key Biodiversity Areas
Kg/capita/day	kilograms per capita per day
l/c/d	Liter per capita per day
LR	Legislative Review
MAS	Palestine Economic Policy Research Institute
MCM	Million Cubic Meter
MEnA	Ministry of Environmental Affairs
MoH	Ministry of Health
MoLG	Ministry of Local Government
MoPAD	Ministry of Planning and Administrative Development
MoPWH	Ministry of Public Works and Housing
MoPWH	Ministry of Public Works and Housing
NAPs	National Action Programmes
NDP	National Development Plan
NEAP	National Environmental Action Plan
NGO	Non-Governmental Organization
NIS	New Israeli Shekel
NPPD	Net Palestinian Population Density
NIPD	Net Israeli Population Density
NBSAPP	National Biodiversity Strategy and Action Plan for Palestine
NPA	National Policy Agenda
NAMA	Nationally Appropriate Mitigation Actions
NAPA	National Adaptation Plans of Action
NAP	National Action Programmes
NCP	North-Sea Caspian-Sea Pattern
NIP	National Implementation Plan
NCSA	National Capacity Self-Assessment
NPFE	National Portfolio Formulation Exercise
NMVOC	Non-methane volatile organic compounds
NSSWM	National Strategy for Solid Waste Management
NOA	North Atlantic Oscillation
NOx	Nitrogen Oxides
NWC	National Water Carrier
NWP	National Water Policy
O&G	Oil and Grease
PA	Palestinian Authority
PARC	Palestinian Agricultural Relief Committees
PCBS	Palestinian Central Bureau of Statistics
PES	Palestinian Environmental Strategy

PHG	Palestinian Hydrology Group
PIEFZA	Palestinian Industrial Estates & Free Zones Authority
PLO	Palestinian Liberation Organization
PNA	Palestinian National Authority
POPs	Persistent Organic Pollutants
PRSP	Poverty Reduction Strategy Paper
PSI	Palestinian Standards institute
PWA	Palestinian Water Authority
PWEG	Palestinian Wastewater Engineers' Group
RST	Red Sea Trough
RCPs	Representative Concentration Pathways
SAPs	Strategy Action Programmes
SDGs	Strategic Development Goals
SOx	Sulfur Oxides
SST	Sea Surface Temperature
SWM	Solid Waste Management
TSS	Total Suspended Solids
UAWC	Union of Agricultural Work Committees
UJR	Upper Jordan River
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Emergency Fund
UNRWA	United Nations Relief and Works Agency
USAID	U.S. Agency for International Development
USD	US Dollar
USM	Union Of Stone & Marble in Palestine
VOC	Volatile Organic Compounds
WBWD	West Bank Water Department
WERD	Water and Environment Research Department
WHO	World Health Organization
WSRC	Water Sector Regulatory Council
WSSA	Water Supply and Sewerage Authority
WW	Wastewater
WWTP	Wastewater Treatment Plant

PREFACE

In 1997, the Applied Research Institute – Jerusalem (ARIJ) published its first comprehensive "Environmental Profile" for the West Bank entitled, “The Status of the Environment in the West Bank”. The Profile included: (1) an overall description and assessment of the state of the environment; (2) a baseline against which changes in the environment can be benchmarked; and (3) a blue-print for future actions to be considered to protect and sustain the environment of the West Bank.

A decade later, ARIJ published an updated profile for the occupied Palestinian territory (oPt), entitled, "The Status of the Environment in the oPt - 2007". The 2007 profile covered both the West Bank and Gaza Strip in order to bring into the forefront the geopolitical conditions that have impacted the potential for sustainable development in the oPt. In 2011, the environmental profile was updated to: (1) monitor and report changes in the state of the environment in the oPt; (2) to expand the scope of the profile to include the human dimensions of environmental change; and (3) to advocate the fundamental right of every Palestinian to an environment adequate for their health and well-being.

The present update of the Environmental Profile will present: (1) a narrative, statistical and cartographic description of the current environmental status in Palestine; (2) the major trends and changes in the environmental indicators over the period from 2011 - 2015; (3) the progress in the legislative, institutional, and developmental aspects of environmental action; (4) the Israeli violations of the Palestinian environmental law and the international conventions for the protection of the environment and basic human rights; and (5) the progress towards achieving the goals set forth by the relevant national strategies and the national development plan.

Dr. Jad Isaac
General Director

Bethlehem - Palestine
December, 30, 2015

1. INTRODUCTION

MAP 1.1: PALESTINE WITHIN THE CURRENT REGIONAL CONTEXT

1.1 The Basic Human Right for a Safe and Sustainable Environment

The relationship between development and human rights, both in terms of concept and practice, has a long history. Human rights and sustainable development are interdependent, inextricably linked, and mutually reinforcing. People are at the center of sustainable development, and as such, "The logic of human rights in development is inescapable" (Robinson, 2000). The development of a society requires the meeting of the basic needs of each individual. The right to development declares that all people should be treated equally in the access to the resources and the means of sustainable development.

The link between sustainable development and human rights has developed over the years. The first time for the right to development to be recognized as an individual and collective right was in 1981, in Article 22 of the African Charter on Human and Peoples' Rights "All peoples shall have the right to their economic, social and cultural development with due regard to their freedom and identity and in the equal enjoyment of the common heritage of mankind". Later, the right to development was proclaimed by the United Nations (UN) General Assembly in its resolution No. 41/128, the Declaration on the Right to Development of 1986, which was adopted. Article 1.1: “The right to development is an inalienable human right by virtue of which every human person and all peoples are entitled to participate in, contribute to, and enjoy economic, social, cultural and political development, in which all human rights and fundamental freedoms can be fully realized”. Article 1.2: “The human right to development also implies the full realization of the right of peoples to self-determination, which includes, subject to the relevant provisions of both International Covenants on Human Rights, the exercise of their inalienable right to full sovereignty over all their natural wealth and resources”. The UN Conference on Environment and Development (Rio Declaration) that took place in 1992 recognized the right to development as one of its 27 principles. Principle 3 of the Declaration states "The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations". Since then the importance of applying a human rights' based approach to meet the objectives of sustainable development has been better understood. The right to development was afterward recognized in the Arab Charter on Human Rights and reaffirmed in several international instruments including, the Vienna Declaration and Programme of Action of 1993, the Copenhagen Declaration on Social Development and Programme of Action of 1995, the Millennium Declaration, the Monterrey Consensus of 2002, and the World Summit Outcome Document of 2005. The Declaration on the Rights of Indigenous Peoples of 2007 recognized the right to development as an indigenous peoples' right, as they have the right to define their own development priorities.

The practices of the Israeli Occupation and control used by the Israeli Authorities have systematically hindered the development of the Palestinians, contributed to poverty increase among them, damaged the environment in the process and resulted in major physical impediments towards accomplishing sustainable development in the OPT. Environmental problems, such as land degradation, deterioration of biodiversity, depletion of water resources, deterioration of water quality, air pollution, etc. have dramatically accelerated during the ongoing Israeli Military Occupation since 1967. These Israeli practices are therefore a clear violation of the aforementioned charters on Human Rights for safe and healthy environment as well as the Human Rights for sustainable development of their resources. The case of the State of Palestine strongly illustrates the often negative relationship between occupation and environmental degradation. All the facts indicate that the Palestinian environmental rights have

been badly violated by the Israeli Occupiers specially during the so-called "peace process". This report provides a systematic review of the state of environment in Palestine and documents the Israeli violations of the Palestinian Environment.

1.2 Physical Characteristics of Palestine

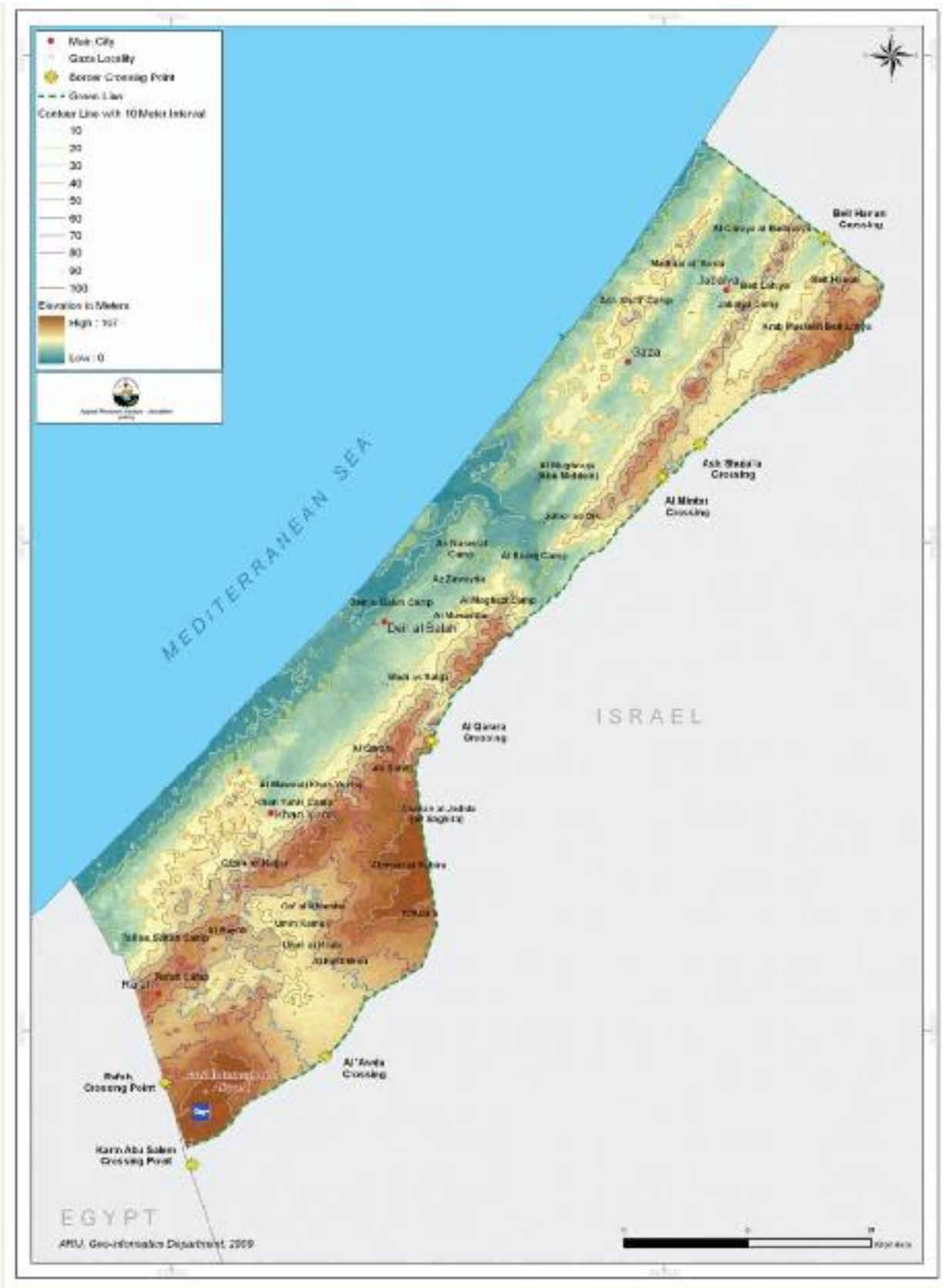
Historical Palestine is part of the historic 'Fertile Crescent', which is considered the cradle of the human civilization and the origin of agriculture. Its unique location at the crossroads between Asia, Europe, and Africa has made Palestine an environmental melting pot for the flora and fauna of the three continents. The total area of historical Palestine is estimated at 27,000 km^2. However The State of Palestine, as it stands today, consists of two physically separated land masses, namely the West Bank and Gaza Strip, with a total area of 5,661 km^2 and 362 km^2, respectively. The West Bank is surrounded by Israel to the west, north, south; and the Jordan River to the east. It is divided into eleven governorates: Jenin, Tubas, Tulkarm, Nablus, Qalqiliya, Salfit, Ramallah and Al-Bireh, Jericho, Jerusalem (East Jerusalem), Bethlehem, and Hebron. The Gaza Strip is a coastal zone at the eastern extreme of the Mediterranean Sea on the edge of the Sinai Desert. It is surrounded by Israel to the east and north, Egypt to the south and the Mediterranean to the west. It is composed of five governorates: North Gaza, Gaza, Deir al Balah, Khan Yunis, and Rafah (**Map 1.1**).

1.2.1 TOPOGRAPHY

Despite its small geographical area, Palestine is characterized by a great variation in topography and altitude, especially in the West Bank where the variation ranges between 1,020 meters above sea level to 420 meter below sea level (**Map 1.2**). This variation is directly reflected on the climate and the distribution and diversification of agricultural patterns, from irrigated agriculture in the Jordan Valley to rainfed farming in the mountains. The West Bank is divided into four major geomorphological areas; Central Highlands, Semi-coastal region, Eastern Slopes region, and the Jordan Valley. The mountainous area of the West Bank serves as the main rainfall collection and replenishment zone for the groundwater aquifers. Many drainage and valley systems are spread in and amongst these aforementioned areas.

The Gaza Strip is essentially a foreshore plain gradually sloping westwards. In the north of the Gaza Strip there are four ridges with different elevations, ranging between 20 to 90 meters above sea level (**Map 1.3**). The four ridges are: Coastal ridge, Gaza ridge, El-Muntar ridge, and Beit Hanoun ridge. Active dunes can be found near the coast especially in the southern part between Deir el Balah and Rafah. Areas with large accumulation of loess can be found 15 km southwest of Gaza and east of Khan Yunis.

MAP 1.2: WEST BANK TERRAIN MODEL



MAP 1.3: THE GAZA STRIP TERRAIN MODEL

1.2.2 GEOLOGY

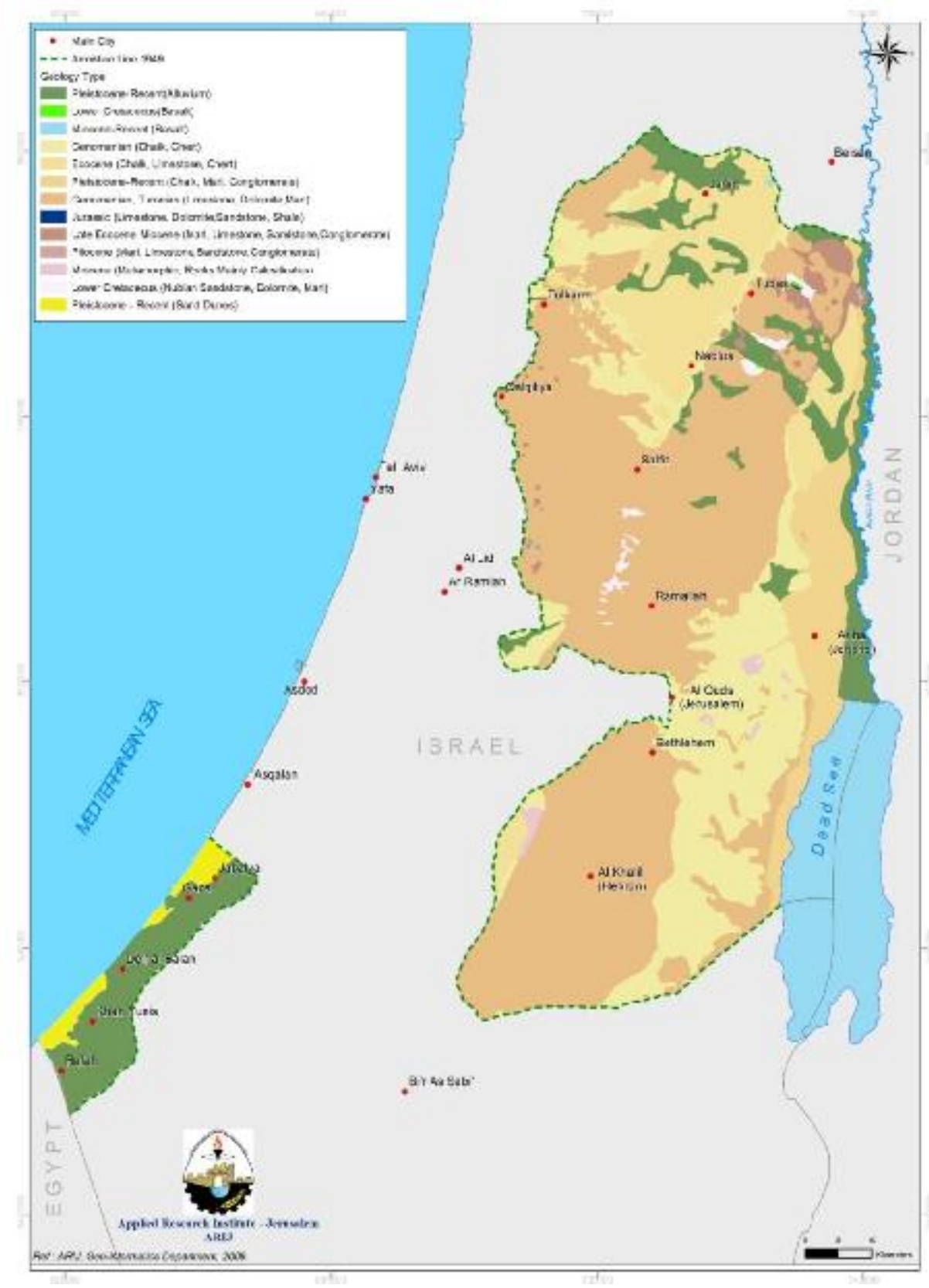
Historical Palestine lies on the northwestern part of the Arabian Shield which is a part of the Nubian-Arabian Shield. During its geological history, this Shield separated from the great Afro-Arabian Shield along the Red Sea line. A branch of this breakage extended along the line of the Gulf of Aqaba, Wadi Araba, the Dead Sea, and the Jordan Valley, and continued northwards to reach Lebanon, Syria and Turkey.

The West Bank occupies the western part of this branch, known as the Jordan Rift Valley that was formed after the Miocene age. The Arabian Shield consists of a complex of crystalline plutonic and metamorphic rocks (known as basement rocks). The metamorphic rocks of the Shield are mainly of a sedimentary origin. The western and northern parts of the Shield received large amounts of clastic sedimentary rocks. During the geological times, these sediments (also known as Shelf deposits) lay with unconformity over the basement rocks. Within the Shield deposits are two sedimentary bodies; the stable continental and the unstable marine. The terrestrial body is marked by interfingering of neritic and lateral deposits. The marine body is mainly composed of carbonate sediments. The West Bank is dominated by this marine body, and most of it is covered by carbonate deposits from the Mesozoic and Cenozoic eras.

The oscillation of the old Tethys Sea over Historical Palestine has resulted in the distribution of marine sediments, hence making it the dominant body in the West Bank.

Throughout the Gaza Strip, the Quaternary deposits are underlain by the Saqiya Formation deposited during Pliocene-Miocene. This formation consists of shallow marine clays, shales and marls, reaching depth of about 1,200 m at the shoreline and fanning out at the eastern boundary of the Strip. Well logs from deep oil exploration wells in the area show that below the Saqiya formation there are other Tertiary deposits (such as chalks, limestones, sandstones and marls) which are found up to a depth of 2,000 m. The quaternary deposits in the Gaza area are about 160 m in thickness.

Currently, the majority of the exposed rocks in the West Bank are marine sediments, mainly composed of carbonates (such as limestone, dolomite, and chalk). **Map 1.4** below shows the lithological units of the West Bank and the Gaza Strip.

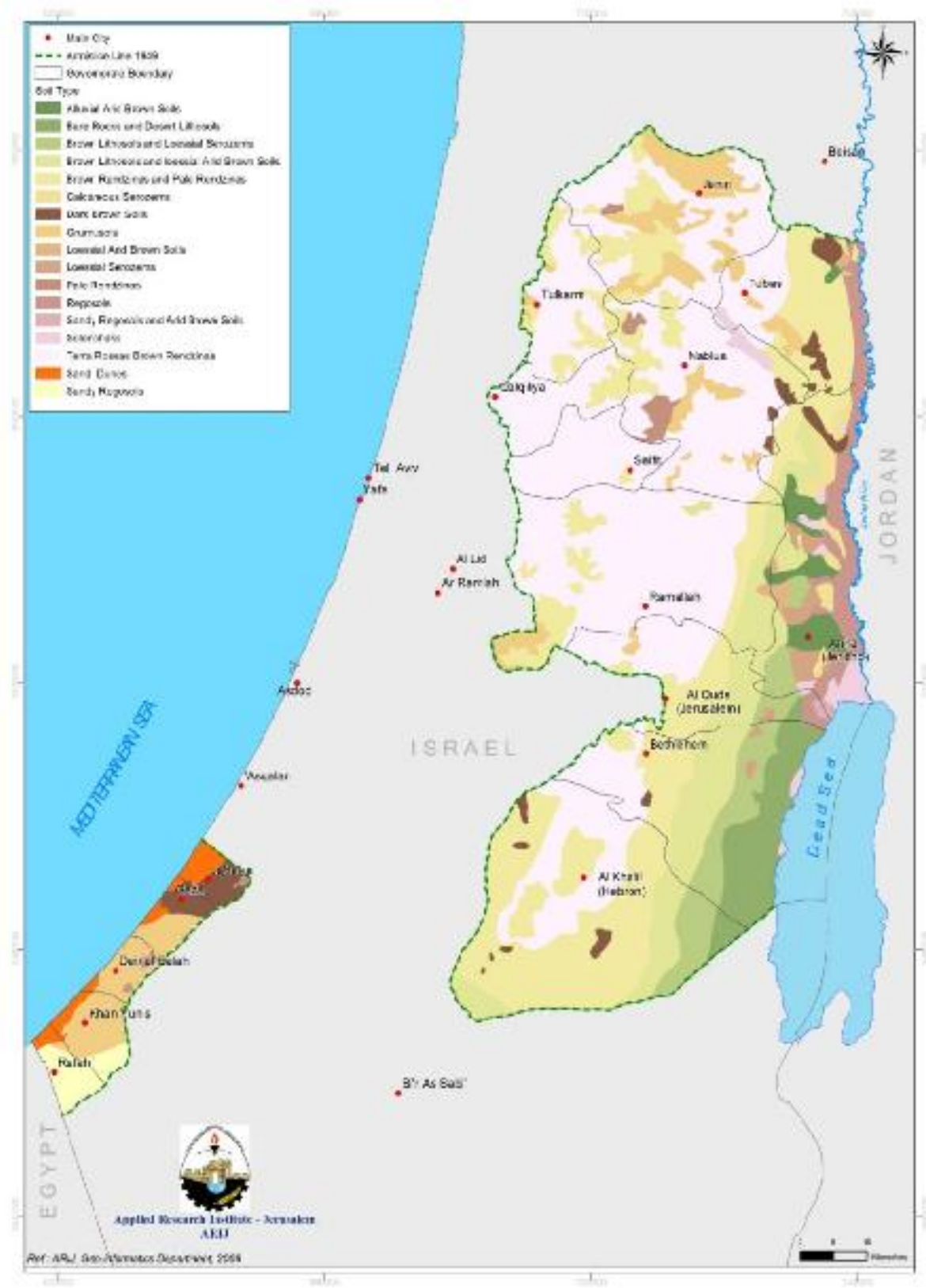


MAP 1.4: GEOLOGICAL MAP OF PALESTINE

1.2.3 SOILS

Although the geographic area of Palestine is relatively small, soils are highly variable in type and characteristics (**Map 1.5**). Soils in Palestine are formed due to several conditions including; climate, physical weathering from wind and water, and other topographic materials, geology, and vegetation. The major soil associations in Palestine are Terra Rossa and Brown Rendzinas; dominating the Central Highlands of the West Bank. Brown Rendzinas and Pale Rendzinas are found to the north and south of the mountain ridge, in Tubas, Qalqiliya, and Hebron Governorates, and also in regions of the Eastern Slopes. In the Gaza Strip, the most common soil type is Grumosols, which dominates the semi-arid loess plain area. Grumosols are also found in the far north and far west of the West Bank, coinciding with low-lying areas that enjoy a more temperate climate than other parts of the highlands. The soil resource of an area is one of the most important elements of its natural resources' base.

The different aridity indices in Palestine especially in the West Bank, with an arid to hyper-arid area along the eastern parts, and semiarid to sub-humid area along the western parts, has resulted in high diversity of soils.



MAP 1.5: SOIL MAP OF PALESTINE

1.2.4 CLIMATE

The State of Palestine lies within the Mediterranean climatic zone. Gaza Strip, in particular, is part of the Mediterranean coast. The climate of the state of Palestine is characterized by a long, hot, dry summers and short, cool, wet winters. Only the southern part of the Jordan Valley has a different transitional climate between dry steppe and the extreme desert conditions of the Dead Sea region. Using the United Nations Environmental Program Aridity Index[1] (UNEP, 1992, 1997), the eastern slopes of the West Bank can be classified as arid to hyper-arid whereas the Western parts of the West bank can be classified as semi-arid to sub-humid.

Climate within Palestine is affected by distance from the Mediterranean, latitudinal position, altitude and orographic effects. Accordingly, the West Bank is divided into four main climatic regions, including; the Jordan Valley, the Eastern Slopes, the Central Highlands, and the Western Slopes. The climate of the West Bank, especially in the south, is influenced by the vast nearby Negev and Arabian deserts especially during spring and early summer. Desert storms move through with hot winds full of sand and dust (locally known as Khamaseen winds) increasing air temperatures and decreasing air humidity.

Precipitation: The rainy season usually starts in the middle of October and continues up until May, where most of the rain falls during the period between November and March. Snow and hail, although uncommon, occur in areas of the West Bank, with the greatest frequency falling in the west of this area, and over the highlands. In the West Bank the average annual rainfall is 535 mm. In the Gaza Strip, the average annual rainfall is 359 (MoA, 2013).

Temperature: In the state of Palestine, temperature is relatively high. The highest temperatures are in Jericho and the Jordan Valley. Temperatures in the Jordan Valley increase from north to south and is inversely related to altitude, with the highest temperature in the Dead Sea. The Dead Sea is the lowest point on Earth and is surrounded by a series of high mountains from both east and west, creating a natural greenhouse climate. During summer months, June to August, the mean monthly temperatures in the West Bank range between 20.8^{o}C and 30^{o}C. In winter, December to February, the mean monthly temperatures in the West Bank range from 8.7^{o}C to 14.7^{o}C. The Gaza Strip is located in a transitional zone between the arid desert climate of the Sinai Peninsula and the temperate and semi-humid Mediterranean climate along the coast. The average temperatures range between 25^{o}C in summer to 13^{o}C in winter.

Sunshine Duration: The state of Palestine has a sunny climate. The Palestinian inhabitants depend on this renewable source of energy (solar energy) for water heating. Solar radiation, reaching Palestine, varies from one place to another. The longest hours of sunlight occur in June or July and the shortest from December to February. In the summer, solar radiation is strengthened by almost completely clear skies. In the winter, a reduction in solar radiation occurs due to cloud cover. The solar radiation reaches its lowest value in December, when the sun is over the Tropic of Capricorn (Southern Tropic) and the days are short.

Relative Humidity: The relative humidity has an influence on people and on all living organisms, especially the very low humidity experienced during the Khamaseen. Hot winds may cause damage to

[1] Arid (0.05≥ Precipitation(P)/Potential evapotranspiration (PET)<0.20, ≤75 growing days/yr), semi-arid (0.20≤ P/PET<0.50, 75≤ growing days/yr<120), and dry sub-humid (0.50≤ P/PET<0.65, 120≤ growing days/yr<180).

the skin of people and animals. Agricultural crops are also affected, especially when the dry wind blows during the flowering period; the first stage of fruiting. The relative humidity in the state of Palestine varies between 50-70%. The Gaza Strip has the highest annual mean relative humidity (69%), increasing from winter to summer. On the other hand, Jericho (in the Jordan Valley) has the lowest relative humidity (52%), decreasing from winter to summer.

Evaporation: Evaporation is particularly high in the summer (the highest evaporation rate occurs in July) due to the rise in temperature, high incident solar radiation, and low humidity. Towards the coastal plain, the rate of evaporation decreases, because of the year round exposure to the humid sea breeze. Evaporation rate is relatively low during the winter months when the solar radiation is lowest, with the lowest evaporation rates occurring in December. Only water surfaces, which are in contact with the air, are fully affected by evaporation. Water that has seeped into the ground is, for the most part, protected. The highest evaporation rates in Palestine occur in the summer months in the Jordan Valley, where the total annual evaporation in Jericho is about 2100 mm. Evaporation from the Dead Sea is particularly high due to intense solar radiation and low relative humidity. Evaporation in the Gaza Strip is the lowest anywhere in Palestine (1580 mm per year), due to high relative humidity, lack of surface water and less intense solar radiation and fewer hours of sunlight.

1.3 Palestinian Population

According to the Palestine Central Bureau of Statistics (PCBS), as of the mid of 2015 the total Palestinian population in West Bank and Gaza was approximately 4.68 million people. The population of the West Bank was approximately 2.86 million in 2015, including 255,686 Palestinians living in East Jerusalem. The population of the Gaza Strip was 1.82 million in 2015. As of mid-2015, most Palestinians (73.9%) lived in urban areas urban, 16.7% lived in rural areas, and 9.4% were residents of refugee Camps.

The National Spatial Planning office estimated that the Palestinian population will reach 6,060,000 by 2025, and 11,320,000 people by 2050. In addition, the Palestinian Authority is planning for an influx of refugees who were expelled or fled from what became the state of Israel in 1948 to return to a Palestinian state, if they choose to give up their individual rights of return to their communities of origin in what is now Israel. If returnee population are factored into population growth estimates, it is expected that the Palestinian population will reach 7,589,000 by 2025 and 14,035,000 by 2050.

Palestine is an overall young society. Palestinians at childhood age (0-14 years) comprise approximately 39.4% of the total population. Youth aged 15-24 makes up 21.5% of the population. Recent demographic trends indicate that, in the future, youth will constitute an ever increasing proportion of Palestinian society (**Figure 1.1**).This is due to the high fertility rate and decline in child mortality. Only 2.9% of the total population is above 65 years old.

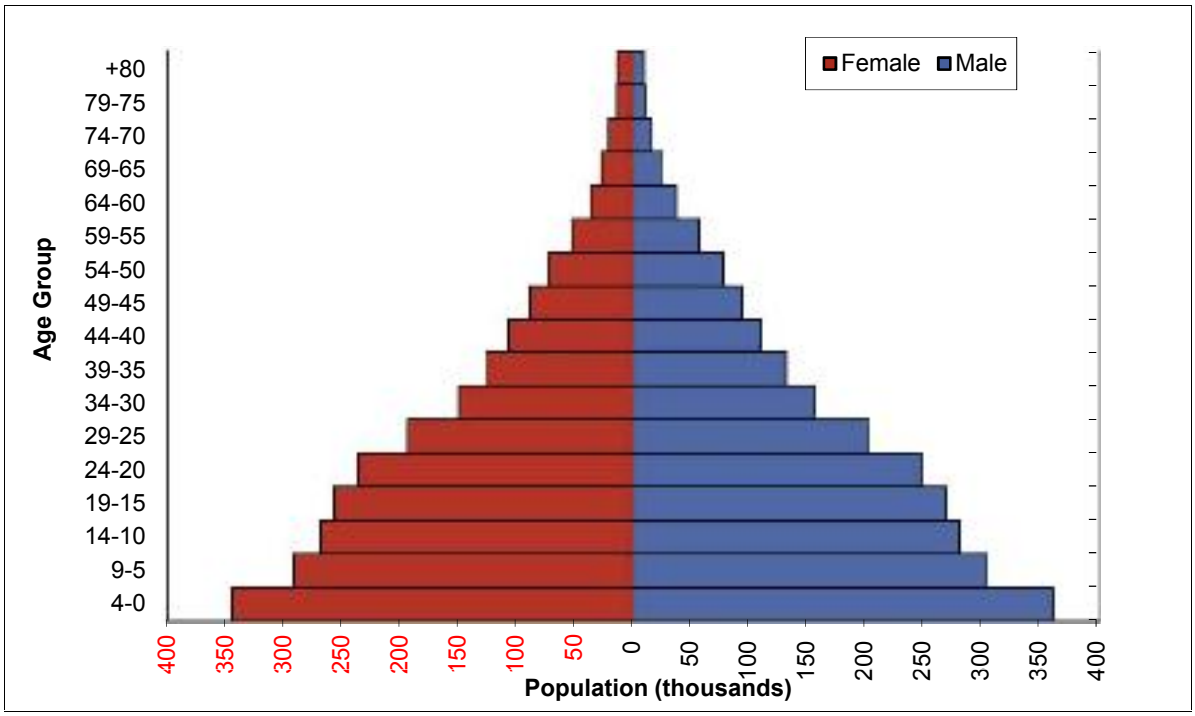


FIGURE 1.1: POPULATION DISTRIBUTION BY AGE AND GENDER, MID 2015

Population Densities in the West Bank

The total area of the West Bank excluding East Jerusalem is (5,579 km^2). There are 2,618,191 Palestinians living in 734 communities in the West Bank (excluding East Jerusalem) (Ministry of local Government, 2016) compared to 486,000 settlers living in 181 Israeli settlements. There is a stark contrast between the Israeli Settlers and the Palestinians in their access to living space and natural resources. The Net Palestinian Population Density (NPPD; population/built-up area) is approximately three folds (or 300% higher) than that of the Net Israeli Population Density (NIPD). When comparing the two populations in Area C; the NPPD is 250% higher than the NIPD. High population densities have been associated with environmental problems such as air pollution, lower living standards (e.g. lack of access to green urban spaces), poverty and congestion. The contrast between the living standards between Israeli settlers and Palestinians is just one of the few injustices Palestinians suffer from the Israeli ICA restriction on development in Area C open spaces (**Figure 1.2**).

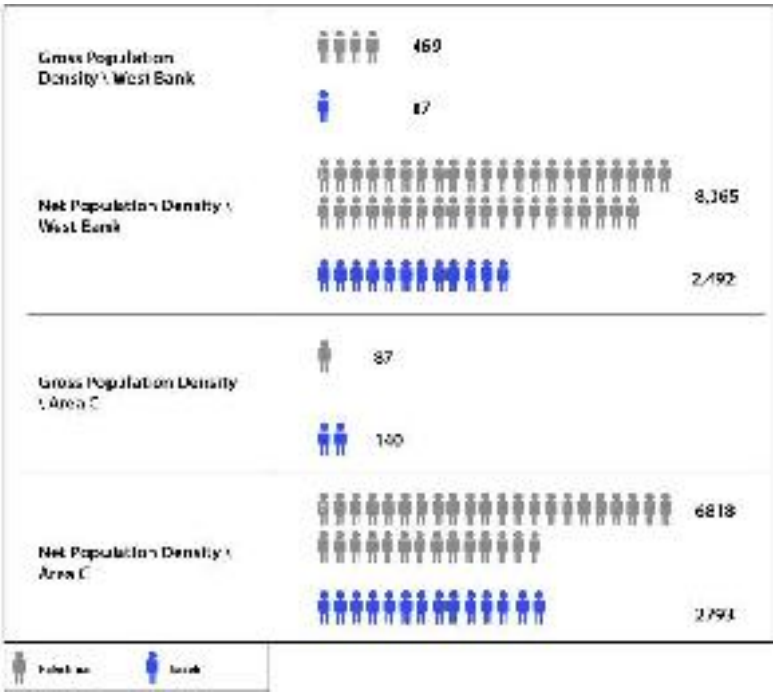


FIGURE 1.2: POPULATION DENSITY IN WEST BANK AND AREA C

The contrast to access to living space and resources between Palestinians and Israeli in Area C is even larger when comparing population densities within the areas allotted for development (i.e. master plans). The Palestinian population density within the proposed master plans in Area C is almost 600% higher than the population density of Israeli's in the settlements master plan (**Figure 1.3**), which is a clear indicator of the settlers' disproportionate and discriminatory appropriation of natural resources in Area C. This is a part of Israel plan to facilitate expansion and development of settlements while restricting the Palestinian potential for development in Area C.

FIGURE 1.3: POPULATION DENSITY IN MASTER PLANS IN AREA C

1.4 An overview of the political situation

Palestine faces the unique future challenge of integrating physical spaces that have been forcibly separated. The Israeli occupation has kept the West Bank, Gaza Strip, and East Jerusalem physically and socially separated, increasingly so since the signing of the Oslo Accords in the mid-1990s. After Oslo, a new complex legal and planning scheme was created one for the West Bank and another for the Gaza Strip, while leaving the issue of authority over East Jerusalem for future negotiations, effectively leaving it under de facto Israeli authority through its illegal annexation in 1967.

The Gaza Strip was physically cut off from the West Bank, but was largely under Palestinian administrative and planning control, the Oslo Accords included a provision requiring a safe passage route from Gaza to the West Bank to enable free movement between the two, but Israel never allowed it to be implemented. In 2005 the settlements and military bases were evacuated, but Israel maintained a "buffer zone" around the edges of the Gaza Strip which had increased in size to 62.6 km² prior to the assault on Gaza which began in July, 2014. That included 36% of Gaza's cultivatable land and 85% of its maritime area (Al Mezan Center for Human Rights, 2012). In 2007, Israel unilaterally and illegally implemented a siege on Gaza, restricting imports and exports and the use of Gaza's maritime area. The "access-restricted area" has dramatically increased in recent months to over 43% of the Gaza Strip being declared "access-restricted" by the Israeli military during the current Israeli assault. Thus while the PNA has theoretically had total civil authority over the Gaza Strip since 2005 it has no effective control over its borders, economic development, and infrastructural development. This is never more pronounced then when Israel mounts a military offensive against the Gaza Strip, as it has done three times in the last six years, destroying billions of dollars' worth of housing settlements and infrastructure.

The West Bank, under the Oslo Accords, was divided into 3 zones: Area A, B, and C. Area A, which makes up 17.7% of the West Bank is made up of the Palestinian city centers (excluding Hebron), is under Palestinian civil and security control. Area B, which makes up 18.3% of the West Bank is made up of the Palestinian built-up areas outside Area A, is under Palestinian civil control and joint Israeli and Palestinian security control, though Israel has exclusive right to enter Areas B to conduct "security operations" as it wished. Area C, which makes up 61% of the West Bank, is under Israeli civil and security control. The Natural Reserve area which makes up 3% of the West Bank area is still under Israeli control which is in contradiction to the agreements signed between the PA and Israel. These area assignments were meant to be temporary, with land being phased into total Palestinian control by the end of the five-year interim period as designated by the Oslo Accords, which was set to end with final status negotiations in 1999. Instead, it has been the foundation for Palestinian planning for the last 20 years, with no significant change to the PNA's authority since their agreements' signings in 1994 and 1995. Because of the lack of final status negotiations, East Jerusalem has remained under de facto total Israeli legal and administrative control through its illegal annexation in 1967. This means PNA institutions have no authority over East Jerusalem and are forbidden from operating within its municipal boundaries.

On the 15th of January 1997, Israel and the Palestinian Liberation Organization (PLO) signed the Hebron protocol, which divided the city of Hebron into 2 parts: Hebron 1 and Hebron 2, better known as (H1 & H2). H2 Area falls completely under the control of the Israeli occupation Army and covers 4289 dunums (19.2% of the total urban area of Hebron city). It includes the Old city of Hebron, the Ibrahimi Mosque, and the Israeli settlements of Abraham Avino, Beit Romano, Beit Hadasa, Tel Ar Rumeida, the areas around the settlements, a number of Palestinian schools, Mosques and archeological sites. This area accommodates today some 35,000 Palestinians and 600 illegal Israeli settlers.

The area identified as H1 is under the full control of the Palestinian National Authority and covers approximately 17936 dunums (79.8% of the total urban area of Hebron city), around 140,000 Palestinians are living there.

Palestine is therefore characterized by the presence of two contradictory planning schemes that aim at exploiting its natural resources to serve two peoples: these are the endogenous Palestinian population and the Israeli settlers and army, which has been controlling the area since 1967. The fragile Palestinian environment has been the first casualty of this reality. It has been exposed to pressures ensuing from the practices of the Palestinian population, on the one hand, and from the practices of the Israeli Occupation, on the other hand, which have significantly contributed to changing the environmental features of the State of Palestine.

Lack of sovereignty over land and natural resources has denied the Palestinian people their rights to regulate land use and to manage the utilization of their own resources, without exceeding the carrying capacity of land. Without ability to regulate land use over a contiguous piece of land, natural ecosystems cannot be maintained; the status of the environment cannot be properly monitored; and environmental protection cannot be implemented. On the other hand, the plans of the Israeli Occupation (the controlling power in the area) in the State of Palestine have been geared by political factors, aiming at grabbing as much as possible of the Palestinian land to implement the Israeli colonizing strategy and to change the demographic characteristics.

By 2015, Israel established 196 settlements in the occupied West Bank, of which 178 settlements are recognized by the Interior Ministry as “communities”, even though some of them contain stretches of land on which the built-up area is not contiguous. In the occupied East Jerusalem 18 other settlements are located on land annexed by Israel in 1967 and made part of Jerusalem. There are additional 232 or so outposts. The number of settlers residing in the settlements is approximately 750,000 Israeli settlers. The built-up area of the Israeli settlements is 196 km square, which compromise some 3.5% of the West Bank total area, while according to the approved Israeli master plan the settlement area is 540 square km.

Area C is a region of the West Bank that is rich in its natural resources. Area C constitutes more than 61% of the West Bank’s landmass. It also contains about 60% of agricultural lands in the West Bank and includes permanent crops, arable lands, heterogeneous agricultural lands and plastic houses. Some 300,000 Palestinians currently live in Area C. The majority of Palestinians (some 2.3 million) currently live in Areas A and B; both of which constitute 39% West Bank’s landmass. Hence, Area C has the potential for significant urban expansion to accommodate Palestinian population growth and economic development needs. Furthermore, this area has many touristic and archaeological sites, water resources from water wells and springs, Dead Sea minerals and salts, and Stone (including marble) deposits.

In spite of its acknowledged importance for sustainable development in Palestine and for the establishment of a sustainable Palestinian State, the Palestinian Authority has no security or administrative control over this area. Rather, Area C is under the Israeli military control. As of 2015; Israeli military zones occupied 29% of Area C, and Israeli settlements occupied 6% of area C and these continue to spawn and expand. An additional 3% of land was designated as nature reserves areas to be transferred to the control of the PA. However, this transfer of control never materialized. Palestinian communities living in Area C therefore find themselves marginalized, often without access to basic services, without adequate schools or clinics, and sometimes even without water or electrical networks.

Area C includes the Jordan Valley region and the settlements, and areas declared as “state land”. Planning and zoning are under full Israeli Control. Palestinian development in Area C requires approval by the Israeli Civil Administration (ICA). The Jordan Valley is one of the most important agricultural areas in Palestine. Its year-long warm climate and fertile land is crucial for the production of food for Palestine's growing population and for turning a profit on agricultural exports; and its extensive uninhabited sections make it attractive for development in terms of energy, infrastructure and industry. Furthermore, Israeli and Palestinian economists alike think that the Jordan Valley needs to be opened to the Palestinian population immediately enabling realization of the potential for economic development in this region, which is crucial to the rehabilitation and development of the Palestinian economy in order to ensure the viability and sustainability of the future Palestinian state.

In recent years, Area C has emerged as a key priority for both the Palestinian National Authority (PNA) and as main interest for the international actors in the development sector operating in the State of Palestine. The development potential of Area C has been acknowledged to be critical to the viability of the Palestinian State and the success of the two-state solution by those actors who are now increasingly more interested to empower existing Palestinian communities to preserve their assets, way of life, and most importantly their continued presence on the land. The underlying reality of Area C is that it holds the key to the future of the Palestinian State. As the current division of the West Bank has the over-urbanized and densely populated Areas A and B forming a patchwork of “isolated islands”. This patchwork of "isolated islands" and inaccessibility of Area C for development jeopardizes the sustainability of the Palestinian economy and the viability of any future Palestinian State. A viable Palestinian State can thus only be achieved by opening Area C for Palestinian development and for the critical realization of a contiguous Palestinian State.

1.5 Environmental National Frameworks and Rio Conventions

In alignment with national priorities, the Palestinian authorities agreed on ratifying 16 multilateral environmental conventions upon which the PA has signed three conventions and one protocol; (i) Basal Convention on the Control of Trans boundary Movements of Hazardous Wastes and Their Disposal, (ii) Convention of Biological Diversity (CBD) and the Cartagena Protocol on Biosafety to the Convention of Biological Diversity, and (iii) UN framework Convention on Climate Change (UNFCCC) (see Table 2). In addition, several national strategies and action plans were set including National Development Plan 2014-2016, Environment Sectoral Strategy 2014-2016, Water Sector Reform Plan 2014-16, Water Strategy 2016-2018, Palestinian Water Authority Strategic Plan 2016-2018, Agriculture Sector Strategy 2011-2013, Energy Sector Strategy 2011-2013, National Strategy for Solid Waste Management in the Palestinian Territory 2010-2014, and the National Policy and Legislation for Promoting the Conservation of Agro-biodiversity in the Palestinian Authority 2005. Some of the strategies needs updating mainly National Biodiversity Strategy and Action Plan for Palestine (NBSAPP). Another relevant strategy is the Environment Strategy Action Plan that will be done on March 2016.

The EQA is working to develop the bylaws needed to be in alignment with the conventions they ratified. The PA is also in process of preparing the requested documents for the remaining selected conventions. Of the main challenges that face the PA in joining the international conventions as noted by EQA in the consultative meetings, is first having the final government decision on the specific convention to join, second is the acceptance and facilitation of the conventions’ secretariat in processing the papers submitted to them. In some cases the Palestinian files were rejected as in the

case of UNCCD (United Nations Convention to Combat Desertification). The funding and available allocated budget for Palestine are still not channeled and in most cases Palestine gets funding only on a small scale projects although Palestine should become eligible for large and medium project budgets especially that it has signed the CBD and the UNFCCC.

Both the 'Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and their Disposal" and the "Convention of Biological Diversity" were signed on the 2nd of April 2014. The UNFCCC, on the other hand, will enter into force for the State of Palestine on 17th of March 2016. EQA staff have already started communicating with partners to prepare for this full membership, mainly by reviewing laws and bylaws to make sure they are in alignment with the convention. For this purpose, the EQA decided to reactivate the National Committee for Climate Change and the National Committee for Biodiversity. The EQA is putting effort into reviewing the technical and legal status of the environment in Palestine in order to have a clearer vision on how to move forward. The EQA has also begun preparations for the multilateral environmental conventions and drafting of the first National Communication Report on Climate Change, which will be published by mid-2016. The NC report is a way to mainstream the environment and climate change issues in national policies and strategies.

Of the current preparations for the UNFCCC conventions, the EQA is working on: (i) Start communication with UNFCCC Secretariat and Green Climate Fund Secretariat regarding readiness activities and eligibility; (ii) Start communication with the Adaptation Fund; (iii) Prepare for launch of the first phase of the National Capacity Development Programme with UNDP; (iv) Begin work on legal and regulatory amendments; (v) Reactivate the national Committee for Climate Change; (vi) Study the options and prepare for gaining potential climate finance.

Another significant success is the change in the status of the environment strategy, from a sector strategy to a cross-sector strategy, which implies mainstreaming the environment across all sectors in the new planning process in Palestine for the planning cycle 2017-2022. Hence the EQA is preparing the Environment Strategy Action plan (SAP) for 2016-2020. The SAP has four main objectives, each of which has many interventions and activities. These four objectives, developed in accordance with the EQA mandate; including:(1) to develop, lead and coordinate environmental planning; (2) to promote and enhance the inspection and monitoring role of the EQA; (3) to develop the legal and institutional framework that regulates the environment sector; (4) to enhance and promote environment-friendly behaviour and practices. The final draft of the SAP will be ready by February 2016. SAP will take into consideration: the SDGs (Strategic Development Goals), the sectoral and cross-sectoral planning process in Palestine that will take place in 2016, and the National Policy Agenda (NPA) that will also be produced in 2016.

In terms of biodiversity, the EQA is in the final stages of producing the 50th Annual Report on Biodiversity, which will be available soon. The EQA, in joint efforts with its partners, has determined 51 protected areas, which have been reflected in the National Spatial Plan. In addition, the EQA and its partners have classified another 51 areas as rich biodiversity areas, and the EQA is now in the final stages of fieldwork to evaluate those areas.

EQA has decided to produce an environmental policy paper to be ready by April 2016; aiming at giving directions to other sectors on how to protect the environment and integrate environmental and climate change issues in their policies and strategies. It will include the main priorities that the EQA will urge all

sectors to take into consideration and include in their sector strategies. to help in three ways: (i) it will form the basis for the EQA contribution to the NPA; (ii) it will form the basis for the coming environment cross-sectoral strategy; (iii) by sharing with other leading public sector agencies before producing the coming sector strategies, it will help to mainstream the environment in other sectors. This environmental policy paper will be developed before starting the planning process in order to guide other sectors on environmental priorities.

TABLE 1.1: LIST OF CONVENTIONS AND NATIONAL/REGIONAL PLANS OR PROGRAMMES

Rio Conventions + national planning frameworks	Date of ratification / completion
UN Convention on Biological Diversity (CBD)	Signed on the 2nd April 2014
CBD National Biodiversity Strategy and Action Plan (NBSAP)	Completed on year 1999
Cartagena Protocol on Biosafety to the Convention of Biological Diversity	Signed on the 2nd April 2014
Nagoya Protocol on Access and Benefit-Sharing (ABS)	----
UN Framework Convention on Climate Change (UNFCCC)	Signed on 1st December 2015
UNFCCC National Communications (1st, 2nd, 3rd)	1st National Communications Report – will be submitted on mid- 2016
UNFCCC Nationally Appropriate Mitigation Actions (NAMA)	Under process
UNFCCC National Adaptation Plans of Action (NAPA)	Under process
UN Convention to Combat Desertification (UNCCD)	National Strategy for Combating Desertification (2010-2020)
UNCCD National Action Programmes (NAPs)	----
Stockholm Convention on Persistent Organic Pollutants (POPs)	----
SC National Implementation Plan (NIP)	----
Poverty Reduction Strategy Paper (PRSP)	National Development Plan 2014 National Food Security Strategy 2005 The National Strategy to Achieve the MDG by 2015
Global Environment Facility (GEF) National Capacity Self-Assessment (NCSA)	----
GEF-6 National Portfolio Formulation Exercise (NPFE)	----
Strategic Action Programmes (SAPs) for shared international water-bodies	----
Minamata Convention on Mercury	----
Others (list) as relevant	----
Basel convention on the Control of Trans boundary Movements of Hazardous Wastes and Their Disposal	Signed on 2nd April 2014

BOX 1.1: THE ENVIRONMENTAL AWARENESS

Environmental awareness is an important tool used to change the attitude of the citizens toward environmental protection. In Palestine the public environmental awareness was one of the issues tackled in many related laws and strategies; the environmental law No. 7 for the year 1999 (MEnA, 1999), Environment Sector Strategy (2011 – 2013) (EQA, 2010), Environment Sector Strategy (2014 – 2016), National strategy for Solid waste management (2010 – 2014) (EQA, 2013), Water and Wastewater Sector strategy (2011-2013) (PWA, 2010). In addition, the environmental awareness issue was addressed in several national laws and strategies, such as: Public Health Law (Palestinian Legislative Council, 2005), Gender strategy in environmental issues with focus on water and solid waste management (PNA, 2012), Education Sectoral Strategy (2011 – 2013) and others.

In April 2014 the EQA published the National Strategy for Environmental Awareness and Education (2014-2020) (EQA, 2014). The strategy has identified the current status and came up with three main strategic objectives: 1) efficient and effective environmental media to increase the level of environmental awareness; 2) creative and integrated curricula, methods and educational activities; 3) environmental values up scaled and practiced by all the community groups.

The governmental and non-governmental organizations, the municipalities, the Joint service councils, UNRWA and international agencies, all implemented and executed many of the awareness activities and campaigns in Palestine but all of these activities do not follow a unifies integrated plan or schedule.

2. WATER AND WASTEWATER MANAGEMENT

2.1 Introduction

One fifth of the world's population, or 1.2 billion people, live in areas of water scarcity, and this is projected to increase to 3 billion by 2025 due to climate change and populations growth (UNEP & UNHABITAT, 2010). In addition to continued lack of access to improved drinking-water sources, 2.6 billion people lack access to basic sanitation. As a result, approximately 1.5 million children under five die every year from diseases linked to the lack of access to water and sanitation (WHO, 2010).

Further population growth and urbanization, rapid industrialization, expanding and intensifying food production are all putting more pressure on water resources and increasing the unregulated or illegal discharge of contaminated water. This presents a global threat to human health and wellbeing, with both immediate and long term consequences for efforts to reduce poverty whilst sustaining the integrity of ecosystems (UNEP & UNHABITAT, 2010). Worsening drought conditions coupled with declining water quality and increasing water demand due to population growth make wastewater treatment and reuse a necessity.

The state of Palestine has one of the scarcest water availability (per capita supply) in the world. The country's water scarcity is due to both natural and man-made constraints; mainly resulting from the Israeli occupation. Over time water shortage in Palestine will increase and become a greater problem as a result of population growth, higher standards of living, expected climate change, and above all, Israeli practices and restrictions imposed on both the water resources and its sector's development.

The right to access water and sanitation is a fundamental human right that has been addressed in several international and regional treaties and conventions, and in the national policies and laws of some States. In 2002, the United Nations' (UN) Committee on Economic, Social and Cultural Rights (CESCR), with the adoption of General Comment No. 15, recognized the right to water, and provided States with the corresponding obligations and guidelines to this Right. Later, in July 2010, the UN General Assembly adopted a resolution recognizing the right to water and sanitation; two months later the Human Rights Council specified this right as a part of the right to an adequate standard of living (FAN, 2010; GIZ, 2009; GOLAY, 2009).

For more than 70 years the Palestinians have been denied from their water rights. The Palestinian's right to equitable and reasonable utilization of shared water resources has been violated by the Israeli occupation. As a result, Palestinian people often suffer from lack of adequate water. Moreover, Israel has played a major role in depleting Palestinian water resources.

2.2 Water and Wastewater Sector Institutional and Legal Framework in Palestine

The water sector's central public authority, the Palestinian Water Authority (PWA), was established under the Presidential Resolution No. 90 of 1995. Its responsibility is to act as the main regulatory body for water resources management, development and infrastructure planning in Palestine, as well as executing water policy. Law No. 2 (1996) concerning the establishment of the PWA indicated that it shall be established and subsequently enjoy independent legal status and independent budget, and be

placed under the direct supervision of the President of the Palestinian National Authority (PNA); who shall designate the head of the PWA. Later in 2002, the **Palestinian Water Law No. 3** was developed, which stated in its sixth article that, "A public institution called “the Water Authority” shall be created by virtue of this law, and it shall have a juridical personality, and its budget shall be included within the general budget of the Palestinian National Authority".

As a result of the Sector Reform, a new Water law “**Decree No.14 relating to the Water law”** was endorsed in 2014 which establishes a new organizational Structure for the Water Sector. The law which consists of 68 articles and divided in twelve chapters, aims at developing and managing water resources, increasing their capacity, improving their quality, protecting water from pollution and depletion, and improving the level of water services. It defines a number of principles and guidelines that form the basis for decisions and structures for a better management and development of the Palestinian water resources through implementing an integrated and sustainable management principle. According to the new law the process of the policy and strategies formulation will be separated from the regulatory functions. Therefore, the mandate of the new law makes the PWA responsible for managing and regulating water resources (licensing) including the abstraction quotas and allocation of resources for different sectors, preparing water policies, strategies and plans and insuring their implementation. For the regulatory functions, the law provides for the establishment of the Water Sector Regulatory council which enjoys independent legal status and independent budget from the PWA, and it will have a Board of Directors made from the public sector, private sector and civil society. The law also calls for restructuring the West Bank Water Department (WBWD) into the National Water Company. In addition the law called for the establishment of two local institutions namely; 1) Regional water utilities and 2) the water users associations. **Figure 2.1** illustrate the new water governance according to the new law.

FIGURE 2.1: THE NEW INSTITUTIONAL FRAMEWORK OF WATER SECTOR IN PALESTINE

Currently the West Bank Water Department (WBWD) in the West Bank and the Costal Municipalities Water Utility (CMWU) in Gaza Strip are in charge of the operation and maintenance of regional bulk water distribution systems. The WBWD was created during the Jordanian administration of the West Bank by Jordanian law No. 37 (1966), and came under Israeli control after 1967. In 1996, the control over WBWD was transferred from the Israeli Civil Administration (ICA) to the PNA, according to Article 40 of Oslo II Agreement. The CMWU was formed in 2005 to unify a fragmented system of municipal and local water utilities in the Gaza Strip. The provision of water for the 25 municipalities is the responsibility of the regional CMWU. The CMWU is working so that the municipalities will receive technical assistance by the CMWU and gradually transfer their staff and assets to it.

Water services delivery including water extraction in the west Bank is carried out by the WBWD and PWA. Water sources are from WBWD and PWA wells, municipal wells and springs, privately-owned wells, and water purchased from the Israel water company, Mekorot. Regional, municipal and local water utilities continue to operate, maintain water network infrastructure inside Palestinian communities, and set and collect payments for water services. Regional, municipal and local water utilities vary in the scale of their operations, depending on the size of the served community; from village councils and municipalities, to joint water councils and water undertakings serving several towns and villages. There are two regional utilities in the West Bank, the Jerusalem Water Undertaking (JWU) in Ramallah area, and the Water Supply and Sewerage Authority (WSSA) in Bethlehem area. In the Gaza Strip, domestic water production and supply is carried out mainly by municipal wells, in addition to water purchased from Mekorot, and the United Nations Relief and Works Agency (UNRWA) wells for supplying the refugee camps.

2.2.1 PALESTINIAN WATER AND WASTEWATER LAWS AND POLICIES

The Palestinian National Authority (PNA) has since started building credible public institutions, laws, regulations, strategies and policies for the management of the wastewater sector. Participation of different stakeholders to enhance the water and wastewater sector has been observed, including stakeholders from both governmental and non-governmental entities as municipalities, village councils, water utilities, donor agencies, Palestinian NGOs, and academic institutions. The following are the sector relevant laws and strategies:

The PWA adopted, in 1995, the **Palestinian National Water Policy (NWP)** which addressed the important issues of water management and planning such as the structure, legislation, and the tasks of water sector institutions. Later in 1998, the **Water Resources Management Strategy** was developed, based on the principles of the NWP. This Strategy highlights the necessary aspects of water resources and sector development and outlines a focus on securing an environmentally sound and sustainable development of water resources, through efficient and equitable water management. In 1999, the Ministry of Environmental Affairs (MEnA), currently replaced by the Environmental Quality Authority (EQA), formulated the **Palestinian Environmental Law No. 7** which was approved by the Palestinian Legislative Council. Chapter three of the Law is titled 'Water Environment'. The Chapter contains three articles regarding standards for quality of fresh, collected and treated water (MEnA, 1999).

The PWA prepared the **National Water Plan of 2000**, which sets directions until 2020 and proposes specific actions to be taken to achieve its goals. Moreover, it provides a program of projects and activities needed for the water sector development in Palestine. The plan describes the role of service providers and shifts many functions and responsibilities from the PWA to regional water utilities, including; design, construction, operations, maintenance, and repairs of many services such as bulk water supply wastewater collection and treatment, and storm water collection.

The **Palestinian Water Law No. 3** (2002) aims to develop and manage the water resources; i.e. increasing their capacity, improving the quality and protecting water resources from pollution and depletion. The Law assigned the PWA the management of water and wastewater sectors. Moreover, the Law stated that all water and wastewater projects must initially obtain a permit from the PWA, and should be managed by it. Article 3 of this Law considers water resources as public property and recognizes water as a human right Therefore, the PNA is obliged under this law to improve its services and ensure that each person in Palestine has access to clean water that satisfies his daily needs.

In 2003, PWA developed a national **Integrated Water Resources Management Plan (IWRMP)** for the West Bank which defines how water resources in Palestine will be managed in an integrated approach. The IWRMP outlines the polices, goals, and objectives of the PWA and provides specific actions for achieving the stated objectives. This Plan was followed by a Master Plan in 2004 and an emergency plan in 2005. These plans were not approved by the National Water Council (NWC) since it is not functioning.

National Sector Strategy: Water and Wastewater 2011-2013: The vision of the strategy is to ensure, *"A regulated water and wastewater sector which contributes to Palestinian statehood as well as the sustainability of water resources built on strong health, environmental, social and economic foundations to meet essential and developmental requirements of the Palestinian Society"*. Four strategic objectives were derived for the Strategy: 1) Promote good governance and provide a legal and institutional

environment, that guarantees equitable services, and sound management of the sector ensuring its sustainability, 2) Integrated water management ensuring equitable and continuous services as well as resource sustainability, 3) Integrated wastewater management which ensures equitable and continuous services, contributes to preserving public health and safeguards the environment, and 4) Efficient and effective water and wastewater institutions engaging all segments of society (PWA, 2010).

To achieve each of the above mentioned objectives, the Strategy defined a number of policies, and for each policy it developed a framework for the required interventions, their costs, and the responsible party. It further defined the monitoring indicators and the targeted objective(s) of each intervention.

Decree No. (14) Relating to the water Law was promulgated in the year 2014 aiming towards water management and development of Palestinian water resources.

Strategic Water Resources and Transmission Plan &, Water Sector policy and Strategy 2014 describe the sector goals and needs, to serve as strategic guidance. Sector that deals with multiple water related aspects such as: water quantities; ground water; surface water; desalination; rainwater harvesting; and wastewater reuse. And where wastewater reuse was considered one of the main water resources for agricultural supply in the strategic water resources development Plan of 2014 (PWA, 2014b, 2014d).

National Development Plan- State Building to sovereignty- 2014-2016 is the third tri-annual national plan and it addresses the four key sectors: Economic Development and Employment; Good Governance and Institution Building; Social Protection and Development; and Infrastructure. The plan describes the National Policy Agenda of the Palestinian government, macroeconomic framework, macro fiscal framework, and monitoring and evaluation framework over 2014-16 (PNA, 2014). The Palestinian Government committed itself in the NDP to implement policies to achieve a Palestinian water and wastewater sector that is more organized and more capable of securing water rights to citizens and materializing a fair distribution for all purposes (PNA, 2014).

Palestinian Water Authority Strategy plan 2016-2018 was developed in line with the national policies and strategies designed to materialize the sovereign state and liberty form the Israeli occupation as well as the government's sectoral plan. In addition, the plan was developed in accordance to the new water law where the legal framework that defines the roles, responsibilities and the relationship between the different institutions was re-defined. This plan was divided in four chapters and it will acts as a strategic road map towards achieving an integrated sustainable management of the water resources on the bases of sound principal and effectiveness. The plan sets and outlines the 1) Water Sector in Palestine which describe the challenges, sector reform and the legal framework, 2) Strategic Framework which stated the PWA vision and mission, value and principles, targets and strategic goals, 3) Program and Interventions which provides specific actions for achieving the stated objectives and goals, and 4) Monitoring and Evaluation which provide a list of a performance indicators for the assessing the level of accomplishment of the Plan and monitoring how effectively the PWA is achieving its strategic objectives and reaching its targets (PWA, 2015c).

The **Palestinian standards for wastewater treatment and reuse** was developed by the Palestinian Standard Institute (PSI) in the year 2005, in order to recommend guidelines for the limit values for effluent from wastewater treatment plants and set values for treated wastewater and reuse.

WATER SECTOR REFORM:

The institutional and legal reforms in the water sector are vital to achieving effective water governance. Aside from the Israeli component hindering effective water governance, the PWA has put forward efforts to reform the institutions forming the Palestinian water sector. Attempts to restructuring of the water sector have put into motion by a number of reforms.

The **Palestinian Reform and Development Plan of 2008-2010** was the first attempt through which the PNA sought to direct and regulate investments into a way that takes into consideration the priorities of the water sector. The PWA sent for approval of a comprehensive reform plan covering the entire water sector's institutional structure with the aim of providing suitable water services to Palestinians and securing their water rights. The Plan was adopted by the Cabinet of Ministers in December 2009 and a Reform Steering Committee was formed to monitor its implementation. The reform is composed of two review programs that work together to initiate the objectives of the reform plan. They include the creation of the Institutional Water Sector Review (IWSR), which shall derive from consensus, a preferred institutional arrangement for the water sector, and the Legislative Review (LR) which will revise the water law in a way that integrates the proposals from the IWSR. The LR will also examine relevant bylaws, regulations and loopholes in existing water laws (PWA, 2011).

Several updates of the water sector reform were prepared and approved by the Cabinet of Ministers Steering Committee (COMSC) after the development of the first plan including: Reform planning document 2011-2013, 2012-14, 2013-2015, and 2014-16. The reform agenda have five objectives that aim to achieve effective water governance though defining and implementing of a comprehensive program of the water sector institutional and the legislative. The five objectives cover the aspects of institutions, infrastructure and service provision, water resources management and the water consumer. The last updated reform document Water Sector Reform Plan 2014-16 was prepared with the aim of providing the guideline and the future direction to drive the water sector and its reform into a new phase over the next year three years. The plan also laid out the Logical Framework for the water sector reform, the preparation and approval modalities, the indicators and targets, as well as the mechanisms to implement and monitor the Reform Plan. In addition a set of recommendations will be developed, to the PWA and other line government institutions on the various measures that they should take to foster the development of the water sector within the long and medium term of the reform process framework (PWA, 2013b).

There have been several achievements as a result of implementation of the Reform agenda such as the approval of the 1) Revised Water Law, 2) Water Tariff By-Law, and 3) By-law on connection to sewer system (PWA, 2013b).

2.3 Analysis of the Current Status of the Water Sector in Palestine

2.3.1 WATER RESOURCES

Palestine has three main sources of freshwater including; the Jordan River, the West Bank's Aquifer and the Coastal Aquifer. Israel controls almost all Palestinian water resources and is exploiting around 85% of the available water; leaving only 15% to the Palestinians. Moreover, since 1967 Palestinians' have been denied their right to access and utilize their water share as a riparian of the Jordan River

System. Israel practices are violating the principle of the permanent and full sovereignty, over natural resources, of peoples under foreign occupation. As a result, Palestinian water resources are limited to a small quantity of groundwater that is not sufficient to meet the water demand in the Palestine.

Rainfall and Recharge

Rainfall is the origin of all sources of water. In the West Bank the mean annual rainfall varies from about 700 mm in the western part to less than 100 mm in the east, with a long term average of 450 mm (PWA, 2013a). In Gaza Strip the long term annual average rainfall is 327 mm.

A study was conducted by the PWA to estimate the average total rainfall and aquifer recharge rates in the West Bank for the hydrological year 2010/20111 and 2011/2012. The annual average in 2010/2011 was 347 and in 2011/2012 was 518 mm (PWA, 2013a). The responding aquifer recharge rates for the two hydrological years were 598 and 721 MCM respectively.

In the season 2011/2012 the average annual rainfall over Gaza Strip is estimated at about 372 mm (PWA, 2013a), and the responding aquifer recharge rate for the same season was 64 MCM (PWA, 2013a).

Table 2.1 shows the recharge estimate for the groundwater aquifers in the West Bank and Gaza Strip for the hydrological year 2011/2012.

TABLE 2.1: THE RECHARGE ESTIMATES IN THE GROUNDWATER AQUIFERS IN THE WEST BANK AND GAZA STRIP

Aquifer	Average rainfall 2011/2012 (mm)	Recharge volume 2011/2012 (MCM)	Long-term average recharge (MCM)
Western aquifer	581	359	318 – 430
North-eastern aquifer	517	152	135 – 187
Eastern aquifer	483	210	125 – 197
Total West Bank	519	721	578 – 814
Gaza Coastal aquifer	372	64	55 – 60

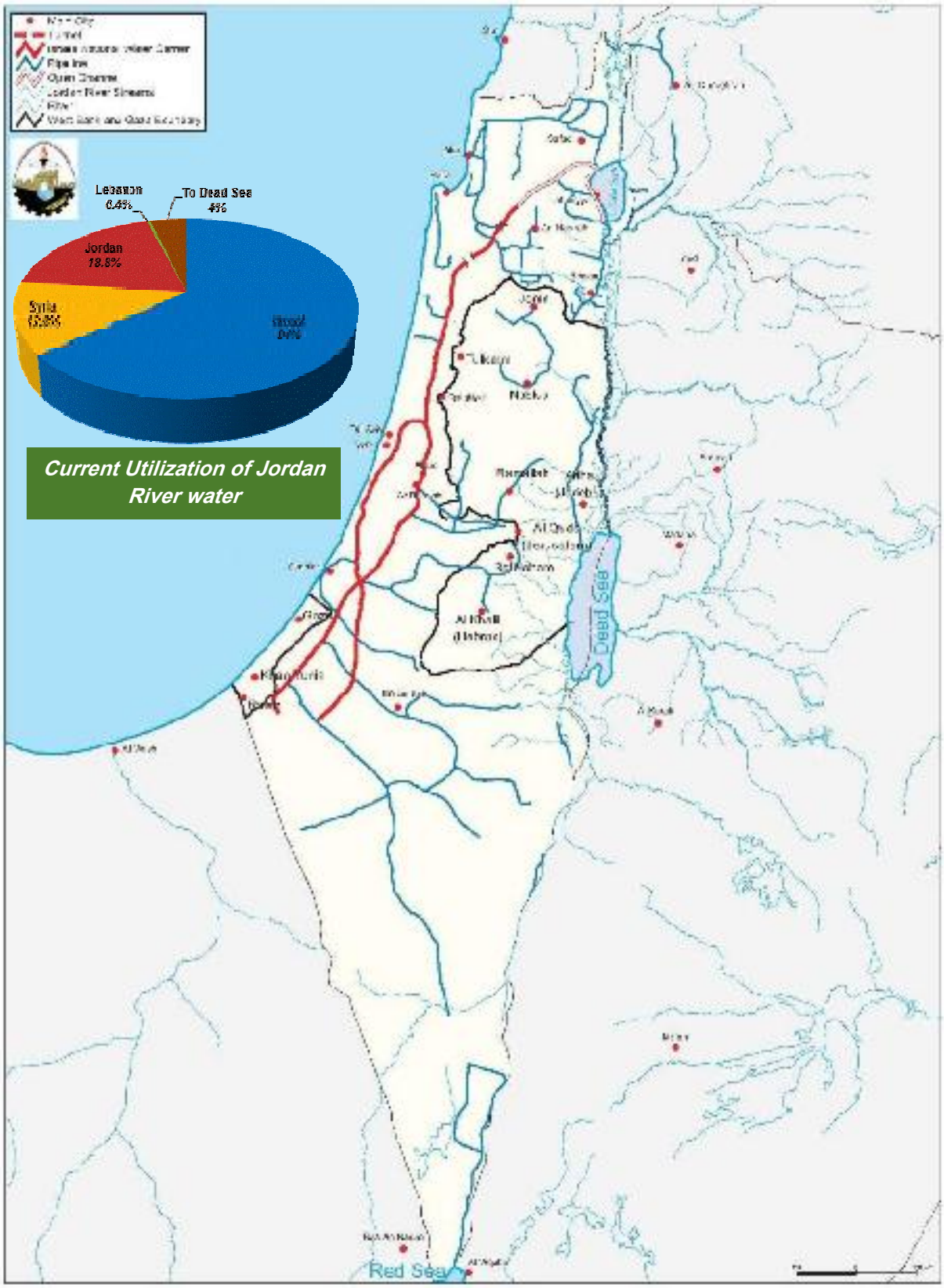
Surface Water

In Palestine the surface water resources are the Jordan River and ephemeral wadis flowing towards the Mediterranean, the Jordan Valley and the Dead Sea.

Jordan River System

The Jordan River is the only permanent river and the most important surface water resource in the region and Palestine. It originates from three main springs: Banias in the occupied Golan Heights, Dan in Israel, and Hasbani in Lebanon (**Map 2.1**). The entire length of the Jordan River is 360 km, with a surface catchment area of 18,300 km^2.

The Jordan River and its tributaries constitute a significant source of surface water in the region, which has resulted in it being a source of conflicts between regional riparian states. The legal riparian's of the Jordan River System are; Lebanon, Syria, Israel, Jordan, and Palestine. However, due to Israeli control over the River, its waters have never been exploited based on the principles of the customary international law, relating to water.



MAP 2.1: JORDAN RIVER SYSTEM

Prior to the 1950s the annual flow of the Jordan River was estimated at 1,400 MCM/Yr (ARIJ, 2007b). Today due to the Israeli diversion of huge quantities of the River's water through the National Water Carrier (NWC) to the Negev and other diversion and dam construction projects, the annual flow of the Jordan River is currently around 30 MCM (PWA, 2013a). This makes Israel the main user among the other riparian countries of the Jordan River with a percentage of 64% of the total water. The NWC alone diverts more than 500 MCM of the Jordan River Water for uses in Israel (PWA, 2013a).

Moreover, the quality of water in the Lower Jordan River is much poorer than in the Upper Jordan River, due to input from saline springs and contamination from irrigation return flows and raw sewage. The reduced input from the Jordan River and the increased use of other sources has resulted in a decline in the level of the Dead Sea. The Dead Sea surface area has shrunk by more than the third of its total area. In addition, the water level of the Sea is dropping at an annual rate of around 1 meter.

BOX 2.1: THE DEAD SEA

The Dead Sea is an international natural and cultural heritage site. The basin is the origin of some world's oldest continuous human settlements. It is a unique environment for wildlife, containing habitats that support hundreds of plant species, in addition of birds species, including that are in danger of extinction. Moreover, the Dead Sea contains about 21 mineral salts, among which some are not found in any other sea or ocean (ARIJ, 2007b). These include sodium, magnesium, calcium, bromine, bitumen and potassium. However, compared with ordinary sea water, the Dead Sea contains 20 times more potassium, 32 times more magnesium and 81 times more bromine. Salt concentration of the Dead Sea is approximately 31.5%, which makes it ten times higher than other seas. The high concentration of these minerals and other salts in the Dead Sea make the extraction process a highly profitable endeavor.

The Dead Sea cover an area of approximately 677 km^2 and it is 85 kilometers long and 17 km wide. The Dead Sea is the lowest point on Earth, at about 417 below sea level and it is also the deepest hyper-saline lake. The Dead Sea and its unique environment are changing, due to the significant decline of the water level. The surface area of the Dead Sea has shrunk by around 30% in the past two decades; a drop in the water level that translates to the rate of approximately one meter per year. For example, the water table in the surrounding area is dropping, causing a drying of the Dead Sea's micro-ecosystem. This has badly affected the surrounding environment, including unique wetland flora and fauna. Moreover, the drop in the water table and the ground water over-exploitation has led to the formation of sinkholes and land subsidence along the shorelines. The reasons for the Sea's decline are well known: a constant decrease of input from the Jordan River and increased use of other sources such as natural spring that supply water to the Dead Sea.

The Dead Sea lies between the West Bank, Jordan and Israel but the West Bank side is entirely lying within area C. Access to the Dead Sea is completely sealed off for Palestinians as far as economic activities are concerned. For the Palestinian economy, this represents a loss proportional to the potential economic value from the exploitation of these resources. Accordingly, if Palestinians had free access to their share of the Dead Sea and were allowed to invest in and develop their mining industries, their production value could range between $917.70 million and $2,366.40 million, or the equivalent of 7.2% - 18.6% of 2014 Palestinian GDP. Hence, the average potential production would equal $1,642.05 million, or 12.9% of GDP. Access to Dead Sea salts and minerals will also allow Palestinians to invest in the cosmetic industry with the potential to generate even more revenue (ARIJ, 2015b).

Surface Runoff (Wadis)

The long-term average annual flow of flood water through wadis in the West Bank was estimated at about 165 MCM/yr. During the 2011/2012 season the annual flow reached 179 MCM/Yr (PWA, 2013a). The flood wadis can be divided according to the flow direction as follows: the eastern flood wadis (toward the Jordan Valley and towards the Dead Sea) and the western flood wadis (towards the Mediterranean) (**Map 2.2**). **Table 2.2** shows the main flood wadis in the West Bank and their estimated flow (PWA, 2013a).

MAP 2.2: SURFACE CATCHMENT AREAS AND DRAINAGE SYSTEM

TABLE 2.2: WADIS IN WEST BANK, THEIR AVERAGE FLOW RATE AND ESTIMATED FLOW FOR THE SEASON 2011/2012

Flow Direction	Catchment	Average flow rate (MCM)	2012 Estimated flow (MCM)
Western wadis flowing towards Mediterranean Sea	Al Moqatta'	3.6	3.7
	Al Khodeira-Abu Nar	8.3	8.35
	Al Khodeira-Massin	11.7	11
	Alexander-Zeimar	8.7	8.3
	Alexandar-Abraq	8.1	7.74
	Qana	12.8	11.94
	Sarida	22.8	23.5
	Al- Dilb	16.4	17.29
	Salman	6.5	7
	Soreq	2.1	2.12
	Soreq Al sarar	1.7	1.8
	Lakhish-Saint	5	5.4
	Lakhish	5.4	6.2
	Shiqma	2.6	2.33
	Besor-Nar	4.9	5.3
	Besor	2.1	2.8
Total		**122.7**	**124.77**
Eastern wadis flowing towards the Jordan River	Malih-Shubash	0.9	0.97
	Malih	1.2	1.9
	Abu Sidra	0.8	1.44
	Faria	6.4	7.24
	Al'Ahmar	4.35	3.87
	Auja	4.6	5.54
	Nueima	1.7	2.53
	Qilt	4.2	5.88
	Marar	0.4	0.45
Total		**24.55**	**29.82**
Eastern wadis flowing towards the Dead Sea	Mukallak	3.5	4.2
	Qumran	0.4	0.28
	Nar	2.4	2.53
	Daraja	5.3	6.8
	Hasasa	0.5	0.85
	Ghar	6.5	6.67
	Abu El-hayyat	2.4	2.5
	Abu Muradin	0.5	0.5
Total		**21.5**	**24.33**
Total West Bank Runoff		**168.75**	**178.92**

Surface flood runoff in the West Bank during the rainy season forms an important potential source of water. Runoff has not been utilized or controlled on a large scale in the West Bank due to the high required investments and the Israeli restrictions on permits for dams construction (PWA, 2013a). A small scale utilization of such surface water is practiced in some villages where cisterns are constructed to capture rain water. This water is used by many Palestinians to meet their domestic needs especially in areas that have no distribution networks. Some farmers use small scale open ponds for irrigation purposes. The harvested quantities of water in the domestic cisterns is estimated at 4,000,000 m^3 and 750,000 m^3 in the agricultural ponds (PWA, 2013a).

BOX 2.2: AL 'AUJA EARTH DAM

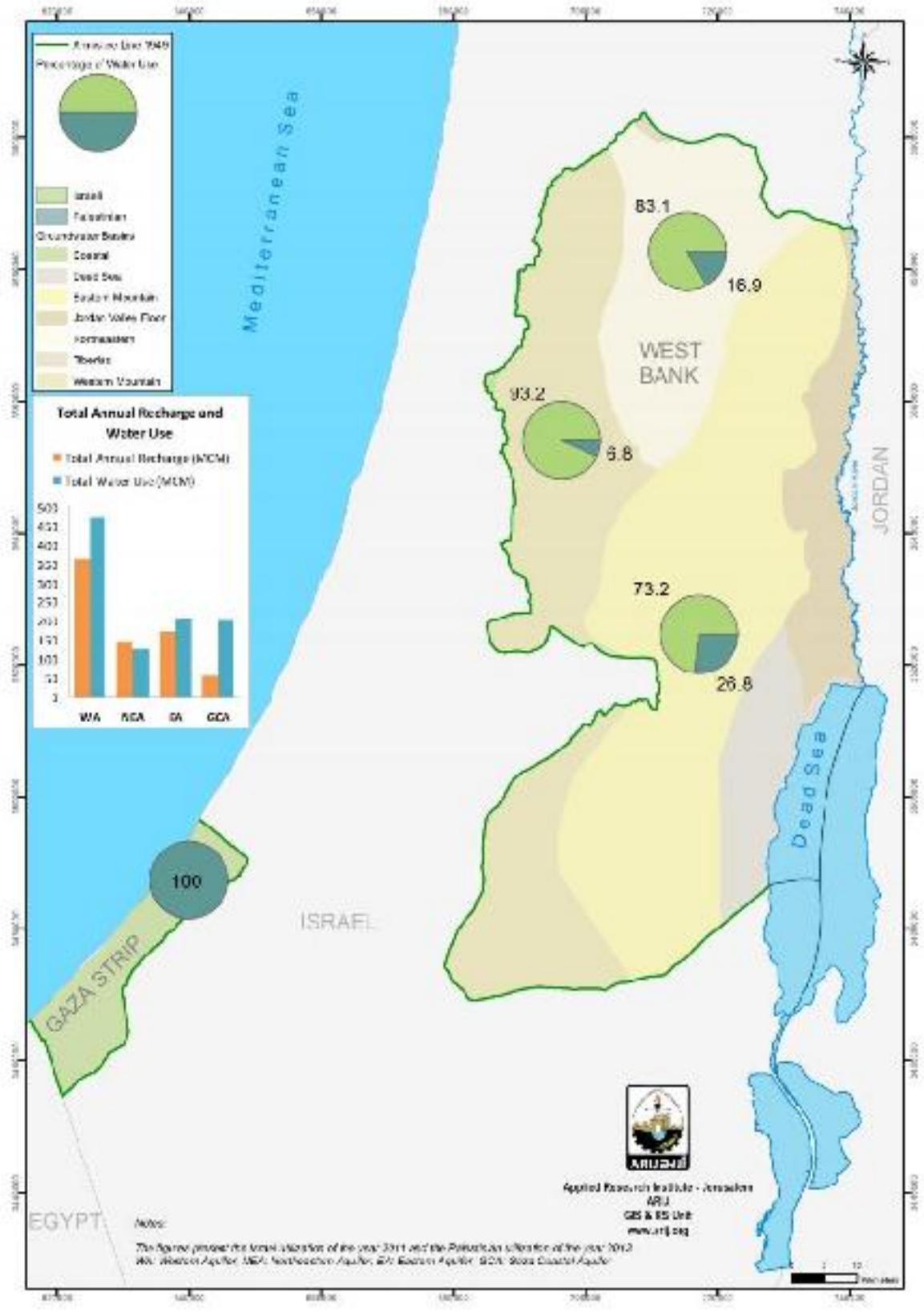
Recently, a dam was built in Al 'Auja village with a storage capacity of 700,000 m^3. Al 'Auja earth dam is located one km west of the village Al 'Auja, about 10 km north of Jericho in the Jordan Valley. The watershed stretches northwestwards up into the mountains. It is about 18 km long and 2.5 km wide and has an area of 44 km^2 (Rimfors & Velivhkin, 2015). The Al 'Auja earth dam benefits from the large catchments area of Al 'Auja valley, approximately 291.4 km^2 with an average rainfall of 350 mm, and the large amount of water that flows through Al 'Auja valley, an average of 2 – 3 MCM/year.

Groundwater Resources

Groundwater is considered the main source of fresh water for the Palestinians in the West Bank and Gaza Strip, where it accounts for more than 90% of the supplied water. The system is classified into four main groundwater aquifers basins, three of them are located in the West Bank: the western aquifer; the northeastern aquifer; and the eastern aquifer. The fourth aquifer is located in Gaza Strip, namely, the Gaza coastal aquifer (**Map 2.3**).

The officially recognized annual recharge of the West Bank basins is 679 MCM, as recognized in Article 40 of Oslo II Agreement. However, as the precipitation rate fluctuates from one year to another, the recharge of this system varies correspondingly.

According to the current utilization, and after 20 years of Oslo Agreement, the overall Palestinian abstraction from the West Bank Aquifer is less than 14% of the total quantity of abstracted water, while Israelis abstraction is more than 86% (**Table 2.3**).



MAP 2.3: GROUNDWATER BASINS AND WATER USE.

TABLE 2.3: WEST BANK AQUIFERS, WATER SHARE ACCORDING TO ANNEX III, APPENDIX I, ARTICLE 40 OF THE ISRAELI-PALESTINIAN INTERIM AGREEMENT, 1995 AND CURRENT ABSTRACTION

Aquifer		The Western Aquifer	The Northeastern Aquifer	The Eastern Aquifer
Recharge area		80% within West Bank boundaries	Majority of the recharge originates within West Bank boundaries	100% within West Bank boundaries
Water Share (Oslo Agreement) (MCM)	Israeli[2]	340	103	40
	Palestinian[3]	22	42	54
Actual abstraction	Israeli	114 % *of the safe yield*	71 % *of the safe yield*	87 % *of the safe yield*
	Palestinian	8 % *of the safe yield*	14 % *of the safe yield*	32 % *of the safe yield*
	Israeli	120 % *of water share*	100 % *of water share*	375 % *of water share*
	Palestinian	136 % *of water share*	50 % *of water share*	102 % *of water share*

Source: (ARIJ, 2007b, 2015c; PWA, 2013a)

The Gaza Coastal Aquifer is the main groundwater aquifer and the only source for water in the Gaza Strip. It is a continuation of the shallow sandy/sandstone Coastal Aquifer in Israel. In recent years the aquifer had been over pumped at a rate of 200 MCM/Yr (PWA, 2015a), which is four times higher than the safe yield. Thus and as a result of the high groundwater pumping quantity, the water level within this aquifer is affected negatively. Over-abstraction, sewage and agricultural fertilizers infiltration have resulted in deteriorating the water quality of the aquifer and polluting 96% of the aquifer's water (PWA, 2015d). This resulted in the deterioration of water quality to standards below those set by the World Health Organization's (WHO) of safe drinking water. In 2014, only 4% of the water that lies under Gaza was drinkable (PWA, 2014a).

2.3.2 GROUNDWATER ABSTRACTION

Over the last years, the overall Palestinian abstraction for the West Bank Aquifer System has been declining. From 2007 – 2013, the extracted amount from this Aquifer System had always been below the Palestinian share[4] from this aquifer. According to the PWA database, the amount utilized from this aquifer by the Palestinians' wells and springs was 112.08 MCM in 2007, whilst in 2011 this amount has dropped to reach only 87 MCM. In 2013 this amount reached 106.9 MCM. On the other hand, the extracted amount from the three aquifers by the Israelis is more than its water share by 37% (**Figure 2.2**).

[2] The figures present the utilization of the year 2011

[3] The figures present the utilization of the year 2013

[4] Palestinian Share is equal to 118 MCM according to the OSLO II agreement. It should be noted though that we should have moved beyond Oslo II before the year 2000 into the "Final Status Negotiations" whereby Palestinian should have been allocated a fair and equitable share of water from the three aquifers. Moreover, to date the Oslo Interim Agreement was not fully implemented. Not even the 28.6 MCM for the immediate needs of the Palestinians is fully available.

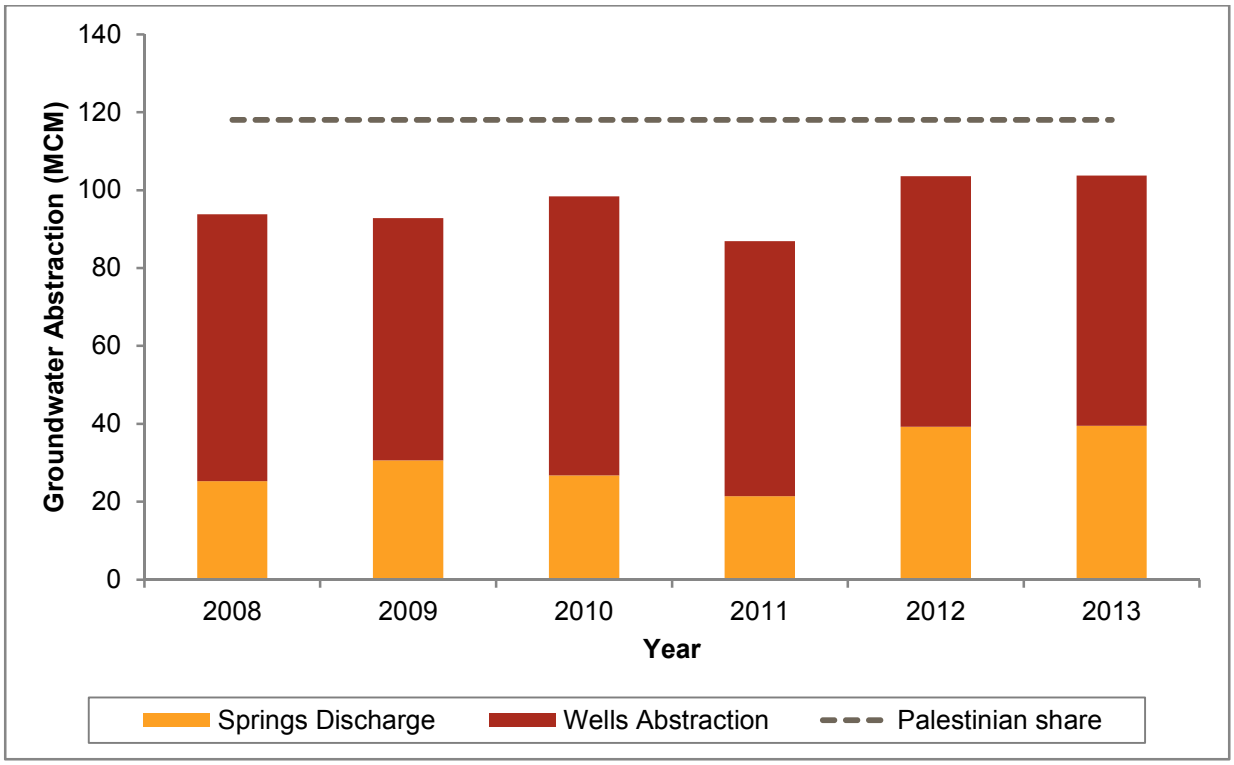


FIGURE 2.2: ANNUAL PALESTINIAN ABSTRACTION FROM WELLS AND SPRINGS IN THE WEST BANK

Well Abstractions

The total annual pumped quantity from the Palestinian wells in the year 2013 was about 262.9[5] MCM; 64.3 MCM from the West Bank's wells and 198.6 MCM from Gaza Strip's wells.

According to the PWA, the total number of the Palestinian wells within the West Bank aquifer system is 383 well (**Map 2.4**). Of the total number, there are 119 wells that are not pumping or abandoned because of the need for rehabilitation. In the year 2013, the abstracted quantity of water for the domestic use was 35.8 MCM and for the agricultural use was 28.5 MCM.

Moreover, Israel controls 39 wells within the West Bank with an average annual abstraction of about 54 MCM/Yr. In addition to the 500 wells located to the west of the Green Line (mainly in the Western basin), which abstract more than the annual recharge rate of all aquifers.

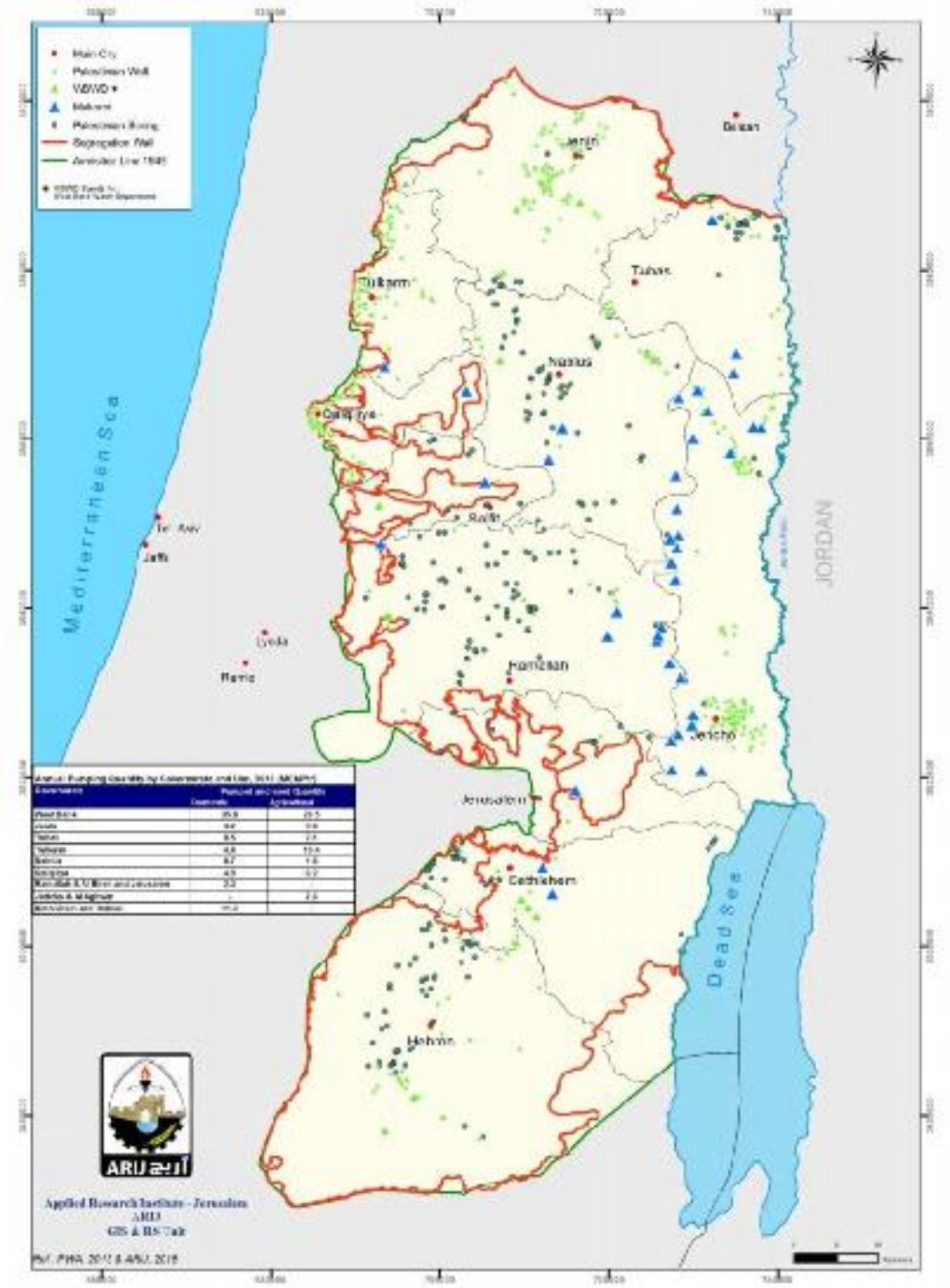
In Gaza Strip, the total abstracted quantity for the domestic use in the year 2013 was 103.3 MCM and for the agricultural use was 95.3 MCM. The safe pumping and the basin sustainable yield is estimated at 50 – 60 MCM/Yr, this means that about 100 MCM is sea water intrude into the aquifer from return flow and 96% of the water pumped from the coastal aquifer does not satisfy the water quality standards of the World Health Organization (WHO).

Springs Discharge

There are about 300 springs in the West Bank (**Map 2.4**); most of them have a minimum discharge rate of less than 0.1 liter/sec (PWA, 2013a). The long-term annual discharge of these springs is around 54

[5] This amount of water doesn't include the abstraction from the unlicensed wells which is estimated at 3 MCM.

MCM (PWA, 2013a). Although the discharge has increased from 21 MCM in the year 2011 to 39.5 MCM in the year 2013 (PWA, 2014c), it is still lower than the long term average annual discharge. The significant increase of water quantities discharged from springs compared with 2011 is a result of high rainfall in the 2011/2012 and 2012/2013 seasons (PWA, 2014c). The most important springs in the West Bank are located within the eastern aquifer in the West Bank, and are mainly used for agricultural purposes (ARIJ, 2007b).



MAP 2.4: GROUNDWATER WELLS AND SPRINGS IN THE WEST BANK

2.3.3 WATER NETWORK COVERAGE

In the West Bank 81% of the localities are connected to the water network (**Map 2.5**). Ninety Eight locality housing 7% of the total number of households in the West Bank remain unconnected to water network (PCBS, 2015a; PCBS, 2013a). These communities are completely dependent upon: water tankers transporting water from nearby networked sources; rainwater collection methods; bottled water; untreated spring water; and agricultural wells. However, those who rely on water bought in by water tankers pay up to 400% more per liter for clean water (EWASH, 2014)

It is important to mention that even the connected communities depend on other sources of water to satisfy their domestic needs, due to the irregular and infrequent supply through the water network. Approximately, 24.3% and 27.6% of the households in the West Bank use water tankers and domestic wells respectively, to complement water supplied by networks (PCBS, 2015a). **Figure 2.3** shows the frequency of water supply services in the West Bank. Only 50.9% of households in the West Bank are supplied with water on a daily basis (PCBS, 2015a).

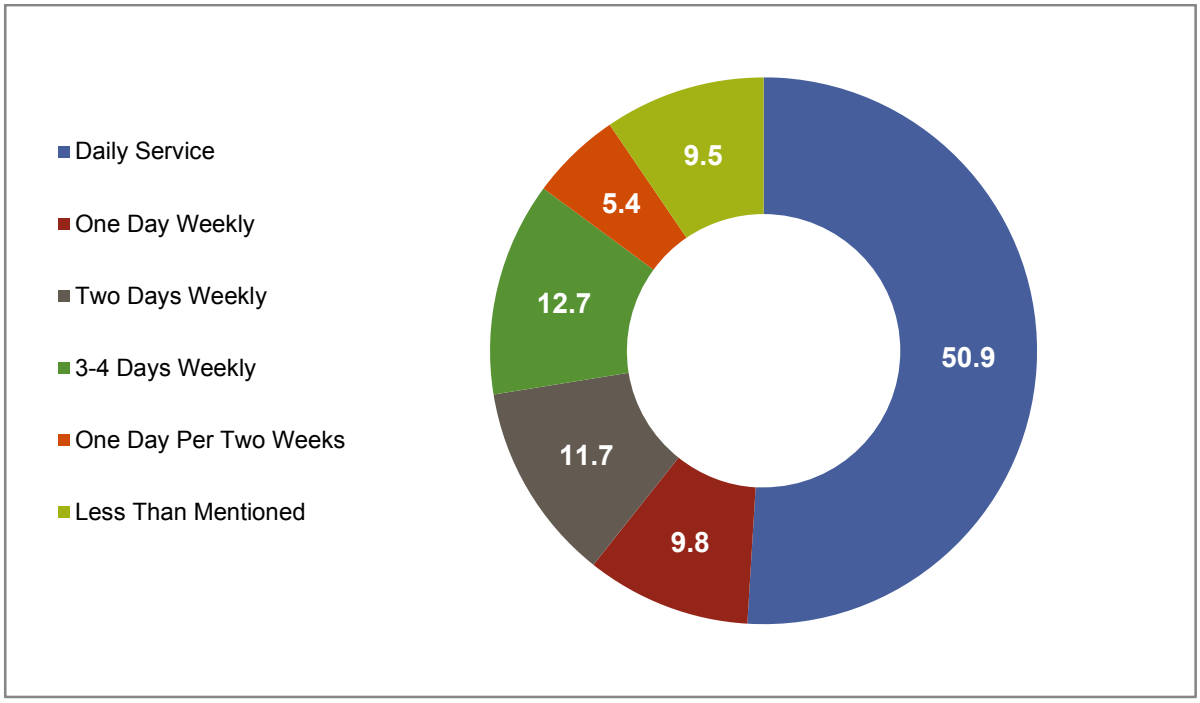
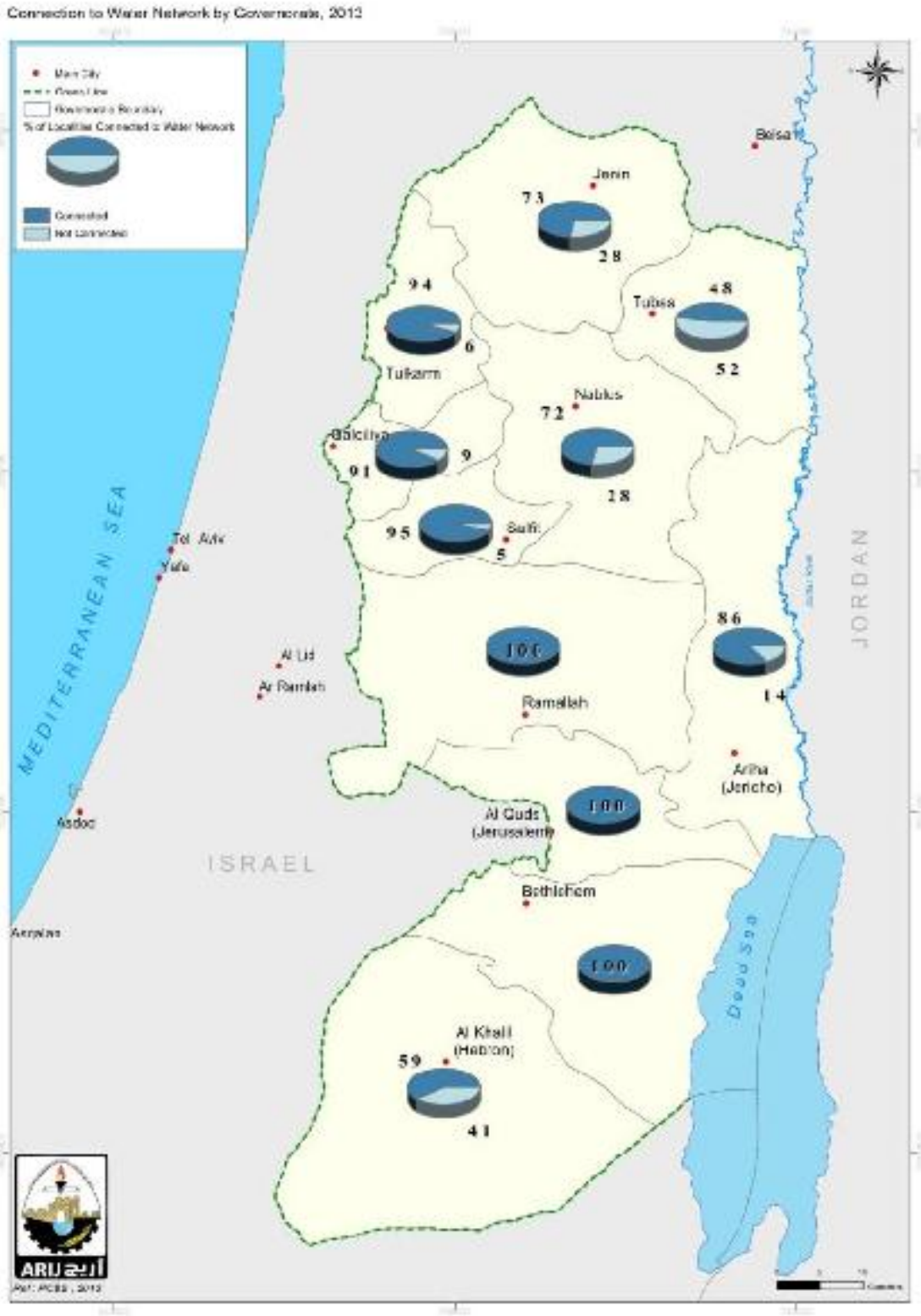


FIGURE 2.3: PERCENTAGE DISTRIBUTION OF HOUSEHOLDS IN WEST BANK BY CONTINUOUSLY OF WATER SUPPLY SERVICE

Moreover, the water losses through leaking pipes and illegal connections are high; in 2013 the overall loss was estimated to vary between 14% in Ramallah and Al Bireh Governorate to 49% in Jerusalem governorate (PWA, 2014c).

All the communities in the Gaza Strip are connected to the water network (93% of the Strip's households are connected to the network). Nonetheless, only 30% of the households have a daily service of water supply (PCBS, 2015a). This increased dependency on un-networked water sources. In 2015, 65.4% of the households depended on water tankers and 24.9% depended on bottled water. During the last Israeli assault against Gaza in the summer of 2014, most of the population did not receive water through the water network for weeks (PWA, 2015d). The network distribution system in

Gaza Strip is characterized with a low efficiency, as the water losses were estimated at range of 59% in the year 2014 (PWA, 2015a).



MAP 2.5: COMMUNITIES CONNECTED TO THE WATER NETWORK IN THE WEST BANK, 2013

Several projects were recently completed or are still under construction to increase access to water in the unconnected localities. These projects includes construction of water reservoirs, installing main pipelines and transmission pipelines, and network connections. **Table 2.4** shows some recent projects that were implemented in Palestine (PWA, 2016a, 2016b).

TABLE 2.4: SOME RECENT PROJECTS IN PALESTINE

Project	Project Description	Budget	Funding Agency	Status / Completion rate
Northeast Jenin Water Network Project	Install transmission pipelines and establish a storage tank and pumping station	$ 11,045,000	USAID	Under construction (52%)
Southwest Jenin Integrated Water Project	Rehabilitation of 6 water reservoirs and install transmission pipelines	$ 12,949,433	USAID	Under construction (10%)
Nahaleen Main Pipeline Project	Local network connections	$ 980,000	WB	Under construction (40%)
Water and Sanitation facilities improvement project in the Bethlehem governorate	Local network connections	€ 6,832,106	AFD	Under construction (20%)
Water Network in Al Carmel Village / Yatta	Local network connections	$ 1,800,000	USAID	Under construction (98%)
Saffarin Water Project	Construction of pipeline, pumping station and water reservoir	$ 1,000,000	MoF	Under construction (90%)
Rebuild and upgrade of wells and reservoirs in Gaza Strip	23 wells and 7 reservoirs destroyed by the last war	na	na	Completed
Deir Al Balah Sea Water Desalination Plant Project	Upgrading the plant	na	Palestinian Islamic Bank	Completed
Establish Water Reservoirs and pumping stations in the Gaza Strip (Part of the Desalination Plant project in Central Gaza Strip)	Establishing four reservoirs in the north, south and middle of Gaza Strip and pumping stations	$ 17,000,000	USAID	Under construction

2.3.4 WATER SUPPLY AND CONSUMPTION

In the year 2013, the annual available water quantity for Palestinians was 365.7 MCM (PWA, 2014c), this quantity of water is supplied to the Palestinians through: local resources; groundwater wells and springs; and water purchased from the Israeli water company “Mekorot”.

In 2013, a total quantity of 163.1 MCM was supplied to the Palestinian localities of the West Bank (PWA, 2014c). Of this quantity, 36% of the water (59.3 MCM) was purchased from Mekorot, while the rest was supplied from local resources (PWA, 2014c).

In 2013, the domestic water supplied to the West Bank from all resources, was 100.9[6] MCM, covering just 74% of the 136.9 MCM needed water[7]. In the same year the deficit[8] in domestic water supply was 36 MCM, while the real deficit[9] in water supply reached 65 MCM. Moreover, the water total losses rate was 29% of the supplied water in 2013 presenting a quantity of 29 MCM (PWA, 2014c).

Table 2.5 shows the quantities of total available water, pumped water from groundwater wells, springs discharge and the water purchased from Mekorot for the West Bank governorates in the year 2013.

TABLE 2.5: AVAILABLE WATER, WATER PUMPED FROM WELLS, SPRINGS DISCHARGE AND WATER PURCHASED FROM MEKOROT BY WEST BANK GOVERNORATES IN MCM, 2013

Governorate	Pumped quantity from Wells		Springs Discharge	Purchased from Mekorot	Total available water
	Domestic	Agriculture			
Jenin	3.2	0.6	0.0	2.9	6.7
Tubas	0.5	2.1	0.8	4.4	7.8
Tulkarm	4.8	10.4	0.0	0.5	15.7
Nablus	8.7	1.6	8.4	3.7	22.4
Qalqiliya	4.9	6.2	0.0	1.0	12.1
Salfit	0.0	0.0	0.3	2.8	3.1
Ramallah & Al Bireh and Jerusalem	2.3	0.0	2.4	20.4	25.1
Jericho & Al Aghwar	0.0	7.6	27.0	2.2	36.8
Bethlehem and Hebron	11.4	0.0	0.5	21.4	33.3
West Bank	**35.8**	**28.5**	**39.5**	**59.3**	**163.1**

During the last years, the purchased quantities of water have increased. In 2007 the annual quantity of water purchased from Mekorot was 45 MCM, and this amount was increased in the year 2010 to reach 55.4 MCM, and 59.3 in the year 2013 (**Figure 2.4**) (PWA, 2014c). At the governorate level, Salfit is the Governorate most dependent on water from Mekorot; whereby 90% of the total water available for the Governorate is purchased from Mekorot. Moreover, the Governorates of Ramallah & Al Bireh, Jerusalem, Bethlehem and Hebron were the governorates that supplied the most from purchased water with a percentage of 70% of the total purchased quantity.

[6] This quantity is supplied for non-agricultural uses and includes water supplied for commercial and industrial uses.

[7] Based on the WHO standards of 150 liter/capita/day.

[8] The demand gap based on the supplied amounts.

[9] The demand gap based on the water consumption and takes the water losses into consideration.

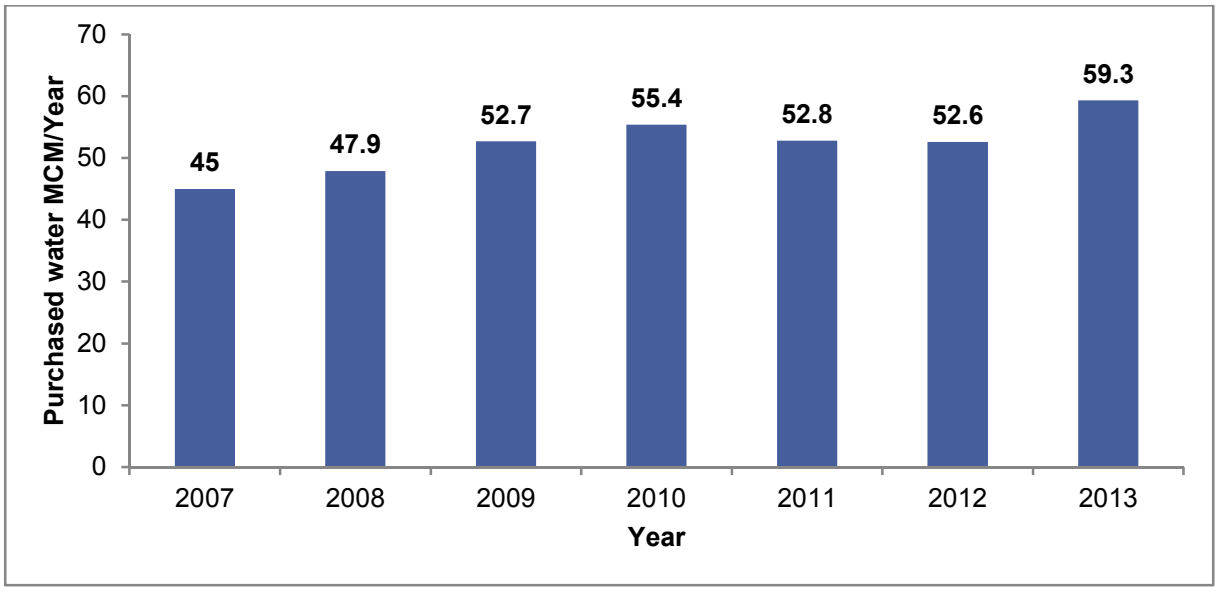
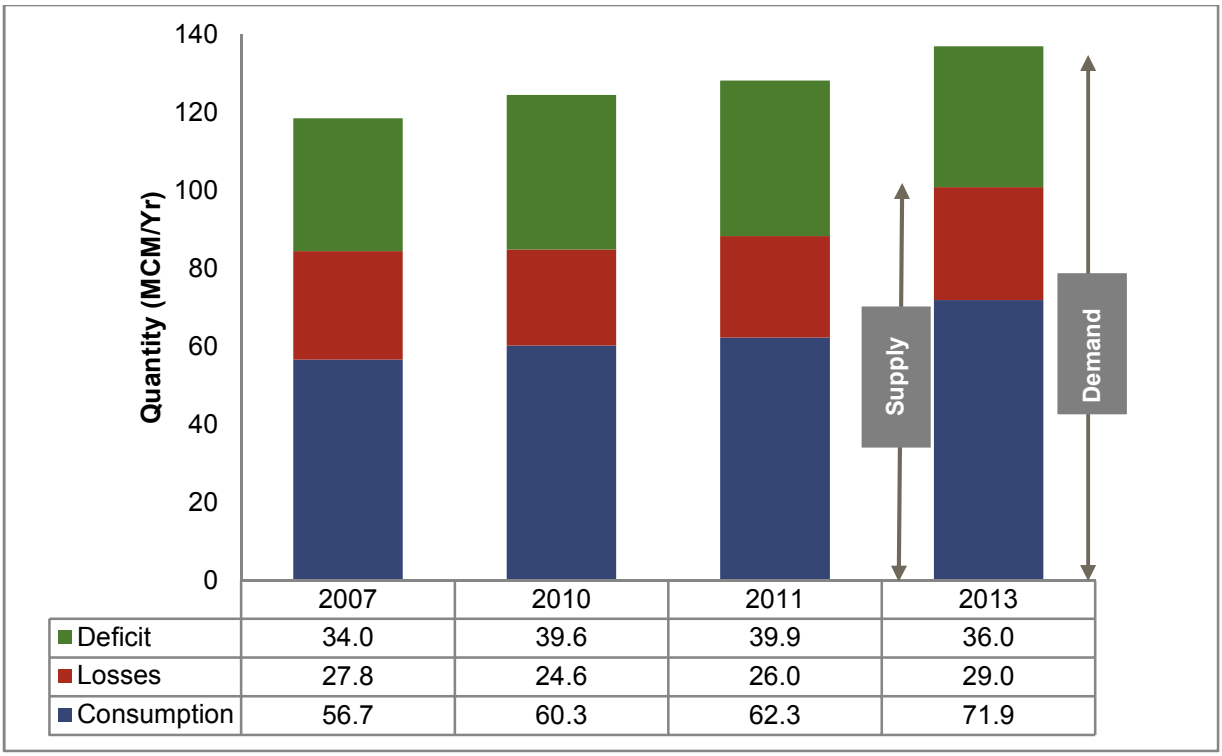


FIGURE 2.4: ANNUAL QUANTITY OF WATER PURCHASED FROM ISRAELI WATER COMPANY (MEKOROT) IN THE WEST BANK GOVERNORATES, 2007 - 2013 (MCM/YEAR)

Figure 2.5 below shows the water needs and demands, in addition to the losses and deficits in the West Bank governorates over the years 2007 - 2013.



	2007	2010	2011	2013
Deficit	34.0	39.6	39.9	36.0
Losses	27.8	24.6	26.0	29.0
Consumption	56.7	60.3	62.3	71.9

FIGURE 2.5: WATER SUPPLY AND DEMAND IN THE WEST BANK, 2007 - 2013

On a governorate level, most of the West Bank governorates suffer from deficit in the supplied water quantities. The only Governorate Jericho and Al-Aghwar does not suffer from any deficit; where the consumed water exceeds the water demand. The governorates that registered the highest percentage of deficits are Tubas and Jerusalem with a percentage of 76% and 70% respectively (PWA, 2014c).

In the Gaza Strip, in 2014, a total of 88.47 MCM water was supplied for domestic sector. Of this quantity, 96% (84.9 MCM) was supplied from local resources through 247 water wells, whilst 4% was purchased from Mekorot (PWA, 2015a). From 2007 – 2014 the annual quantity of water purchased from Mekorot has not changed so much. In 2007 it was 4.6 MCM and it increased in a small percentage in the year 2010 to reach 4.9 MCM. In 2014, the annual quantity of purchased water decreased to 3.5 MCM (PWA, 2014c, 2015a). It should be mentioned that the quantity of supplied water through the desalination plants is about 6 MCM/Yr (PWA, 2015a).

The water losses rate in the Gaza Strip (overall loss and uncounted for water) is higher than that in the West Bank, and was 41.1% of the supplied water in 2014 (PWA, 2015a). North Gaza Governorate has the highest water losses rate at 50%.

TABLE 2.6: SUPPLIED, CONSUMED AND LOST WATER BY GOVERNORATE IN THE GAZA STRIP, 2014

Governorate	Supplied water (MCM/Yr)	Consumed water (MCM/Yr)	Losses (MCM/Yr)
North	23.39	11.66	11.73
Gaza	27.02	17.02	10.00
Middle	13.64	8.29	5.35
Khan Younis	14.70	9.00	5.71
Rafah	9.71	6.09	3.62
Total	**88.47**	**52.06**	**36.40**

According to the PWA, the estimated water quantities for agriculture use including the livestock are about 95.3 MCM/Yr in the Gaza Strip. It is clear that there is an annual increase in the agricultural water consumption of about 9.5 % compared to 2012 (PWA, 2014a).

Water supply and consumption rate

On a per-capita basis, the average water supply by Palestinians in the West Bank was 103 l/c/d in 2011 and 110 l/c/d in 2013 (PWA, 2014c). It is noted that the supply varies from one governorate to another (**Figure 2.6**). Tubas and Jerusalem Governorates have the lowest per capita supply rate in all of the West Bank governorates of 71 l/c/d and 69 l/c/d respectively (PWA, 2014c).

Although the average supply rate for the West Bank was higher than 100 l/c/d "WHO minimum standard of water consumption" (Amnesty International, 2009), the actual consumption rate is much lower due to the high water losses rate. In 2010 the average actual consumption rate in the West Bank was 73 l/c/d and 78.8 l/c/d in 2013 (PWA, 2014c). **Figure 2.6** shows the domestic water supplied and consumed quantities and the consumption rate for the West Bank governorates in the year 2013.

It is important to note that the actual supply and consumption rates per capita are less than the numbers indicated above since the quantity of water supply for the domestic sector includes also the water supplied for commercial and industrial uses. Moreover, for the case of Jericho and Al Aghwar governorate the consumption and supply rate is significantly higher since the quantity of water supply includes recreational, touristic and economical activities.

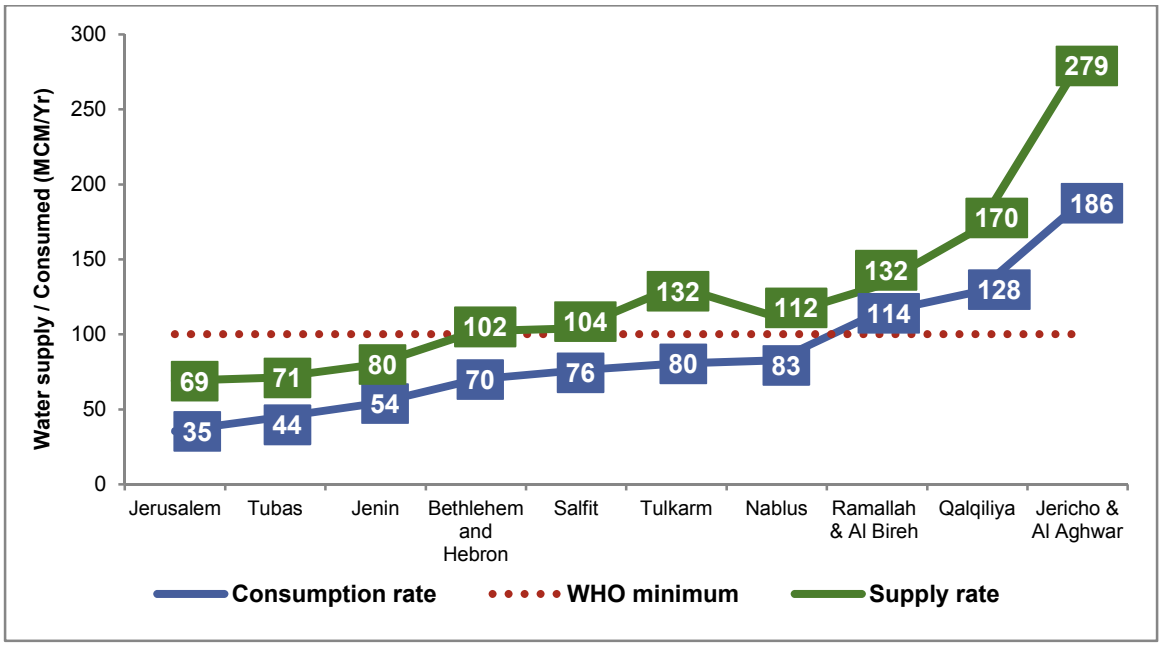


FIGURE 2.6: QUANTITY OF WATER SUPPLY FOR DOMESTIC SECTOR AND WATER CONSUMED AND DAILY ALLOCATION PER CAPITA IN THE WEST BANK, 2013

In the Gaza Strip, the average supply rate was 135 l/c/d in 2014 while the average consumption rate was only 79.8 l/c/d. North Gaza Governorate has the highest per capita supply rate of 180 l/c/d but also the highest water losses' rate of 50%. While Rafah Governorate has the lowest water losses rate of 36% and the lowest per capita consumption rate of 75 l/c/d. North Gaza Governorate has the highest water losses and highest per capita supply and consumption rates of 180 l/c/d and 90 l/c/d, respectively (**Figure 2.7**) (PWA, 2015a).

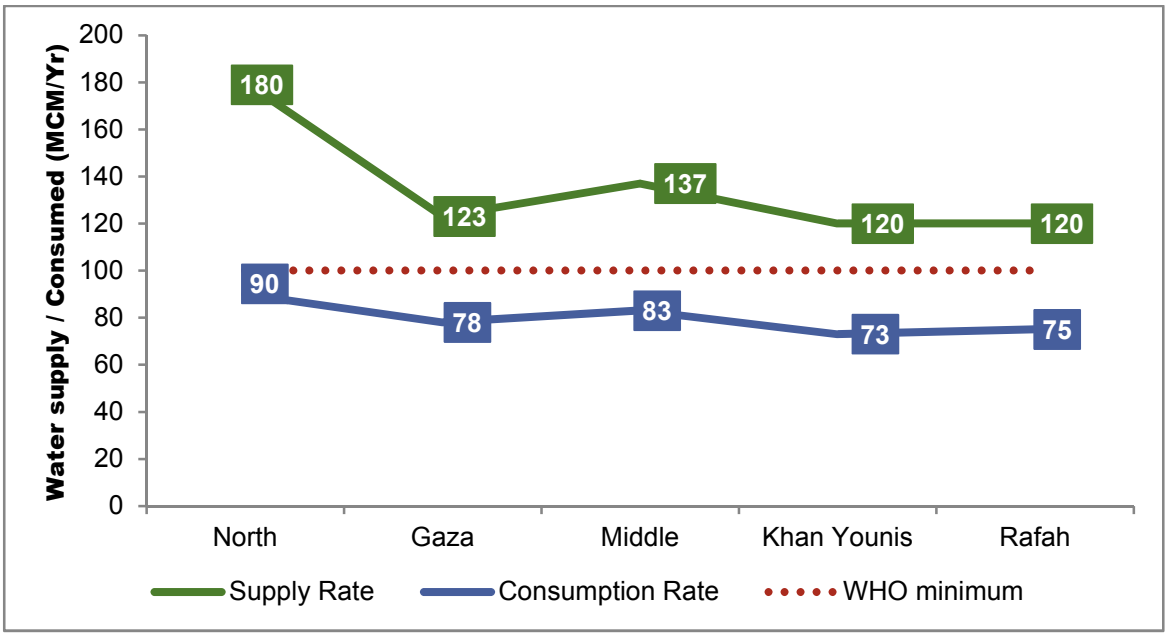


FIGURE 2.7: QUANTITY OF WATER SUPPLY FOR DOMESTIC SECTOR AND WATER CONSUMED AND DAILY ALLOCATION PER CAPITA IN THE GAZA STRIP, 2013

However, the average consumption rate for the West Bank and Gaza Strip is lower than what is recommended by the World Health Organization (WHO), of 100 l/c/d as a minimum standard of water consumption (Amnesty International, 2009).

2.3.5 GROUNDWATER QUALITY

According to the PWA annual report, the latest available data for the groundwater quality in the West Bank is limited to selected wells located in the Jordan Valley, Qalqiliya and Tulkarm. The tests show that most of the wells in the Jordan Valley have high concentration of chloride exceeding the acceptable guideline of the WHO (250 mg/l), whilst showing a quite low nitrate concentration (PWA, 2013a). Regarding Tulkarm and Qalqiliya, the nitrate concentration exceeds 50 mg/l (WHO allowable limit) in some wells, while the chloride concentration in these wells stayed within the acceptable limit (PWA, 2013a).

The problem of water quality in Gaza Strip is one of the most serious challenges facing the Palestinian water sector. 96% of Gaza Strip's groundwater resources are polluted with high proportion of nitrates and chlorides that exceed accepted international guidelines for potable water resources (PWA, 2015d). The poor quality has resulted from years of over-exploitation in addition to sewage infiltration into the aquifer.

Most of the ground water wells in the Gaza Strip show a high chloride concentration due to over-abstraction, pollution and sea water intrusion. The WHO approved guideline for chloride concentration is 250 mg/l. Only a limited part of the aquifer in Northern Gaza and West of Khan Younis have waters with chloride concentration less than 250 mg/l. The major parts of the aquifer have chloride concentration of 500 – 1500 mg/l, while along the coastal line the concentration of chloride exceeds 2000 mg/l (PWA, 2015a).

The intensive use of agricultural pesticides, in addition to the inflow of sewage into the aquifer resulted in high concentrations of nitrate ion in groundwater. The WHO guideline recommends less than 50 mg/l of nitrate concentration. The concentration of nitrate varies from 50 mg/l in areas not occupied by residents (southeast part of Rafah) or characterized by low transitivity of thick unsaturated layers (e.g. Al Nusairat area) to more than 300 mg/l in the areas of Gaza Strip that are still served by cesspits (such as Khan Younis) (PWA, 2015a).

BOX 2.3: THE DESALINATION PLANT IN CENTRAL GAZA STRIP

With the worsening water and humanitarian crisis in Gaza Strip and with no alternative existing source of fresh water, the urgency for the desalination facility has increased. The European Union and the UNICEF launched in March 2014 a project to build a desalination plant in Deir al Balah in the center of Gaza Strip, in order to provide 75,000 people in Khan Yunis and Rafah in the south with drinking water. The main objective is to alleviate the health crises threatening Gaza people through the improvement of water supplies quality and quantity while at the same time preserving the water of the Coastal Aquifer through reducing pumping rates. The concept design of the desalination plant with a capacity of 55 MCM/y for the first phase of the project was conducted. It is important to mention that, in the year 2003 the project tender for the desalination plant project has been launched by USAID and was frozen for political reasons (PWA, 2015b).

There are many concerns regarding the establishment of the desalination plant. These can be summarized in the following: (1) the main concern is the guaranteed supply of power required to operate the desalination plant, (2) the long term cost recovery of the plant and its operations in the future, and (3) security of the project with regard to the political situation (PWA, 2015b).

It is worth mentioning that there is a plan to build three short term low volume seawater desalination plants with a yearly capacity of 13 MCM. The establishment of these plants is not completed yet because of the lack of materials needed for their construction and the lack of electricity or fuel for their operation (EWASH Advocacy Task Force, 2015).

2.4 Analysis of the Current Status of the Wastewater Sector in Palestine

2.4.1 WASTEWATER COLLECTION, TREATMENT AND FINAL DISPOSAL

The environmentally sound management of waste requires adequate collection and treatment of wastewater and disposal/reuse of treated effluent. To date, the current management practices for the wastewater sector in Palestine are mostly limited to the collection of wastewater by sewage networks and cesspits. Furthermore, wastewater treatment facilities are restricted to a few Palestinian localities. The lack of sufficient and appropriate infrastructure for wastewater collection and treatment has been the limiting factor in the development of Palestine's wastewater and sanitation sector.

Based on the per capita wastewater generation, the total volume of wastewater generated for the year 2015 was estimated at 114.36 MCM, from which 65.82 MCM are generated in the West Bank and 48.54 MCM are generated in the Gaza Strip (**Figure 2.8**) (ARIJ, 2015c; PCBS, 2013c, 2015c).

In the West Bank the wastewater treatment and collection service is the responsibility of the local authorities (utilities, municipalities and village councils). These providers do not and should not make profit from the collection service, but do keep their accounts on basis that guarantee the sustainability (operation, maintenance and future expansion needs) of the services and the infrastructure. In the refugee camps, the UNRWA has been providing the sewage collection service. In the Gaza Strip, the water and wastewater services are provided by the Coastal Municipalities Water Utility (CMWU).

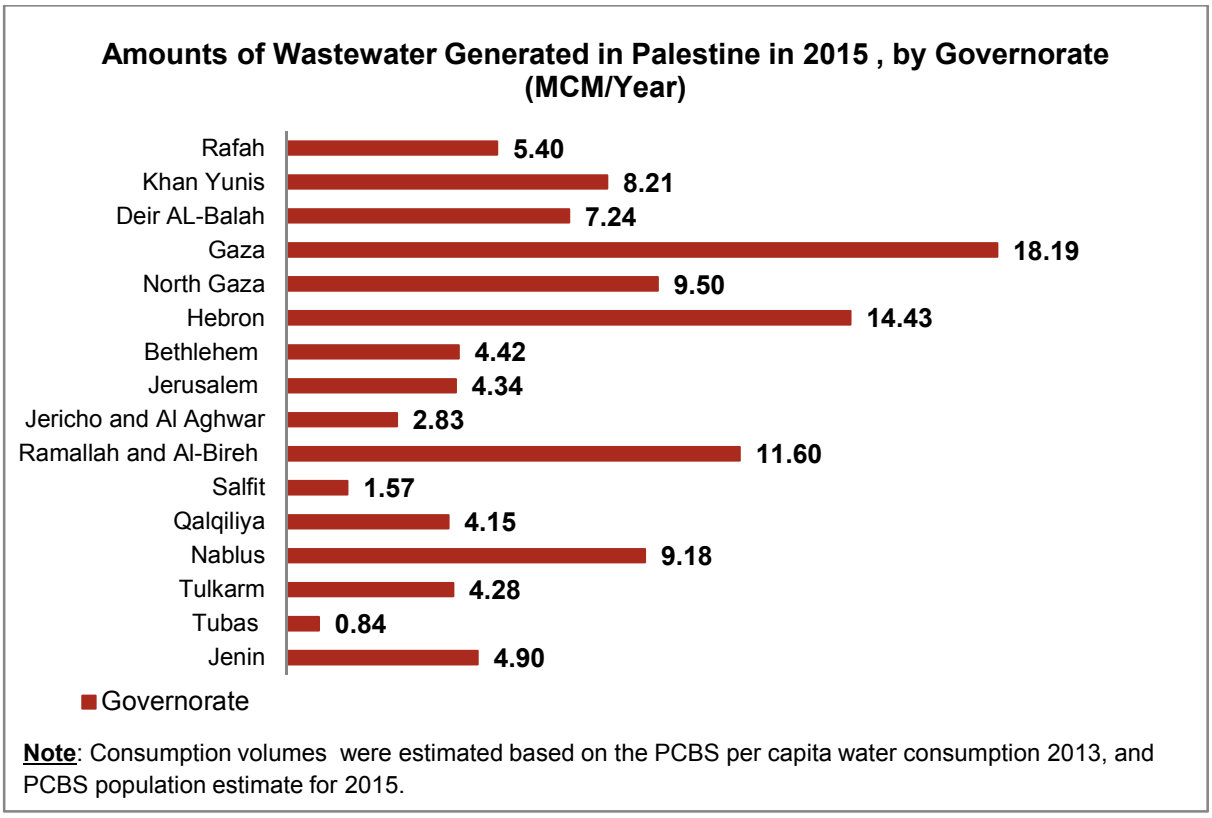
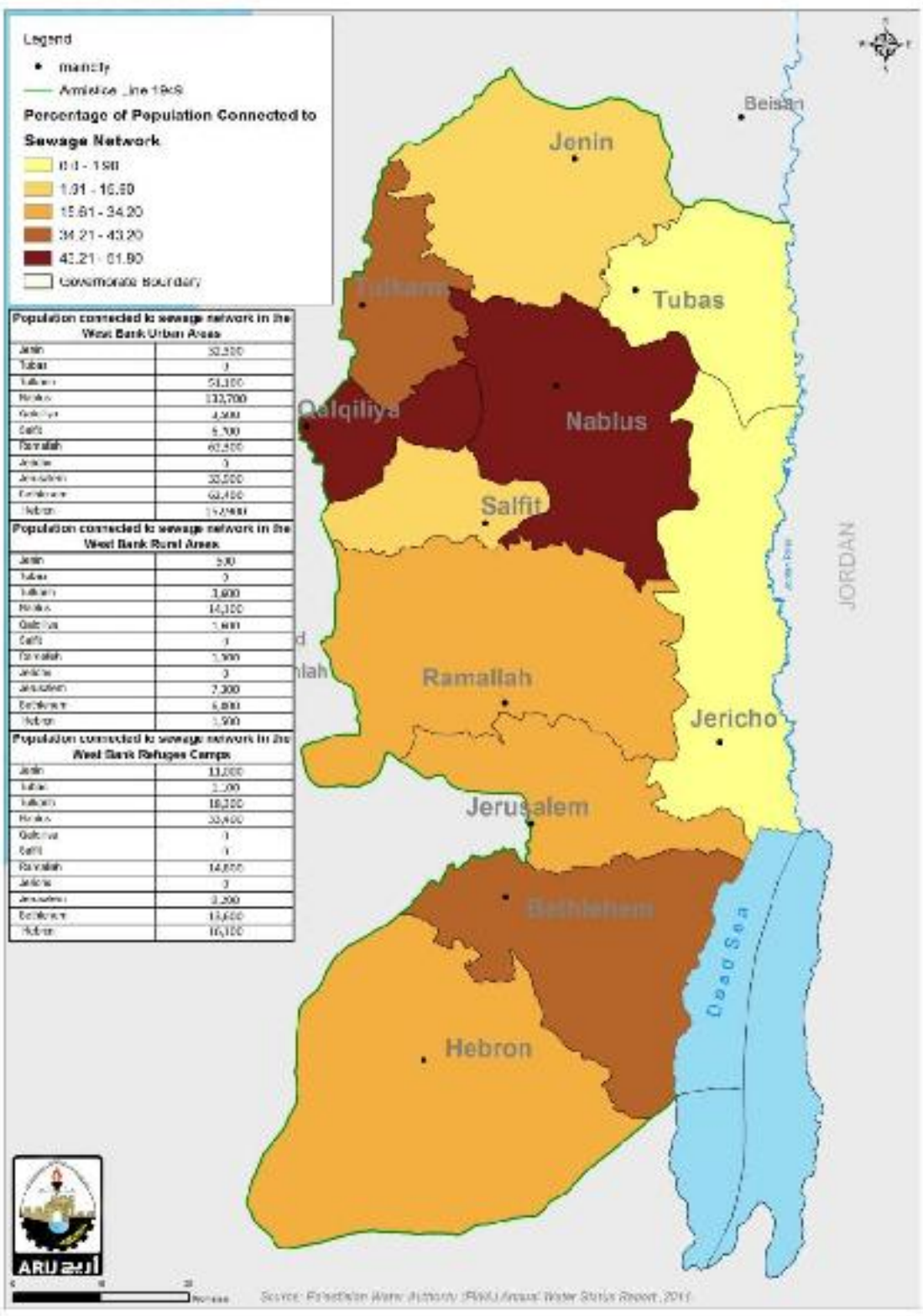


FIGURE 2.8: ESTIMATED VOLUME OF WASTEWATER GENERATED IN PALESTINE IN 2015

2.4.2 CONNECTION TO SEWAGE SYSTEMS

The wastewater collection and treatment services provision has a limited coverage due to years of neglect during the Israeli occupation when limited investments were expended in networks rehabilitation and expansion projects as well as for the development of wastewater treatment infrastructure (World Bank, 2009).

Since 1999 however, there was significant progress in the level of sewage connection. According to the PCBS, there was an increase in the connection coverage of households from 39.3% for the year 1999, to 52.1% for the year 2009 and to 53.9% for the year 2015 (PCBS, 2009a). Wastewater collection network is mostly limited to the major cities and refugee camps (**Map 2.6**). In many rural areas, it is not financially feasible to connect rural housing units to conventional centralized wastewater management systems due to the high capital cost of installing sewage collection networks in areas with dispersed housing patterns. Alternatively, household-level small scale wastewater treatment plants are "more" economically feasible than centralized systems and reusing the treated wastewater can: create an additional water resource for irrigating fruit trees and forages; improve soil fertility and organic content; increase crop yield while decreasing the need for inputs of synthetic fertilizers; reduce contamination of soil, surface and ground water resources; and subsequently reduce the health risks of contracting water-borne diseases.



MAP 2.6: WEST BANK CONNECTION TO SEWAGE NETWORKS, 2015.

According to the PCBS, the geography of sewage collection network coverage is as follows: (1) 83.5% of the households in the Gaza strip are connected; (2) only 38.4% of the households in the West Bank

are connected as follow: In the northern part of the West Bank only 33.5% of the households are served by sewage collection network, followed by the Southern part where only 36% of the households are served, followed by the Middle part of the West Bank where 47.9% of the households are served by sewage network (PCBS, 2015a) (**Figure 2.9**).

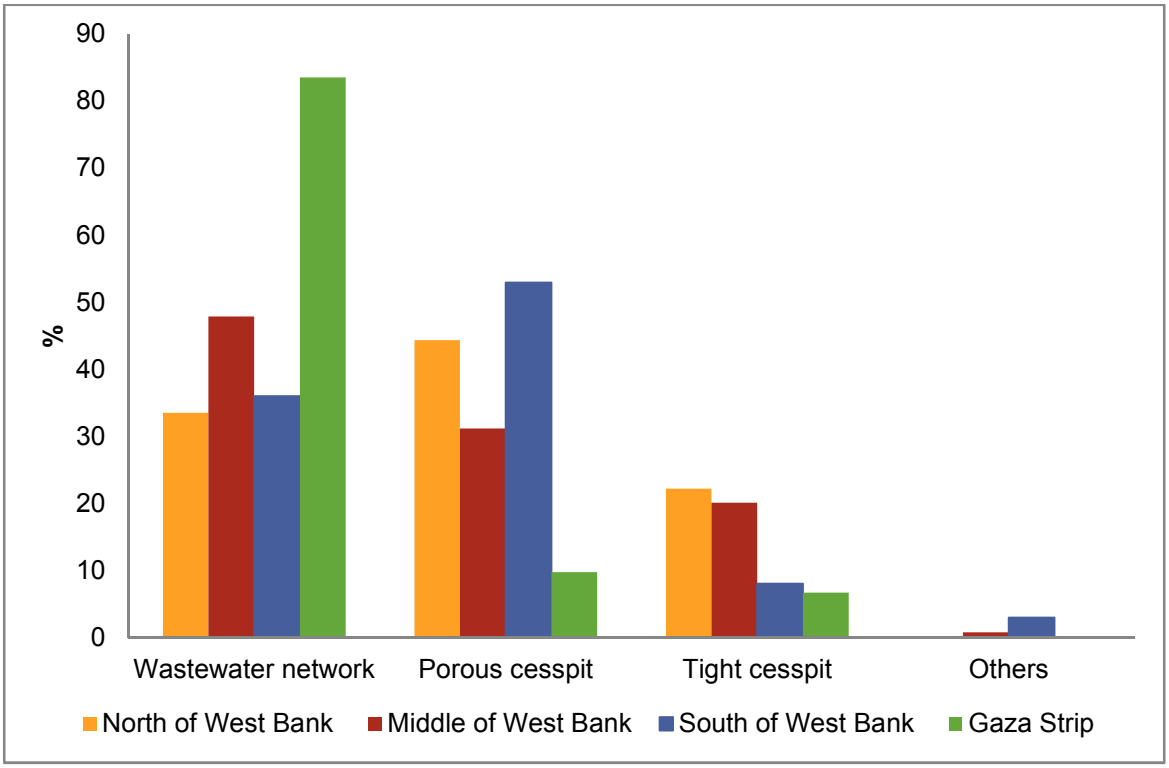


FIGURE 2.9: HOUSEHOLDS PERCENTAGES IN ACCORDANCE TO WASTEWATER COLLECTION SYSTEM, 2015

Note: (1) North of West Bank refers to: Jenin, Tubas, Tulkarm, Qalqilya, and Nablus Governorate.
(2) Middle of West Bank refers to: Ramallah, Salfit, Jerusalem, and Jericho Governorate.
(3) South of West Bank refers to: Hebron and Bethlehem Governorates.

At locality level, the data from the PCBS revealed that only 104 Palestinian localities out of 557 are served totally or partially by wastewater networks. It should be noted that many of these networks are old and poorly designed as they were established before 1967 through Jordanian Administration and were neglected during the years of Israeli occupation (PWA, 2012). The remaining localities (approximately 81% of the total Palestinian localities) rely on septic tank and cesspits or simply release raw sewage directly into the environment without any treatment.

Table 2.7 illustrates the number and the distribution of the localities by the wastewater collection system. According to the PCBS, in the year 2015, 80 Palestinian localities out of 524 in the West Bank had sewage networks, 456 had porous cesspits and 181 had tight cesspit (septic tanks) (PCBS, 2015c). In the Gaza Strip, 24 localities out of 33 had sewage networks, 26 had Cesspits and only one had tight cesspit (PCBS, 2015c). From the above, it can be concluded that porous cesspits are still the most widespread collection method in the West Bank. This is a dangerous situation as a broad list of wastewater pollutants (heavy metals, pharmaceuticals, disinfection by-products, etc.) can slowly leach into groundwater sources from which almost all communities in the West Bank draw drinking water. In

the Gaza Strip, sewage collection networks became the most common method of wastewater collection.

TABLE 2.7: DISTRIBUTION OF LOCALITIES IN PALESTINE BY WASTEWATER COLLECTION SYSTEM, 2013

Governorate	Wastewater disposal method - Number of localities				
	Exposed wastewater network	Exposed wastewater channels without network	Sewage network	Cesspit	Tight cesspit
Jenin	1	1	4	76	23
Tubas	2	1	0	15	7
Tulkarm	2	1	7	32	14
Nablus	0	2	13	56	15
Qalqiliya	1	0	6	33	14
Salfit	0	0	2	18	8
Ramallah and Al-Bireh	2	6	9	68	45
Jericho and Al Aghwar	0	1	1	13	4
Jerusalem	3	4	22	23	13
Bethlehem	3	4	10	37	20
Hebron	5	8	6	85	18
West Bank	***19***	***28***	***80***	***456***	***181***
North Gaza	0	0	5	3	0
Gaza	0	0	4	4	0
Deir AL- Balah	1	2	10	8	1
Khan Yunis	1	2	2	7	0
Rafah	0	0	3	4	0
Gaza Strip	***2***	***4***	***24***	***26***	***1***
Palestine	**21**	**32**	**104**	**482**	**143**

Note:

- Data identified 557 localities in Palestine, distributed into 524 localities in West Bank and 33 in Gaza Strip.
- It is important to mention that there are some localities use not only one method for wastewater disposal, which explains that the number of the localities is higher than the total number of localities in the West Bank and Gaza Strip.

Source: (PCBS, 2015c)

Improving the sewage collection infrastructure is a crucial component of the wastewater sector and a prerequisite for an integrated system that includes treatment and reuse. Several projects were recently completed or are still under construction to increase the volume of generated wastewater collected in networks (**Table 2.8**).

TABLE 2.8: SOME RECENT SEWAGE COLLECTION NETWORK PROJECTS IN THE WEST BANK

Wastewater Project	Status	Components
Wadi Zomar Sewage Project (9 localities in Tulkarm Governorate)	Under construction	Collection system, trunk line, pre-treatment
Expansion of Jericho sewage network	Delivery phase	Collection system
Beit Qusein and Beit Wazn sewage network project	Design phase	Collection system, capacity building and wastewater treatment and reuse
Habla, Baqa al Sharqieh, Barta'a	Completed	Collection System
Artas Sewage Project	Completed	Collection system & boosting station

Source: (ARIJ, 2015c; PWA, 2013a, 2016a)

PHOTO 2.1: A PALESTINIAN HOUSEHOLD IN AL WALAJA VILLAGE (BETHLEHEM GOVERNORATE) WITH GREEN VEGETATION IN ITS SURROUNDINGS FEEDING ON CONTINUOUS WASTEWATER OVERFLOW FROM A CESSPIT THAT IS SERVING ONE OF THE NEIGHBORING HOUSES.

2.4.3 TREATMENT AND FINAL DISPOSAL

Only two thirds of the generated wastewater collected in sewage networks is discharged into a wastewater treatment facility. The annual wastewater collected by sewage networks reaches 15 MCM/year in the West Bank, and around 10.3 MCM of it is treated or partially treated (PWA, 2012) in 6 centralized wastewater treatment plants and in 16 collective wastewater treatment plants (ARIJ, 2015c) (See **Map 2.7**).

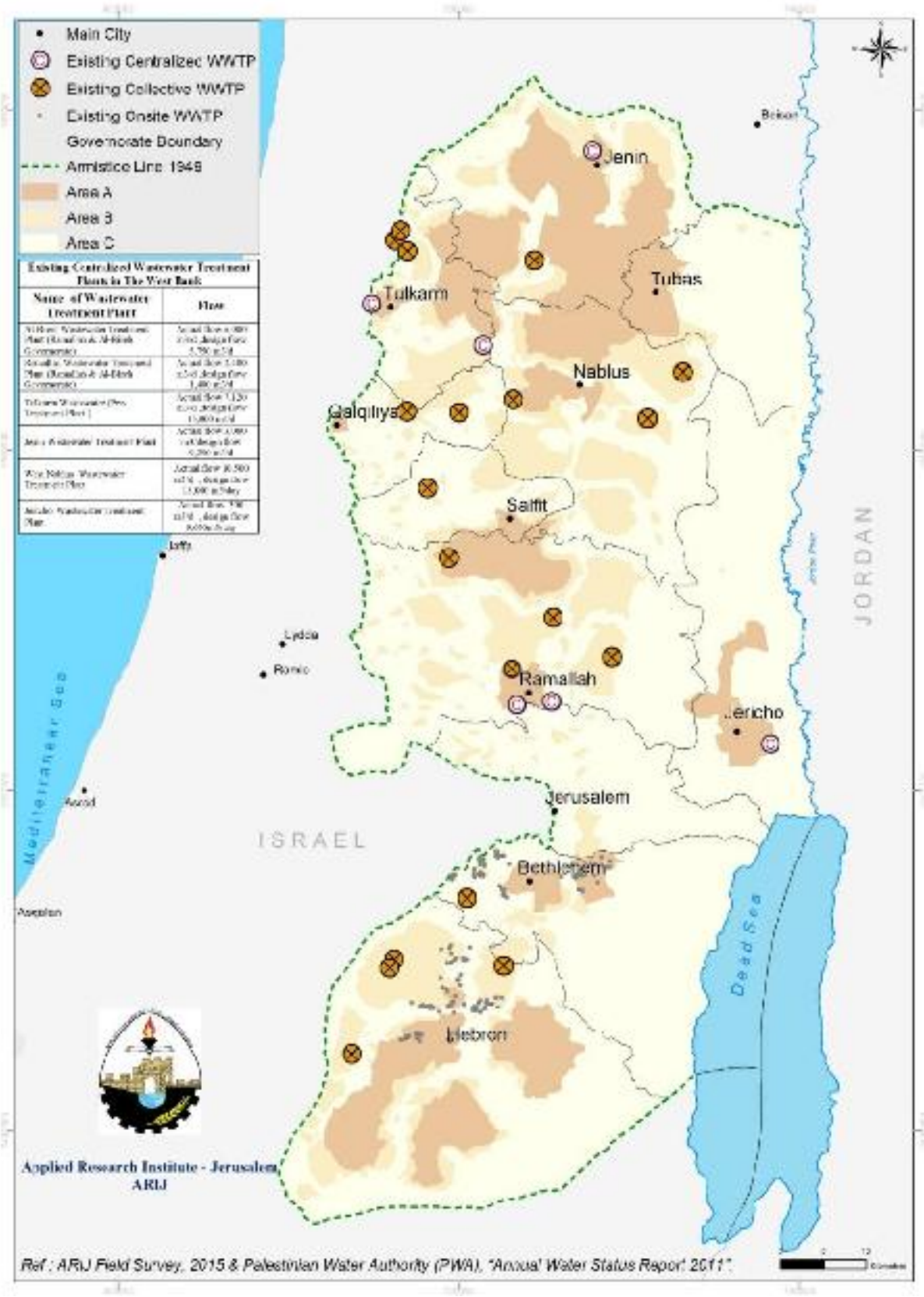
Existing centralized wastewater treatment plants that are operating at a good efficiency rate are: West Nablus, Jenin, Jericho and the Tulkarm pre-treatment plant. The Ramallah and Al Bireh WWTPs are overloaded and functioning at low-moderate efficiencies (ARIJ, 2015c) (**Table 2.9**). Al Bireh WWTP

has been facing various operational and maintenance problems and is currently under rehabilitation. The new centralized wastewater treatment plants of West Nablus and Jericho are expected to achieve efficient treatment. Unfortunately, the households of Jericho are not yet connected to a sewage network and the Jericho waste water treatment plant receives wastewater collected by tankers and a very limited sewage collection network. The treatment capacity of Jericho WWTP is 9,600 m^3/d but is currently treating 300 m^3/d due to the lack of sewage collection network infrastructure in Jericho. Other wastewater sewage networks discharge the collected wastewater into open streams creating serious environmental problems. One must therefore challenge the wisdom and/or the conditions that have led to the construction of wastewater treatment facilities where no sewage collection system exists and vice versa discharging the collected wastewater in networks into open streams especially that the costs of establishing a collection network far exceeds the costs of treatment.

TABLE 2.9: THE EXISTING CENTRALIZED WASTEWATER TREATMENT PLANTS IN THE WEST BANK

Name of Wastewater Treatment plant	Actual and Design Flow (m3/day)	Status of WWTP
Al-Bireh WWTP	Actual Flow = 6,000 Design Flow = 5,000	Operational year 2000; overloaded, currently under rehabilitation and upgrade
Ramallah WWTP	Actual Flow = 2,400	Operational year 1975 and rehabilitated in 2002/2003; not operating well (overloaded) and does not meet the requirements for effluent discharge
Tulkarm Wastewater Pre-Treatment Plant	Actual Flow = 7,120	Operational year 1972 and rehabilitated in 2004. Operating well with high efficiency
Jenin WWTP	Actual Flow = 9,000	Operating after being rehabilitated
West Nablus WWTP	Actual Flow =10,000 Design Flow =12,000	Operational year 2013. Operating under monitoring after start up
Jericho WWTP	Actual Flow =300 Design Flow = 9,600	Operational year 2013. Treating only 300 m^3/d due to the lack of sewage collection network

Source: (ARIJ, 2015c; PWA, 2013a)



MAP 2.7: EXISTING WASTEWATER TREATMENT PLANTS IN THE WEST BANK

PHOTO 2.2: NABLUS WEST WASTEWATER TREATMENT PLANT INAUGURATED ON THE 29TH OF JULY 2013.

In spite of the collection of some 15 MCM and the treatment of 10 MCM of wastewater per year, the reused volume of treated effluent in agriculture or in industrial process remains close to zero MCM/year. The existing centralized wastewater treatment plants in Palestine should treat the wastewater to standards suitable for reuse. New wastewater treatment projects are including a reuse component as an integrated part of system design. Social acceptability or the lack thereof of reusing treated wastewater in agriculture and industrial processes should also be addressed. Reusing wastewater should reduce water scarcity problem and contribute to the financial sustainability of the collection and treatment systems through fees collected from the sales of treated wastewater to agricultural and industrial enterprises.

In addition to the potential of irrigated agriculture to partially recover the operational and maintenance costs of WWTP, irrigation with wastewater can significantly improve agricultural yields. In the West Bank, irrigated field crops, for example, produce an average yield 11 times greater than would be possible with rain-fed agriculture. Similarly, gross revenue from open-field irrigated agriculture is 10 to 11 times greater than that from rain-fed agriculture. Hence, reusing treated wastewater can improve the livelihoods of resource-poor farmers by increasing the supply of domestic savings and capital formation. Irrigated agriculture can also promote development in other economic sectors in Palestine.

Existing collection networks and centralized wastewater treatment systems if not constantly maintained and updated to serve a growing population and hence larger influents become obsolete and incapable of treating the wastewater to the national standards set by the Palestinian Standards Institute (PSI).

In addition to the centralized wastewater treatment plants (WWTPs), a number of the non-governmental organizations (NGOs) and academic institutions have established two types of decentralized WWTPs:

a) Collective wastewater treatment systems: These were established in several localities that lacked sewage collection networks and that depended on cesspits for wastewater disposal. Such wastewater treatment systems are composed of a vacuum truck collection system plus a collective WWTP.

Table 2.10 outlines the location of the existing collective treatment systems, the applied wastewater treatment process, the operational year of the system, design flow and actual flow.

TABLE 2.10: EXISTING COLLECTIVE WASTEWATER TREATMENT SYSTEMS

WWTP Name	Governorate	Wastewater Treatment Process	WWTP related information*
Kharas WWTP	Hebron	Upflow Anaerobic Sludge Blanket (UASB) - Horizontal Flow Constructed Wetlands	O =2003 and was rehabilitated in 2016, D=120, A=100
Nuba WWTP			O=2002 and was rehabilitated in 2016, D=120, A=200
Deir Samit WWTP		Septic Tank - Anaerobic Upflow Gravel Filter	O=2001, D=13.5, A=na
Sair WWTP		Activated Sludge	O=Under Construction, D=1,200, A=na
Al-Quds University WWTP**	Jerusalem	Extended Aeration Process – Chlorine Disinfection and Sand Filtration	O=2007, D=50, A=na
Bani Zeid (Al-Gharbiyeh) WWTP	Ramallah & Al-Bireh	Upflow Anaerobic Sludge Blanket (UASB) - Vertical Flow Constructed Wetlands	O=2004, D=100, A=20
Al-Tireh WWTP		Activated Sludge - Membrane Bioreactor (MBR)	O=2013, D=na, A=2000
'Ein Siniya WWTP		Anaerobic Baffled Reactor – Activated Sludge Process – Multimedia Granule Filtration – Ultraviolet Disinfection	O=2007, D=10, A=na
Rammun - El Taibeh WWTP		Rotating Biological Contactor (RBC)	O=2014, D=na, A=450
Sarra WWTP	Nablus	Constructed Wetlands	O=2004, D=na, A=130
Bait Hassan WWTP		Constructed Wetlands	O=2013, D=na, A=80
Bait Dajan WWTP		Activated Sludge	O=2014, D= na, A=100
Biddya WWTP	Salfit	Septic Tank – Horizontal Flow Constructed Wetlands	O=2007 and was rehabilitated in 2014, D=35, A=20
'Anza WWTP	Jenin	Activated Sludge	O=2015, D=na, A=80
Zeita (1) WWTP	Tulkarm	Septic Tank – Constructed Wetland	O=2004, D=na, A=na

WWTP Name	Governorate	Wastewater Treatment Process	WWTP related information*
'Attil WWTP	Tulkarm	Septic Tank – Anaerobic Upflow Gravel Filter – Aerobic Trickling Filter – Polishing Sand Filter	O=2006, D=14, A=na (Overloaded)
Zeita (2) WWTP	Tulkarm		O=2008, D=14, A=30-35
Sir WWTP	Qalqiliya		O=2006, D=14, A=15
Hajja WWTP		Sedimentation Tank – Horizontal Flow Constructed Wetlands	O=2004, D=30-40 , A=40

Note:

* O=Operational Year, D=Design Flow (m^3/d), A=Actual Flow (m^3/d),, na: not available.

** The Al-Quds University WWTP was moved from Nahhalin village to the University in the year 2016 due to technical reasons.

Source: (ARIJ & CENTA, 2010; ARIJ, 2015c)

BOX 2.4: EFFORTS MADE BY STAKEHOLDERS TO CONTRIBUTE IN THE DEVELOPMENT OF THE WASTEWATER TREATMENT AND REUSE IN THE PALESTINE (COLLECTIVE WASTEWATER TREATMENT SYSTEMS)

In 2013, The Applied Research Institute-Jerusalem (ARIJ) started working on providing an integrated system of wastewater treatment and reuse with an average treatment capacity of 1200 cubic meters per day, built in Sair - Hebron Governorate; with the support of the Spanish Agency for International Cooperation and Development (AECID).

This project targets treating the wastewater stream coming from Al 'Arroub Refugee Camp passing from, Shuyukh Al Arroub and 'Orkan Trad. With the main objective to put an stop to the damages resulting from the wastewater stream that not only pollutes the environment but also exposed the surrounding population to health risks. This project included design an implementing of an integrated treatment solution that suits with the local conditions and allows achieving a proper quality effluent to be reused in different purposes .This action is addressed not only to give a basic sanitation service to the target population but also targeted to recover and valorize a resource for its reuse in irrigation, among other possible uses.

The wastewater treatment plant utilizes extended aeration technology among the treatment processes, and is designed to treat the wastewater generated from al 'Arroub Refugee Camp. The built wastewater treatment plant with an average treatment capacity of 1,200 cubic meters per day.

PHOTO 2.3: SAIR WASTEWATER TREATMENT PLANT DURING CONSTRUCTION PHASE

b) Onsite small scale wastewater treatment plants have been established in several rural localities of the West Bank, where the dispersed pattern of houses in these rural localities makes it economically unfeasible to construct wastewater collection networks and centralized wastewater treatment plants. On-Site small scale wastewater treatment plants, which often serve a single house or building, respond to the needs and conditions in rural localities. They can solve the wastewater collection and disposal problems in such communities, along with the benefit of generating a water resource that can be utilized for irrigation purposes where land is available and agriculture is a main subsistence source or a source of income. Two types of onsite small scale wastewater treatment systems were implemented in the West Bank, namely: (1) Black wastewater treatment and, (2) Grey wastewater treatment. **Table 2.11** shows the agencies that implemented on-site small scale black/grey wastewater treatment plants, and the number of the implemented units.

TABLE 2.11: AGENCIES THAT IMPLEMENTED ON-SITE SMALL SCALE BLACK/GREY WASTEWATER TREATMENT PLANTS

Implementing Agency	WWTP Type	Total Number of WWTPs
Applied Research Institute – Jerusalem (ARIJ)	Black WW	252
	Grey WW	107
Palestinian Hydrology Group (PHG)	Grey WW	156
Union of Agricultural Work Committees (UAWC)	Grey WW	67
United Nations Food and Agriculture Organization (FAO)	Grey WW	67
Palestinian Wastewater Engineers' Group (PWEG)	Grey WW	81
Palestinian Agricultural Relief Committees (PARC)	Grey WW	80

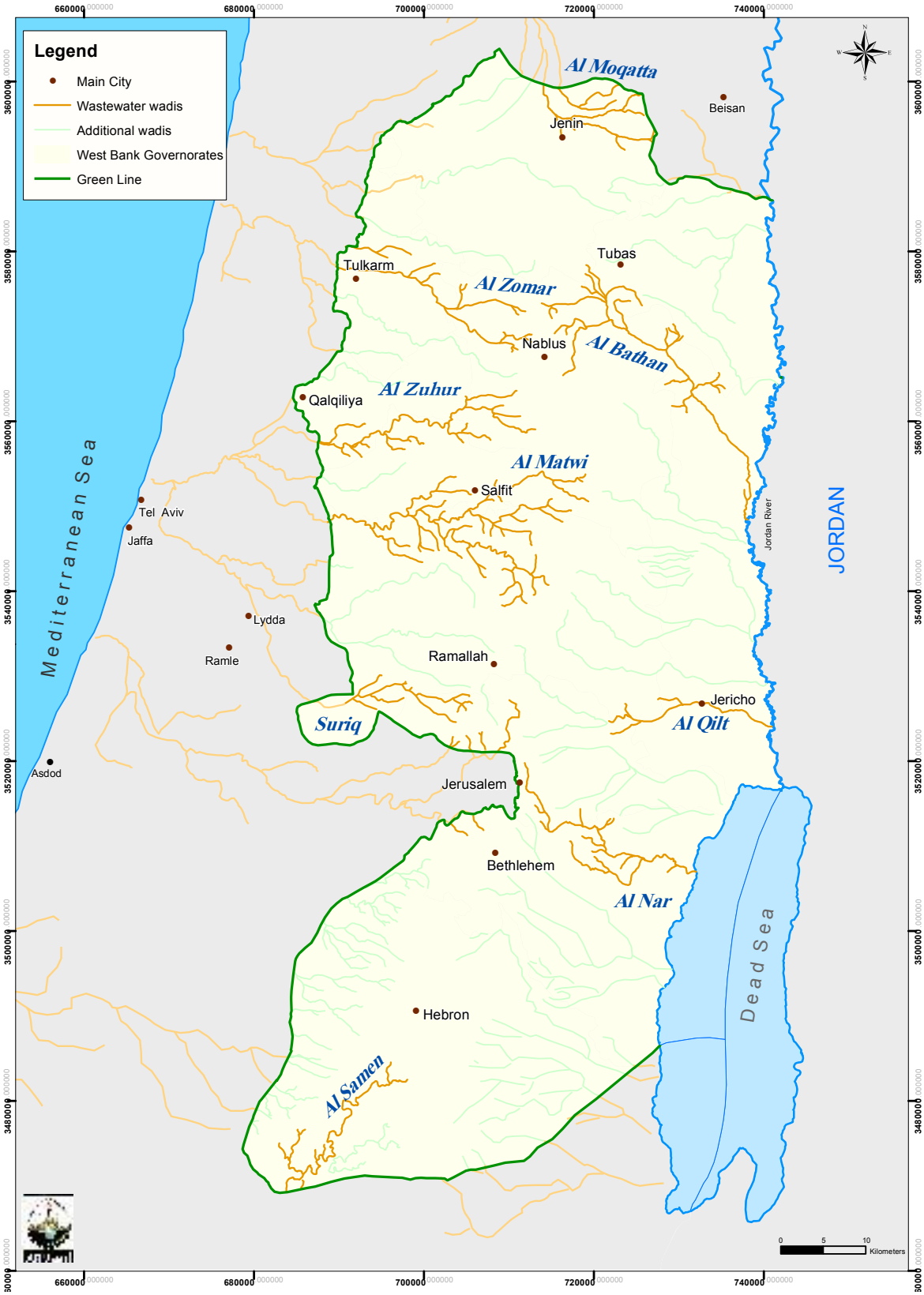
Source: (ARIJ & CENTA, 2010)

BOX 2.5: SMALL SCALE WASTEWATER TREATMENT PLANTS IMPLEMENTED BY ARIJ

NGOs have been actively involved in finding solutions to alleviate the problems resulting from the lack of wastewater collection and treatment infrastructures. An example is a locally made household level wastewater treatment model developed by ARIJ. The model simplified the often sophisticated activated sludge treatment technology rendering the treatment units cheaper, easier to install, and cheaper to operate. This system does not require the separation of the gray wastewater from the black wastewater. The quality of the effluent allows the onsite reuse of the treated wastewater in irrigation fodder crops and fruit trees. Such contributions can provide real and feasible solutions for the wastewater sector in the rural Palestinian areas.

PHOTO 2.4: ARIJ'S SMALL SCALE ONSITE WASTEWATER TREATMENT PLANTS

In the absence of sufficient wastewater infrastructure and limited number of wastewater treatment plants in the West Bank to deal with the generated wastewater, the Valleys (Wadis) in most of the cases are converted to wastewater streams, polluting the surrounding environment; leaching contaminants into groundwater, and increasing the health risks of waterborne diseases. Among the major wastewater streams in the West Bank are: Wadi Al Zomar, (Nablus), Wadi Suriq (Ramallah), Wadi Al Samen (Hebron) and Wadi Al-Nar (Bethlehem) (**Map 2.8**).



MAP 2.8: MAIN WASTEWATER STREAMS IN THE WEST BANK

Table 2.12 illustrates the daily estimated flow for some wastewater stream (PWA, 2012).

TABLE 2.12: MEASURED FLOW FOR SOME WASTEWATER STREAMS IN THE WEST BANK

Stream	The measured daily flow (Cubic Meter / Day)
Wadi Al Zuhur (Qalqilia City)	6,000
Wadi Al Samen (Hebron City and Kiryat Arbaa Settlement)	10,500
Wadi Al Moqatta (Jenin City & Jenin Refugee Camp)	3,000
Wadi Al Zomar (West Nablus, Ein Beit Alma and some adjacent communities)	4,000
Wadi Al Zomar (Tulkarm City , Tulkarm Camp and Nur Shams Camp)	11,000
Wadi Al-Sajour (East Nablus,Askar and Balata Camps, Azmut, Salim and surroundings)	8,800
Wadi Suriq (Ramallah City)	3,300
Wadi Al-Nar (Bethlehem and Beit Sahour)	4,500

Source: (PWA, 2012)

PHOTO 2.5: WADI AL-NAR WASTEWATER STREAM BETHLEHEM GOVERNORATE

It should be noted that some of the partially treated wastewater and untreated wastewater streams flow into Israel. Approximately, 14.97 MCM/year of the wastewater produced in the West Bank flows into Israel and is treated or partially treated in five Israeli treatment plants and thereafter reused in the Israel's agricultural sector (PWA, 2012). The cost associated with this treatment is charged to the PWA and deducted annually by Israel from Palestinian tax revenues (Yasin, 2015). According to the Water Sector Regulatory Council, Israel deducted approximately over 82 million NIS from the Palestinian tax revenues in 2015 (WSRC, 2016) for the treatment of the Wastewater produced in the West Bank (**Figure 2.10**). It is worth mention that the tariff for the treatment is different from one place to another, for example Israel charges the PNA around 1.88 NIS[10] for the treatment of one cubic meter of wastewater that is discharged in Wadi Beit Jala and treated in the Israeli treatment plant "Ein Soreq' in West-Jerusalem, where in Wadi Surik they charge the Palestinian around 2.12 NIS/cubic meter (ARIJ, 2015c).

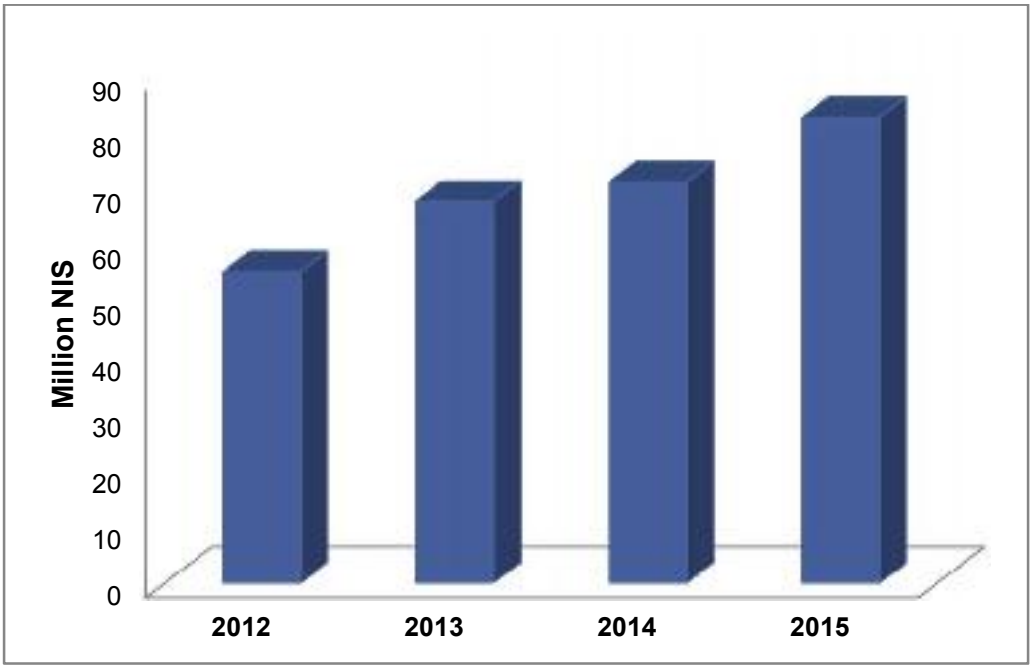
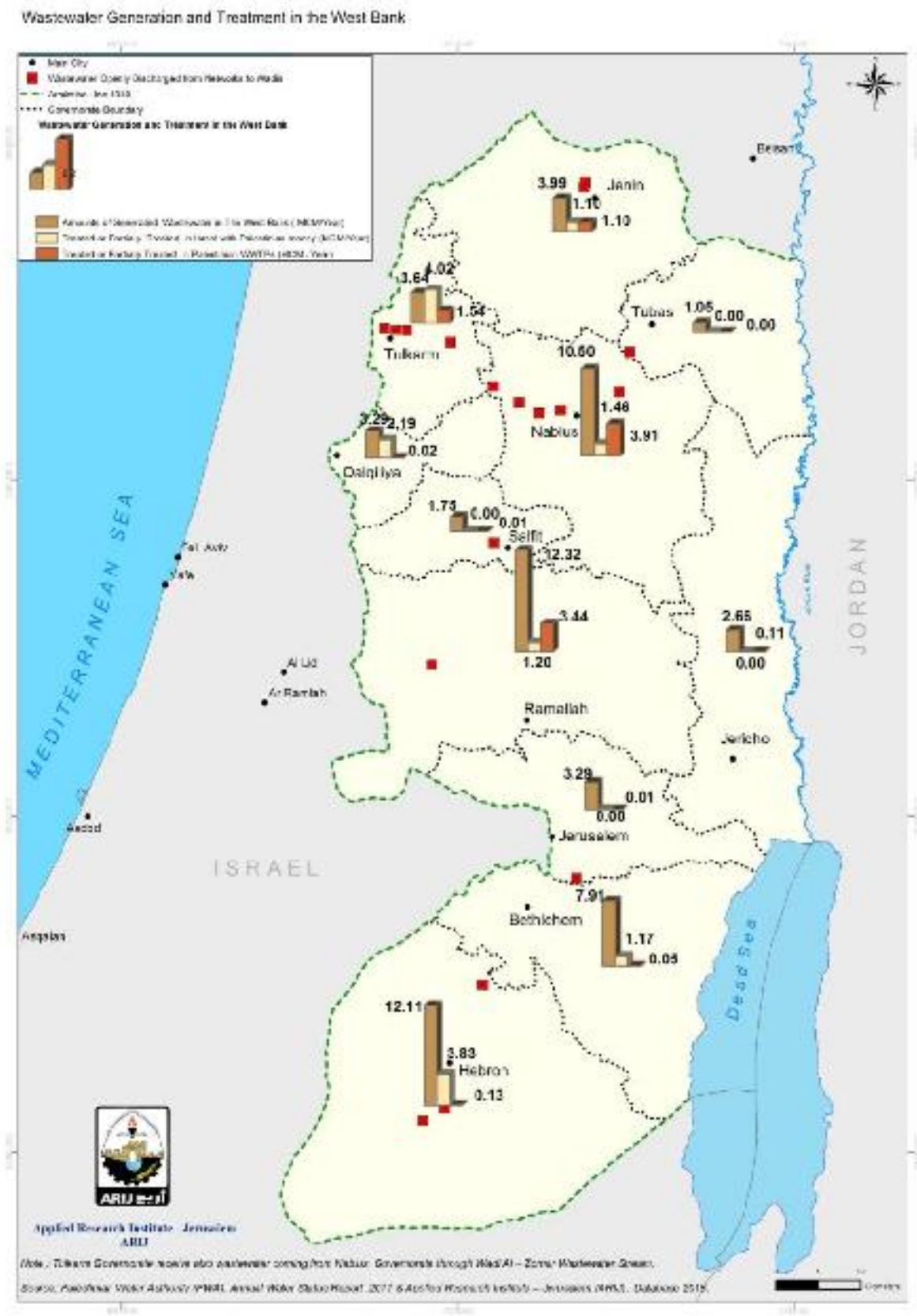


FIGURE 2.10: TAX REVENUES DEDUCTED ANNUALLY BY ISRAEL FOR THE TREATMENT OF THE PALESTINIAN WASTEWATER

Israel's unilateral decision to build a wastewater treatment plant in the Palestinian Lands of Al-Nabi Musa (to treat Wadi Al-Nar wastewater stream), without the joint water committee approval, is a clear example of Israel violation to the Interim Israeli- Palestinian Agreement, demonstrating once again the lack of Israel's commitment to signed agreements, the construction of this wastewater treatment plant by Israel, can result in making Palestinians pay to Israel fees as wastewater treatment concept, when at the same time treated effluent is expected to serve Israeli agriculture activities in the area. Taking this approach not only will deteriorate the Palestinian economy, but also will prevents the development of the Palestinian agriculture sector in the area, since the treated effluent can contribute to the development of the Palestinian agriculture sector in the Dead Sea area, and to the creation of new job opportunities for Palestinians.

[10] This value includes the addition of 16% for the value added tax



MAP 2.9: WASTEWATER GENERATION AND TREATMENT IN THE WEST BANK

BOX 2.6: ARE VACUUM TANKERS A SOLUTION TO THE WASTEWATER PROBLEM WHERE NO WASTEWATER TREATMENT INFRASTRUCTURE IS AVAILABLE?

In the absence of sewage collection network cesspits are still one of the most common wastewater disposal methods in the West Bank, are purposely designed and constructed without a concrete lining in order to allow seepage into the ground. With time, cesspits are filled with wastewater which necessitates periodical emptying by vacuum tankers. On the other hand septic tanks are rarely used in the West Bank. However, whether with sewage from septic tanks or cesspits, in the absence of a wastewater treatment infrastructure to receive the collected wastewater, vacuum tankers used to transport the problem instead of solving it, releasing the wastewater in most of the cases in the nearby wadis.

Hiring the service of vacuum tankers despite of not being a real solution to the problem is a costly service that in many cases goes beyond citizens' affordability (Example: In Bethlehem the cost of disposing wastewater trough vacuum tanker easily could exceed the 20 NIS/ cubic meter).

In the Gaza strip, the annual wastewater collected by sewage networks is approximately 41.27 MCM/year from which 37.62 MCM/year are partially treated before being discharged into the Mediterranean Sea. The wastewater treatment plants are: (1) North Gaza - Beit Lahia WWTP; (2) Gaza WWTP - Gaza Central WWTP; (3) Khan Younis intermediate treatment plant ;(4) Rafah WWTP, and under construction Wadi Gaza WWTP (PWA, 2012).

The existing wastewater treatment plants in Gaza (**Map 2.10**) are overloaded and are highly inefficient and hardly functioning. The treatment inefficiencies had been attributed to lack of proper operation and maintenance; unreliable electric supply, and difficulties in the availability of spare parts as result of the Israeli blockade on the Gaza Strip.

Currently, both north Gaza Beit Lahia WWTP and Gaza WWTP are under rehabilitation and expansion. The proposed upgrade will replace the existing overloaded plant equipment with new higher capacity equipment in order to improve treatment plants efficiency and the quality of effluent being discharged to the environment; under construction Wadi Gaza WWTP, Project funded by the International Committee of the Red Cross (ICRC) to serve population form middle Gaza (Al-Zahra) north to the south to Deir al-Balah (WAFA, 2013).

In the Gaza Strip, both partially treated and untreated wastewater is discharge into open areas including wadis such as Wadi Gaza or into the Mediterranean Sea. Many discharge points are registered along the shoreline in the Gaza Strip (Auda & Shahin, 2005).

It was estimated that around 32.5 MCM/Y of partially treated and raw wastewater is being discharged into the Sea; from which 25.2 MCM/Y is partially treated effluent and 7.3 MCM/Y is raw wastewater (Hilles, Al Hindi, & Abu Safieh, 2014).

TABLE 2.13: THE EXISTING CENTRALIZED WASTEWATER TREATMENT PLANTS IN THE GAZA STRIP

Name of Wastewater Treatment plant	Actual Flow (m3/day)	Status of WWTP
North Gaza Beit Lahia	Above 18,000 m^3/d, when original design flow was 5,000 m^3/d	Established in 1974, with a design capacity of 5,000 m^3/d ,currently overloaded ,under rehabilitation & Expansion with a convening pipe line of 8km to NGWWTP achieving a design capacity of 30,000 m^3/d (Under Rehabilitation and expansion).
Gaza Wastewater Treatment Plant (Gaza Central)	42,000	Established in 1979 upgraded in 1996 to increase its capacity to 12,000 m^3/d, upgraded again in 1998 to reach a treatment capacity of 35,000 m^3/d, currently overloaded, under rehabilitation & Expansion through an Emergency Project to reach a design capacity of 50,000 m3/d, with funds from the KFW.
Khan Younis	Only Temporary Basin (Lagoons)	In late 2007, CMWU established a wastewater lagoons, in 2009 was added a second lagoon in (Almawassi area), in 2003 was added a third lagoon (Hai El-Amal), after 2007 was established an alternative lagoons to collect and treat wastewater before pumping it to the sea; currently are works on building a new WWTP with a capacity of 26,600 m^3/d as first phase.
Rafah	8,000	Established in 1989, with an originally treatment capacity of 4,000 m^3/d. Upgraded to increase its treating capacity to 20,000 m^3/d ,getting advantage of the availability of the destroyed boarder concrete pieces after the Israeli forces withdraw out of Gaza.

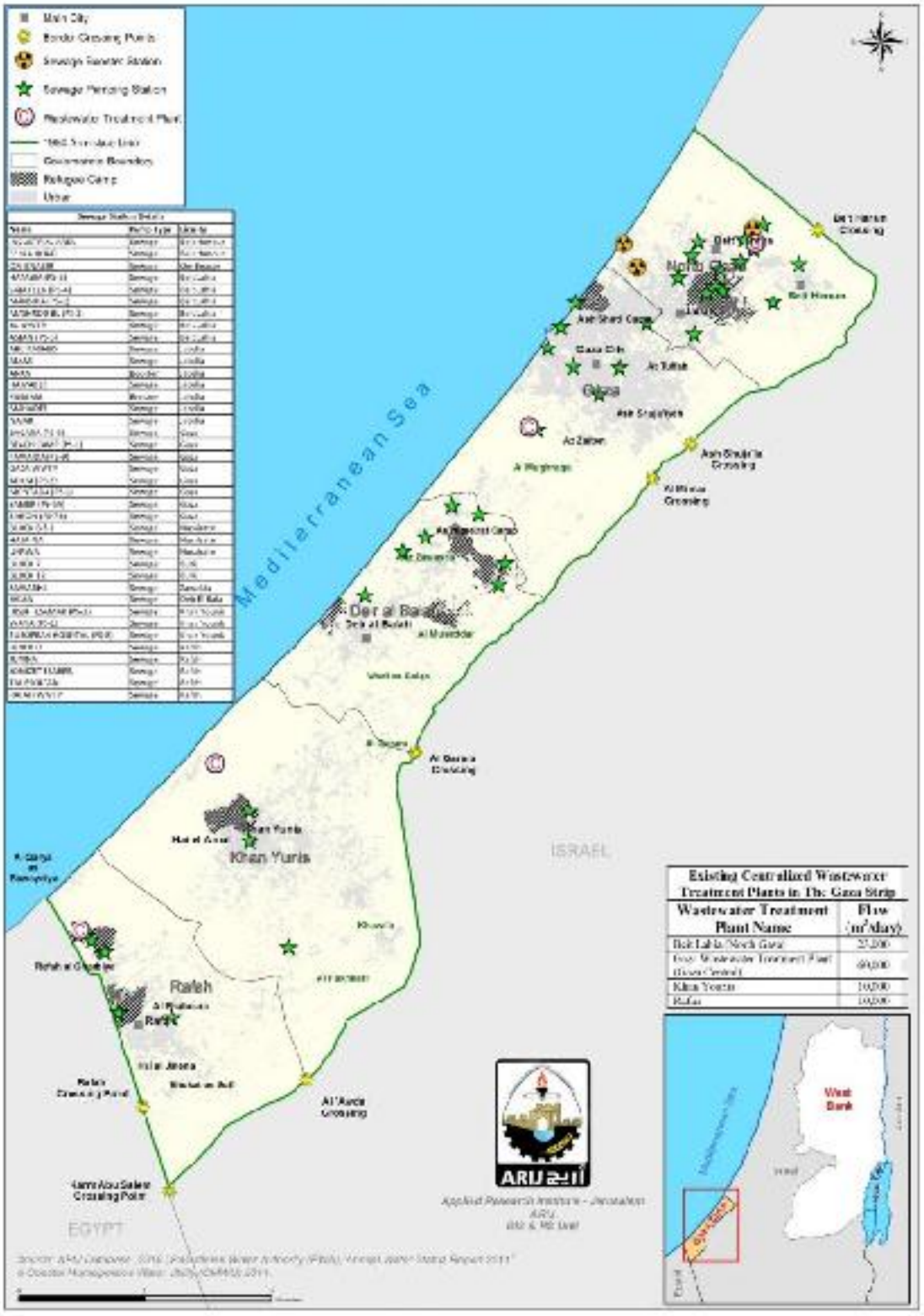
Source: (ARIJ, 2015c)

To develop the wastewater treatment sector in Palestine, the PNA has been working jointly with several donors. **Table 2.14** illustrates some of recent projects related to the development of the wastewater treatment infrastructure in Palestine.

TABLE 2.14: SOME RECENT WASTEWATER TREATMENT INFRASTRUCTURE PROJECTS

Wastewater Infrastructure Project / Area	Status	Components
North Gaza Beit Lahia / Gaza Strip	Under construction	Emergency Phase: Rehabilitation and Expansion of existing WWTP
Gaza Central /Gaza Strip	Under construction	Emergency Phase : Rehabilitation and expansion of existing WWTP
Al'Aroub WWTP / West Bank	Under construction	Construction of WWTP
Rehabilitation of Jenin Treatment Plant / West Bank	Completed	Rehabilitation of existing WWTP

Source: (ARIJ, 2015c; PWA, 2013a)



MAP 2.10: EXISTING CENTRALIZED WASTEWATER TREATMENT PLANTS AND SEWAGE PUMPING STATION IN THE GAZA STRIP

Source: (ARIJ, 2015a; CMWU, 2011b; PWA, 2012)

BOX 2.7: CASE STUDY: CREATIVE IDEA TO OVERCOME THE SHORTAGE OF CONSTRUCTION MATERIALS: FRAGMENTS OF THE DEMOLISHED WALL SEPARATING GAZA AND EGYPT WERE RECYCLED AND USED FOR THE BUILDING OF THE NEW LAGOONS AND THE SLUDGE DRYING BEDS RAFAH-GAZA

Rafah wastewater treatment plant has been insufficient for treating the sewage of the city due to increase in population and connection coverage with almost untreated effluent discharged to the sea and without the possibility of reuse. Affecting by that the environment of the city of Rafah and has threatened the health of the population as the sewage often overflowed from the wastewater system.

To address this problem, the International Committee of the Red Cross (ICRC) jointly with the Coastal Municipality's Water Utility (CMWU) and the Municipality of Rafah has been working on a project to construct a wastewater treatment plant. In 2008, the ICRC and the CMWU started works and implemented in several phases: (1) Construction of two new lagoons for treatment and grit removal. Plant treatment capacity: 10'000 m3/day, (2) Extension of the plant with construction of two bio towers, effluent pump station, new pressure pipeline and one administrative building. Plant treatment capacity: extendable up to 20'000 m3/day, (3) Operation, maintenance and pilot phase on re-use of wastewater.

Today, the treatment plant contributes in alleviating the problem serving a population of 180,000 inhabitants from Rafah and the surrounding areas.

PHOTO 2.6: RAFAH WASTEWATER TREATMENT PLANT UNDER UPGRADE TO INCREASE ITS CAPACITY AND ENHANCE ITS EFFLUENT UTILIZING RECYCLED FRAGMENTS OF DEMOLISHED WALL SEPARATING GAZA AND EGYPT. (PHOTOS COURTESY OF ICRC)

2.5 Challenges and Limitations Facing the Palestinian Water and Wastewater Sector

The Palestinian water and wastewater sector is facing many limitations and challenges that prohibit its sustainable development. The unique status of Palestine, of being an occupied territory in which Israel controls Palestinian natural resources, imposes new challenges not often faced by other developing countries. Improving water and wastewater management is hence one of the greatest challenges facing environmental planners in Palestine.

The main challenge could be summarized as following: (1) The Political Situation, (e.g. (a) Israeli obstacles, Israel didn't approve several water and wastewater projects as: Abu Dis, project submitted in 1997 and Ramallah, project submitted in 1997, (b) Conditioned aids to political situation (USAID cancelled Hebron wastewater project in 2006 as consequence of election results) (2) Financial, (e.g. limited availability of fund and citizen affordability) (3) Technical, (e.g. (a) Minimization of Operation & Maintenance costs related to water and wastewater infrastructures, (b) selection of appropriate systems and technologies that fit the particularity of Palestine), (4) Institutional,(e.g. Legislations: Enforcement of laws and standards) (5) Social and Environmental aspects.

2.5.1 POLITICAL SITUATION

Prior to the establishment of the PNA in 1993, Palestinians have had limited control over the water and wastewater management sector. None of the municipalities and village councils possessed any power of regulation or legislation. Moreover, the Israeli civil administration made various amendments to the Jordanian law following the 1967 occupation to fit their own interest. The political and bureaucratic hurdles put in place by the Israeli Civil Administration caused various negative effects on the economic, social and environmental situation; therefore, minimum progress in the sector has been made in Palestine.

Restrictions imposed from the Israeli occupation continue to be the most significant impediments to the development in the sector; chief among them are: **(1)** Area C geographical territory division, where Palestinians have no control over this territory **(2)** Israeli Settlement and Israeli settlers practices against the Palestinians **(3)** Physical restriction on access to water and sanitation.

Restrictions on Water and Sanitation Sector in Area C

All water and sanitation projects in Palestine must be approved by the JWC, and as a result the approval process lengthy and complicated. This additional layer of bureaucracy can add many more months to project planning. While water and sanitation projects and infrastructure within Area C requires an official permit from the JWC, development in Area C also requires a permit from the Israeli Civil Administration in Bet El. This is a long, bureaucratic procedure and often results in permission being denied, even if the project is approved by the JWC. Projects executed without prior approval are demolished by the Israeli military. Between 2011 – 2013 Israel rejected 97% of applications for building permits in Area C, including applications for developing related water and sanitation projects (EWASH, 2015b).

The Israeli military authorities and the Israeli settlers target the water structures for destruction. Recently, destruction of water, sanitation and Hygiene (WASH) structures in the West Bank has increased. Since the beginning of 2010 until the end of October 2015, there have been 335 cases of

demolition of WASH structures belonging to Palestinian in the West Bank (EWASH, 2015a). The demolitions of water structures were carried out in different locations of the West Bank and for different WASH structures such as storage and rainwater harvesting cisterns, wells, springs, water tanks, agricultural pools, amongst others.

Among demolished structures there was 113 demolished cisterns between 2010 and 2013. Around 46 of these were demolished in 2011 alone. The rainwater harvesting cisterns are considered as essential source of water for domestic and agricultural use especially for the Palestinian in the absence of water network connection. The **Figure 2.11** shows the number of demolitions of WASH structures in the West Bank for the years 2010 – 2015.

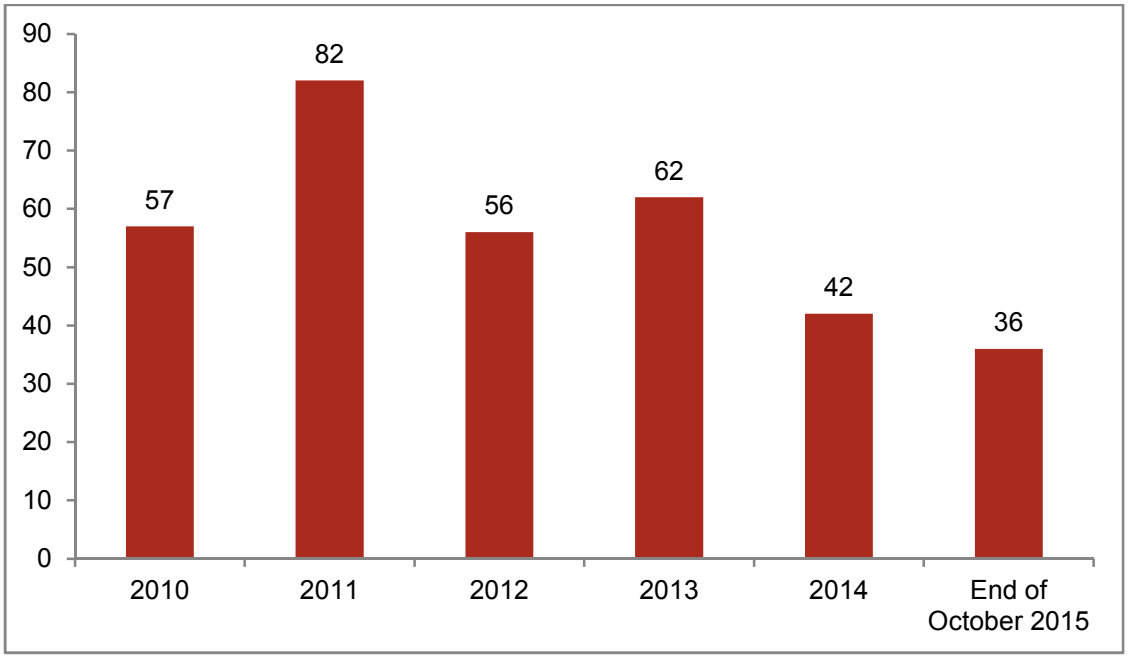


FIGURE 2.11: DEMOLITIONS OF WASH STRUCTURES BY THE ISRAELIS IN THE WEST BANK

The destruction of these structures is a violation to the state's obligation to respect the right to water. Moreover, these demolitions are in violation of the Israeli-Palestinian Joint Water Committee' declaration (Joint Declaration for Keeping the Water Infrastructure out of the Cycle of Violence), signed in 2001 (http://www.internationalwaterlaw.org/). Some of these structures were demolished under the pretext that they were constructed without obtaining the relevant Israeli permit; but most were in fact demolished without any reason. The Fourth Geneva Convention (**Box 2.8**) prevents the destruction of such facilities which are considered as protected civilian objects under the laws of war.

BOX 2.8: FOURTH GENEVA CONVENTION

Articles 53 and 56 of Geneva Convention IV are provisions which prevent unnecessary destruction of civilian infrastructure and emphasize the responsibility of the occupying power in ensuring public health and hygiene (EWASH, 2011).

Article 54 of the 1977 additional protocol to the Geneva Conventions prohibits destruction of infrastructure vital to the survival of the population (EWASH, 2011).

Discrimination in water availability and consumption

The inequality in the distribution of the shared resources and the discrimination against the Palestinians in use of water resources is obvious through the figures of the per capita consumption rate. The average daily per capita water consumption rate (domestic, urban and industrial use) is around 79 litres in the West Bank and 91 liters in Gaza Stip. Both figures are below the WHO standards of 100 l/c/d. The Palestinian average consumption is much lower in certain areas of the West Bank such as Tubas governorate where the average consumption rate for the 61,605 Palestinians who reside there is 44.5 litres per person per day. Furthermore, in communities without water infrastructure, specifically in area C, the population struggle with 20 l/c/d (EWASH, 2014), which presents only the fifth of the consumption recommended by the WHO. In contrast to this, the citizens in Israel consume 300 l/c/d and the settlers consume about 369 1/c/d, almost four times more than the Palestinians. These settlements are connected to a water network and serviced by the Israeli water company (Mekorot) from wells in the West Bank and in Israel. **Figure 2.12** illustrates this disparity in water usage.

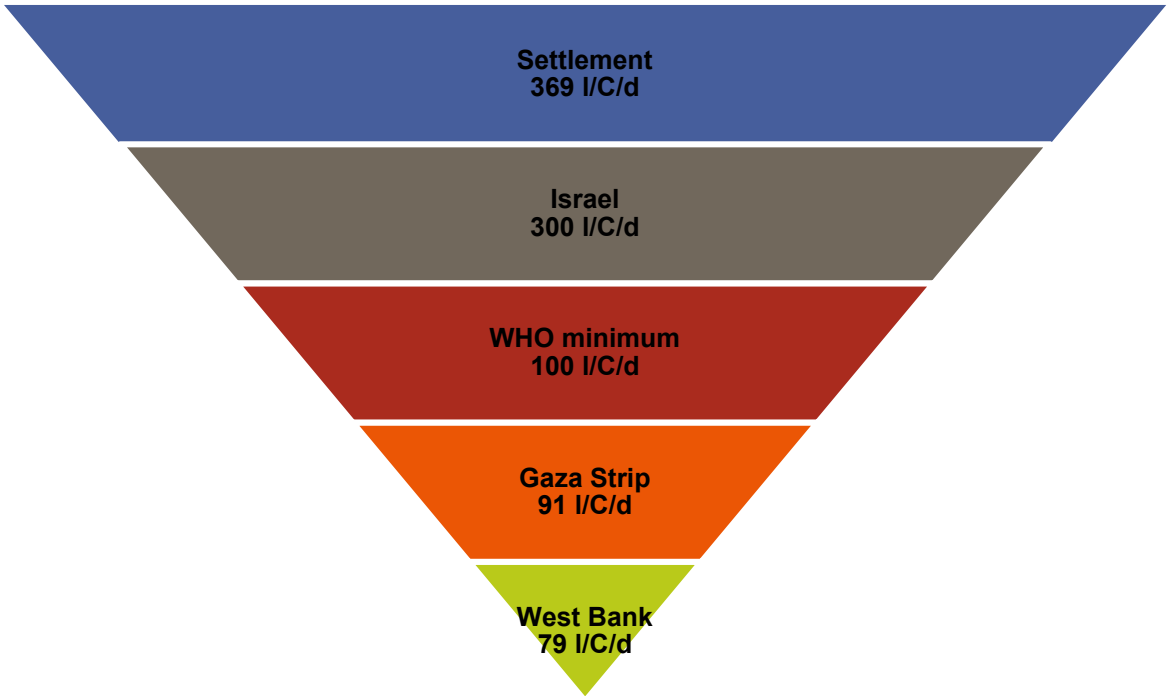


FIGURE 2.12: WATER USAGE BY PALESTINIANS IN COMPARISON WITH THE ISRAELIS WATER USAGE IN THE SETTLEMENT AND ISRAEL AND THE WHO MINIMUM

Israeli settlers practices against the Palestinian

In recent years water springs in the vicinity of Israeli settlements throughout the West Bank have become the target of settler activities that eliminated, or put at risk, the access to these springs and their use by Palestinians. A survey carried out by OCHA identified a total of 56 such springs, the large majority of which are located in Area C on land parcels recorded by the Israeli Civil Administration as privately owned by Palestinians. Thirty (30) of these springs were found to be under full settler control, with no Palestinian access to the area. In almost three quarters (22) of these Palestinians have been deterred from accessing the spring by acts of intimidation, threats and violence perpetrated by Israeli settlers. In the remaining eight springs under full settler control, Palestinian access has been prevented by physical obstacles, including the fencing of the spring area, its de facto annexation to the settlement

(four cases), the isolation of the area from the rest of the West Bank by the segregation Wall and its subsequent designation as a closed military zone (four cases).

The other 26 springs are at risk of a settler takeover. This category includes springs that have became the target of regular tourism activities of settlers, and/or patrolling by the security coordinators of settlements (OCHA, 2012). The inability to access and use springs has significantly undermined the livelihoods and security of Palestinians living in affected communities. Many farmers have been forced to either cease cultivating the land or face a reduction in productivity. This also has increased the expenditure for herders and households who are forced to purchase piped or tankered water.

Since settlers in the West Bank use Israel's water-supply system, neglect of wastewater treatment in the Palestinian area has almost no effect on them. Palestinians, however, and especially residents of small towns and villages, rely on water from natural sources. As a result, pollution of these sources aggravates the chronic drinking-water shortage in the West Bank. The domestic wastewater generated annually by the Israeli settlement living in the West Bank including East Jerusalem is around 77.4 MCM of wastewater annually (ARIJ, 2015c). This is more than the annual amount of wastewater generated by the 2.86 million Palestinians living in the West Bank (PCBS, 2015c), this is result of excessive water consumption by Israeli settlers.

According to B'Tselem (B'Tselem, 2009), it is estimated that 81 out of 121 Israeli settlements in the West Bank are connected to wastewater treatment facilities. In addition, the treatment process is often sub-standard and does not meet the minimum standards set forth by either the Israeli or Palestinian laws. Most of Israeli treatment facilities suffer frequent technical breakdowns and at times shut down completely. To date, some 5.5 MCM of wastewater per year generated by Israeli settlements are not treated and flow as raw wastewater into West Bank streams and valleys.

Furthermore, the Israeli industrial activities in Palestine add further pressure on the Palestinian environment as they do not apply the Israeli and Palestinian environmental laws and dispose the generated industrial waste without any treatment in nearby Palestinian lands (For more information see **Chapter 4**).

BOX 2.9: A CONCISE LIST OF THE DAMAGES CAUSED BY ISRAELI SETTLEMENTS IN PALESTINE

Violation in the year 2015:

- **Israeli Settlement / Violation Perpetrator:** Barkan

Violation and Affected Area: Barkan colony chemical wastes destroy the environment of Salfit village of Bruqin By pumping untreated chemical liquids from Barkan industrial colony towards the pasture lands and valleys in Bruqin village.

- **Israeli Settlement / Violation Perpetrator:** Hayovel outpost (An extension of Eli Settlement)

Violation and Affected Area: Pumps sewage water into Qaryut village lands -Nablus, (pumped sewage water into 6 dunums of olive orchards in the area of al-Mawwaja, east Qaryut village).

Source: (ARIJ & LRC, 2015)

Moreover, Israel has been force the use of Palestinian infrastructure to serve Israeli settlements. This is, and rightly so, a proposition that is often rejected by Palestinians since it legitimizes the presence of Israeli settlements in the West Bank. Several environmental projects have not been approved by the JWC because of Israeli persistence that wastewater generated in settlements be treated in Palestinian Wastewater treatment plants. Yet, Israel was able to force the hand of Palestinians to connect Pesagot Israeli settlement near Al Bireh to Al-Bireh Wastewater treatment plant. Other projects have been stalled by the JWC often citing insufficient technical specifications and a multitude of other reason. An example is Beit Lahia Treatment Plant Rehabilitation plan, 2006. For instance, in 1998, the PWA received funding from the German Development Bank (US$ 300,000) to build a wastewater treatment plant in the Salfit Governorate. The JWC approved the project conditional upon connecting the largest West Bank settlement of Ariel to the treatment plant (El-Jazairi, L. 2008). A similar situation occurred in the Wadi Nar Valley, in the Bethlehem Governorate.

However connecting the illegal settlements to wastewater infrastructure is a demand that the Palestinians are unable to comply with since it legitimizes the existence of the settlers which works against permanent status and peace negotiations. Israel has not only failed to support Palestinian attempts to advance solutions for wastewater treatment, it has delayed them. As a result, most donors are discouraged from investing in the sanitation sector within Palestine due to the bureaucratic constraints of the JWC system. Aid agencies are required to go through the same process for a permit even if the intervention is humanitarian in nature. Some agencies only implement sanitation projects after permits are obtained, meaning that Area C is neglected from intervention. Agencies that proceed without a permit run the risk of project demolition and jeopardize their reputation within Israel and the community who benefits from the project (EWASH, 2012). Zeitoun (2007) summarizes the situation succinctly: “only one-quarter of the land within the Palestinian political boundary of the West Bank is subject to equal Palestinian-Israeli joint management, with the rest subject to an approval mechanism that prioritizes Israeli military objectives and settlement expansion over Palestinian developmental or environmental objectives” (Zeitoun, 2007).

The Segregation Wall

Water resources have been lost to the seam zones following construction of the Wall. The segregation Wall illegally isolates 28 groundwater wells in Palestine (19 from the governorate of Qalqiliya), and also 17 springs in Bethlehem. The total yield of the isolated wells reaches 4 MCM per year, which constitutes more than 30 percent of Palestinians’ share in the Western Aquifer as stated within the interim agreement (PHG, 2008).

The segregation Wall has also resulted in the de facto appropriation of agricultural wells in the West Bank (EWASH & AL HAQ, 2011). This loss cannot be replaced by the Palestinians who are restricted from drilling news wells in the Western Aquifer, which is the most productive aquifer in the region, and thus the Western Aquifer itself has essentially been unlawfully annexed by Israel. The implementation of the Israeli unilateral segregation policy within the West Bank, especially the construction of the segregation wall, occurs at the expense of not only Palestinian lands and water resources, but it also directly harms and destroys the social life and cultural heritage of the villages that have been segregated from each other or from their agricultural lands (Richard, 2012).

Gaza Siege

The Israeli assault on Gaza Strip has started on the 6th July, 2014 and continued till the temporary cease fire had been declared on 5th August, 2014. The attack resulted in serious damages and destruction to water and wastewater sector. During the attack the IDF aircraft focused on shelling the water supply sources (groundwater wells). The most destruction occurred when the IDF start invading the eastern, northern and southern borders by the tanks, where most of the water and wastewater facilities within 3 km from the eastern and northern Gaza Strip borders have been totally demolished (CMWU, 2014).

The damages to the water infrastructure have resulted in cuts or severely restricted water provision to Gaza's citizens, where the damages to the wastewater treatment plants and the sewage network has caused sewage flooding in the residential areas and the mixing of sewage with water, posing a severe environmental threat and risk of water-borne diseases (ARIJ, 2014). Furthermore, as a result of the bombing of the Gaza Strip's power station causing a shortage of electricity, which was compounded by the shortage of fuel needed to operate the power station, pumping stations of water wells and the waste water treatment plants, as well as the desalination process was disabled while water supply to the houses, sewage collection and treatment were severely restricted. Due to the massive damages to the water and sanitation infrastructure and the lack of access to clean water and sanitation facilities, at least 1.4 million (OCHA, 2014) of Gaza's population has been affected and left, particularly the children, vulnerable to serious public health risks. A preliminary damage assessment has been conducted by CMWU and the Municipal Water Departments. According to the data provided in the report, the value of damages to the water and sanitation infrastructure is estimated at $15,739,000 and $7,590,100, respectively. This is in addition to another $11,105,000 for the total damages that have been incurred by water and sanitation vehicles, equipment & IT, stationary and other unforeseen damages. This total amount is distributed as illustrated in **Table 2.15** (PWA & CMWU, 2014).

TABLE 2.15: ESTIMATED COST AND QUANTITIES OF DAMAGES IN THE WATER AND SANITATION SECTOR

Type	Type of damage	Estimated Quantities	Estimated Cost ($) of Repair/ Reconstruction
Water Wells	Partially	15	419,000
	Completely	11	1,650,000
Water Network	Partially	17500 m	3,310,000
	Completely	29300 m	4,325,000
Water Tank	Partially	11	1,300,000
	Completely	5	4,400,000
Desalination Unit	Partially	4	205,000
	Completely	2	130,000
Wastewater Network	Partially	10310 m	2,427,100
	Completely	7238 m	2,492,000
Wastewater Pump Station	Partially	12	1,447,000
Wastewater treatment plants	Partially	4	1,224,000
Vehicles & Equipment's damages		50	8,850,000
IT and Stationary Damages		1	255,000
Unseen Damages		1	2,000,000
Total			**34,434,100**

Map 2.11 shows the location of damaged water and wastewater infrastructure during the offensive on Gaza Strip based on the CMWU data.

MAP 2.11: DAMAGED WATER AND WASTEWATER INFRASTRUCTURE DURING THE ISRAELI OFFENSIVE ON THE GAZA STRIP 7JULY - 14 AUGUST 2014

For the rehabilitation of the water and sanitation infrastructure, immediate humanitarian interventions are needed to repair the damaged water supply and wastewater facilities, provide potable water for domestic use and sanitary installations for displaced population, and provide fuel, generators and equipment to operate facilities. Early recovery interventions would include the reconstruction of the damaged water supply and wastewater facilities, supplying fuel to operate those facilities, supply of chlorine for the disinfection of water supply, the provision of water and sanitation vehicles, in addition to spare parts and equipment. The long term interventions would provide additional water supply with good quality through: constructing regional seawater desalination plants, and Gaza North-South carrier and short term seawater desalination plants, improving the efficiency of water distribution network, constructing new efficient wastewater treatment plants and improving the efficiency of the existing ones, increasing the coverage of sewerage network, and initiating the reuse of treated wastewater for agriculture. The total estimates for the different interventions at the three stages immediate, recovery and long term are detailed in **Table 2.16**.

TABLE 2.16: FINANCING REQUIREMENTS FOR THE REHABILITATION/RECONSTRUCTION OF THE WATER AND SANITATION SECTOR

Level of Intervention	Financing Requirements ($)
Immediate Humanitarian Intervention	30,826,100
Early Recovery Intervention	32,690,00
Long Term Intervention	620,000,000
Total	**683,517,100**

Source: (PWA & CMWU, 2014)

Moreover, On 19 August 2011, the Israeli jet-fighters raid over the Gaza Strip destroyed Al Nussirat sewage pumping station; this pumping station was constructed by UNRWA. It was designed to collect and divert sewage from Al-Nussirat and Al-Burraij camps to Gaza Central Wastewater Treatment Plant, which is under construction. 200,000 Palestinians in Middle Gaza Strip were affected by the destruction of the pumping station. Wastewater flow into the neighboring valley deteriorated the water quality and increased health risks. The Cost of the damages in this sewage pumping station was estimated to range between, 1.5 to 2 million USD (CMWU, 2011a). The same day the CMWU Gaza main office was partially damaged as a result of other Israeli jet-fighters raid over the Gaza Strip. The damages were estimated 30,000 USD (CMWU, 2011a).

2.5.2 AFFORDABILITY (WATER SUPPLY AND WASTEWATER COLLECTION & TREATMENT SERVICE)

Water and wastewater services were traditionally considered as social services and were provided at very low prices; therefore hikes in service prices are often faced with social rejection. Widespread poverty and unemployment are other social constraints that need to be considered when water and wastewater tariffs are set.

Affordability analyses for water and wastewater services should become an integral and indispensable element of tariff revision procedures. They should be introduced into the regular practice in the process of approving tariffs and strategic development plans of water and sewerage utilities. Such analysis might also be useful in revising water consumption standards as well as levels and quality of services. Affordability assessments require feasibility studies for large investment projects to ensure that consumers would be able to pay for the investment, operational and maintenance costs. Results of the

affordability and willingness to pay analyses could serve as a valuable source of information needed for designing social protection programs and for establishing eligibility criteria for social assistance. Social protection systems should be realistic i.e. financially sustainable, based on actual budget capacities to provide such support.

Water prices are non-unified and vary significantly between the various Palestinian areas, as each water service provider applies a different system than the others. According to the PWA annual report, the lack of a unified tariff system is attributed to many reasons including: source of water; whether it is local or purchased, quantity of water consumed, cost of water production, unaccounted for water cost, operation and maintenance costs and cost recovery (PWA, 2012). For example, in Hebron governorate the price 100 cubic meter of water vary from 500 NIS to 1800 NIS, which is the highest price among all governorates. The lowest price is in Jericho governorate which is estimated at 100 NIS for 100 cubic meter (Al-Rumhi, 2010). Moreover, many Palestinian communities have high reliance on tanked water for basic needs, such as communities in Area C, where Israeli authorities prevent the Palestinian household to connect to water networks. Those who rely on water bought by water tankers pay (3-6) times more than piped water, and the water supplied is often not of acceptable quality.

In the year 2013, the PWA has proposed a new water tariff policy (PNA, 2013) which has been endorsed by the Palestinian Council of Ministers. This system has not yet officially published in the newspaper in order to resume with enforcing it. The Palestine Economic Policy Research Institute (MAS) conducted a study to assess the PWA proposed tariff system. The study results can be summarized as follows:(1) the goal of achieving social and economic justice sometimes collides with the goal of cost recovery (2) interferences of the different authorities affected the application of the system (3) the system did not state specific indicators or rates to measure performance (4) the study presented a number of issues that the system overlooked, including the imposition of sanctions on those who violate the provisions of the rule (5) the study also provided observations and final comments regarding the structure of material, typos and misspellings (MAS, 2013).

2.5.3 EFFICIENCY AND EQUITY OF PUBLIC EXPENDITURES

The development of the water and wastewater sector depends on PNA public expenditures and on funds obtained from international donors. The sector expenditure in 2014 was US$ 15.6 million (PNA, 2014). It is important to mention that a significant part of investments in the water and wastewater sectors depends on donor contributions. Donor fatigue and any other reasons leading to lower funding to the sector can seriously harm efforts tailored towards a "more sustainable than today" management of the sector in Palestine.

Several projects have been cancelled or postponed due to Israeli impediments. Conditioning aid money to political conditions is another factor that does not contribute in achieving a sustainable development in the wastewater collection and treatment sector. In line with the NDP 2014-2016, and in order to improve the sector, many important water and wastewater management projects in Palestine were implemented. Key achievements are shown in **Table 2.17** (MoPAD, 2015).

TABLE 2.17: KEY ACHIEVMENTS IN THE WATER AND WASTEWATER MANAGEMENT SECTOR

Achievements	West Bank	Gaza Strip
Installing new water supply network	412.6 km	13 km
Rehabilitation of water networks transmission pipelines		4.3 km
Rehabilitation or installation of water networks transmission pipelines	9 km	
Rehabilitation of water wells	3 (Arraba, Sanur, and Qabatiya)	5
Installing of water well pumps	3	15
Construction of wastewater treatment stations	5 (Anza, Beit Dajan, At Tayba, Sarra, Hajja, and At Tira)	-
Construction of central wastewater treatment Plant	1 (Jericho WWTP)	-
Installation of new sewerage networks and transmission pipelines	11.2 km	9.4 km
Rehabilitation of sewerage networks and transmission pipelines	-	4 km
Rehabilitation and installation of sewerage networks and transmission pipelines	10 km	
Installation of wastewater pumps	-	5

2.5.4 LACK OF LEGAL INSTRUMENTS & ENFORCEMENT

Palestinian rural areas are especially threatened by serious environmental challenges related to the current water and wastewater management status. There is a general lack of infrastructure already causing adverse environmental results. Serious public health risks arise from the spread of diseases due to contamination of food, water, air, and soil.

Contaminated water, food, and other sources have contributed to the high prevalence of enteric diseases in the West Bank. The PCBS (2012) reported an increase in waterborne diseases prevalent among children from 11.5% in 2006 to 14.8% in 2010. Children in the age group of 12-23 months were the most susceptible with a reported prevalence rate of 21.3% (PCBS, 2012). Circa 2005 epidemiological studies on the prevalence of the waterborne Cryptosporidium spp. in children with diarrhea -an agent known to cause high morbidity and mortality rates - ranged between 11.6% and 13.5%. For the same time period, this ratio was much higher than that found in India (7.3%), Iraq (8.8%), and Irbid-Jordan (1.5%).

In few governorates, such as Tubas, a high percentage of households rely on water from tankers and springs as the main source of drinking water (PCBS, 2013c). Spring water is susceptible to contamination from environmental pollutants especially untreated wastewater. Water from tankers on

the other hand are often used to fill domestic rain wells (cisterns) which are often deeper than cesspit levels; ultimately leading to contamination of water in cisterns.

The enforcement of environmental laws and water law has often been weak and ineffective. , At the same time the enforcement of the law has been limited due to the political divisions of Palestine into Areas A, B and C; the lack of authority of the PNA in Area C, is a clear example. Strategies to improve environmental enforcement generally involve strengthening the legal instruments of enforcement, particularly the usage of civil penalties and criminal proceedings. Rigid interpretation of the law and formal legal penalties should characterize the environmental enforcement.

2.5.5 POOR GOVERNANCE

The presence of the Israeli occupation hinders the development of good water governance in the state of Palestine. But this is not the only factor that affects the efficiency of water governance. The lacks of accountability in managing the water sector especially the technical problems. Another factor effecting good governance is the fact that many bodies (municipalities) manage this sector; these bodies are not capable of conducting good governance and lack institutional expertise on the technical, financial, investment, and management levels.

Moreover, the PWA is not capable of monitoring and controlling the water abuses in the West Bank. This is due to the lack of Palestinian control over in Areas C and B where many abuses occur. The PWA monitoring over the abuses of the main water pipelines and water resources and water thefts in Area A is also weak. Corruption, political and tribal nepotism and favoritism in providing water services are also key factors that hinders the good governance in the Water sector

2.6 Conclusions and Recommendations

The Palestinian water sector is facing many limitations and challenges that prohibit its sustainable development. The majority of these are stemming from the Israeli occupation's policies and practices. The discriminatory and unfair division and utilization of the shared water resources between Israel and Palestine had led to creating chronic water shortage in Palestine. This violates the Palestinian right to water and the associated rights such as the right to health and the right to adequate standards of living.

Currently, all of the water resources in Palestine are exploited up to the safe yield and some resources are overexploited which resulted in the deterioration of water resources in terms of quantity and quality, this has already happened in the Coastal Aquifer where over pumping has resulted in lowering the groundwater table below sea level, and hence, sea water intrusion to the Aquifer. Any solution to the water conflict will have to consider equitable allocation and joint management between all the riparian of all trans-boundary water resources.

The gap between water supply and demand is expected to increase in the coming years. This fact and the limited access to water resources in Palestine, in addition to over pumping of some resources, which are mainly attributed to the Israeli occupation's practices, stress the urgent need for Israeli-Palestinian negotiations over the Palestinian water rights and the reallocation of the shared water among the two sides.

There is a need continue the development of new wells, reservoirs, pipelines, and new water infrastructure as well as rehabilitation of the ancient wells, in addition to implementing surface run-off

capture and rainwater harvesting schemes. In Gaza Strip it is of great importance to build more desalination facilities.

To solve the water shortages in Palestine, it is important to: 1) obtain the Palestinian water rights; 2) adopt an integrated water resources management approach; 3) use non-conventional water resources especially the treated wastewater, desalinated water and surface water runoff.

3. SOLID WASTE MANAGEMENT IN PALESTINE

3.1 Introduction

According to the Palestinian Central Bureau of Statistics (PCBS),Solid Waste refers to the useless and sometimes hazardous material with low liquid content. Solid wastes include municipal garbage, industrial and commercial waste, sewage sludge, demolition wastes, mining residues, and wastes resulting from agricultural, animal husbandry, and other connected activities (PCBS, 2013c). Most solid waste in the State of Palestine is composed of organic matter, paper, cardboard, plastics, metals, and glass.

Solid waste collection and disposal services are mainly the responsibility of the local authorities (municipality, village council and or joint council for services planning and development) (PCBS, 2015a), but in some localities private contractors or other entities are responsible for the collection and disposal process. In the refugee camps, the United Nations Relief and Works Agency for Palestinian Refugees in the Near East (UNRWA) carry out this duty using its own equipment and normally uses disposal sites of the local authorities.

Currently, there are three operational sanitary landfills in the West Bank namely; Zahrit al-Finjan located in Jenin governorate, Jericho landfill in the Jordan Valley and Al Minyah in Bethlehem governorate. In the Gaza strip, there are three sanitary landfills; Rafah, Deir El Balah and Jahr Al Deek sanitary landfills. According to ministry of local government (2015), 50 % of the generated solid waste in Palestine is transferred and dumped in the central sanitary landfills (MoLG & JICA, 2015). The remaining waste (50%) is disposed of in 100 unsanitary dumpsites, vacant lots and remote areas distributed in the West Bank and Gaza Strip.

By 2015, 5% of Palestinian localities (all located in the West Bank) were still without solid waste collection services by municipalities or other public authorities (MoLG & JICA, 2015). This uncollected solid waste is often destined for uncontrolled dumping and informal incineration sites such as vacant lots, residential streets, and remote areas.

3.2 Current Status

After the establishment of The Palestinian National Authority (PNA), several laws and solid waste management policies and strategies have been instituted (**Box 3.1**) to manage the various aspects of solid and hazardous waste collection and disposal efforts. Since PNA took control over solid waste services, the status of solid waste management in Palestine has improved. The PNA worked to develop the sector in an attempt to compensate for the lack of infrastructure services and equipment inherited throughout years of occupation. Achievements in the last two decades included: (1) the establishment of a number of regional sanitary landfills (Zahrit al Finjan, Jericho and Al Minyah landfills) which have contributed to limiting the health and environmental damage caused by random dumping sites; (2) the closure and rehabilitation of 100 random dumping sites especially in the Hebron, Bethlehem, Nablus and Jenin governorates; and (3) the purchase and operation of equipment such as collection vehicles, compactors and containers to expand the geographical extent of solid waste collection services (the waste collection rate has increased from about 64% in 1994 to 95% in 2015).

In spite of the achievements mentioned above, the sector is still facing several political, legislative, and institutional challenges. A major obstacle to improving solid waste management remains the political situation. All land that can be used to construct waste disposal facilities is located in “Area C”. Hence construction permits are required not only from relative Palestinian institutions, but also from the Israelis. Licensing of the sanitary landfill in Ramallah, for example, has not been granted by the Israeli authorities. Therefore, most localities in the districts of Ramallah and Salfit are still disposing solid waste in 65 random dump sites. In addition, about 80% of the solid waste generated from Israeli settlers estimated at 0.45 million tons/year is disposed of in random dumpsites in the West bank (ARIJ, 2015c).

The legislative and institutional challenges include the insufficiency of legislation, weak enforcement of laws, and loop-holes in the current laws which resulted in ambiguity in institutional frames and the overlap and conflict in the solid waste management duties of several institutions. For instance, bylaws for solid waste and hazardous waste management have not been approved yet. The bylaws should identify roles and responsibilities in waste management, detailed classification for wastes and hazardous wastes, procedures and specifications for hazardous waste separation, storage, collection, transport, treatment as well as waste tracking. As the bylaws have not been approved, the draft National Master Plan for hazardous waste management prepared by EQA (2010) was never approved. Equally important are the incomplete: (1) technical specifications and regulations for the handling of hazardous wastes; (2) specifications of solid waste dumpsites; (3) guidelines and specifications for agricultural chemicals that are allowed to be imported, manufactured, and distributed in Palestine. Regulations, instructions, specifications and norms for waste management are among the scope of the EQA and should be developed in collaboration with relevant institutes such as the ministry of Health (MoH), and the Palestinian Standards institute (PSI).

Ambiguity in institutional frames and the overlap and conflict in the solid waste management duties of several institutions may have also hampered efforts in developing an effective and organizational framework for solid waste management. The public health law grants the MoH the role of issuing the conditions related to transport, store, treatment, and disposal of the hazardous waste. This is in conflict with the environmental law which grants the same role to the EQA. The Environmental Law also assigns the responsibility for monitoring the implementation of the Solid Waste Management Strategy to EQA, but the Ministerial Cabinet Decision (No 05/49/13, dated 16 May 2010) assigned this role to the National Team for Solid Waste Management that is chaired by Ministry of Local Government.

The Medical waste bylaw for year 2012 has a detailed description and classification of medical wastes, and identifies: (1) procedures for the separation of waste; (2) means for separation; (3) means and responsibilities of transport of waste; and (4) modes of treatment of medical waste. According to the bylaw, all institutions generating medical waste should have abided by its articles by Feb 2014. In spite of the installation and operation of autoclave and microwave units for the disinfection of medical waste at some 25 hospitals, there are several hospitals operating uncontrolled incinerators and while the hazardous waste cell in Jericho is operational, the one in Gaza is still not in operation and was not used due to high costs of operation and inability of enforcing laws. Overall, it is not clear to the authors the percentage of the generated medical waste that is being properly disposed of. This is in part due to the ambiguity related to the volume of generated medical waste as hospitals and other medical centers do not, in general, measure and report the generated amounts.

A general overview of the current status of solid waste management in Palestine is presented in **Table 3.1**. It contrasts the achievements in the sector with the targets set by the National development plan. Options for improvements in the sector include: (1) Development of the legal framework; and enforcement of Laws; (2) development of a waste information system; institutional building and improvement; increasing cost recovery; development and upgrade of tariff systems, billing systems, and fees collection system.

TABLE 3.1: SOLID WASTE PERFORMANCE INDICATORS

Performance Indicators	Before 2012	2013	Realized Value 2015	Target 2016
% of households connected to solid waste collection services	92%	95%	95%	100%
% of total solid waste disposed in sanitary landfills out of produced waste	33%	40%	50%	60%
% of solid waste recycled out of produced waste	NA	2%	6%	25%
% of solid waste fee collection	NA	85%	85%	90%

BOX 3.1: LEGISLATIONS CONCERNING SOLID WASTE MANAGEMENT

The basic regulation on the Joint Service Councils of year 1996, and its updates, last in 2006 ;

Local government law No. 1 of 1997: Describes the roles and responsibilities of the local authorities within their jurisdiction, the law clearly shows that solid waste management is the responsibility of these local authorities.

The Investment Promotion Law No.1/1998

Environmental law of 1999: The law establishes the general legal framework for solid waste management in Palestine. Reduction of the negative effects resulted from the Solid Waste and providing the legislative related to Sanitary landfills, forbidding waste burning and encouraging reusing and recycling of solid wastes.

The Palestinian Environmental Impact Assessment Policy of 2000: It defines the activities subject to an Environmental Impact Assessment (EIA) which includes all solid waste projects.

Palestinian Law (2003) identifies the right to a clean and a balanced environment as a basic right of every Palestinian and that preservation of the Palestinian environment for the sake of both present and future generations is a national duty (article 33).

Public health law No. 20 of 2004: Describes the regulations concerning solid waste management, roles of hazardous waste management and ensuring health conditions.

The Medical Waste Management Bylaw 2012

The National Strategy for Solid Waste Management (NSSWM)(2010 – 2014): aims at setting the development path for the Palestinian solid waste management (SWM) until 2014.

3.2.1 STRATEGIES RELEVANT TO SOLID WASTE MANAGEMENT

The strategies relevant to solid waste management include: the Environment Sector Strategy (2011-2013) (EQA, 2010), the Environment Sector Strategy (2014-2016) (EQA, 2013), the National Strategy for Solid Waste Management (2010 – 2014) (PNA, 2010), and the National Development Plan (NDP) (2014 – 2016) (PNA, 2014).

The National strategy for Solid Waste is considered as the first cross-sectoral strategy for solid waste management in Palestine. It constitutes the reference point and strategic framework for all decisions, programs, activities and medium term investment plans, aiming at developing the solid waste sector in the next years (PNA, 2014). As mentioned in the Public Expenditure Plan in the NDP 2014-16 which reflect the priorities over the next three years, US$ 34.7 million, which represent 8.3% of the overall Infrastructure sector development expenditures, will be investing in environmental conservation and management of natural resources including the development of solid waste collection and processing facilities. This will include the construction of sanitary landfills, procurement of equipment, closing random dumping sites and establishment of specialized facilities to treat hazardous waste (PNA, 2014).

Unfortunately, the political situation and illegal Israeli measures in Palestine normally stand against the planning and implementation of several projects especially in area C which hinders promoting any foreseeable sustainable development. The PNA tries to improve the situation and some improvements have been observed. More efforts are being directed to enhance solid and hazardous waste management (MoPAD, 2014). However, the PNA still suffers from limited sovereignty in areas classified as B and C as it is out of its control (civilian and military control) and even in area B, where the PNA has the civilian control, where the PNA is required to obtain permits from the Israeli authorities for solid waste management projects.

3.2.2 SOLID WASTE GENERATION

In Palestine the population growth, which is approximately 2.9% (PCBS, 2014d), have resulted in an increase in the amount of the generated solid waste. According to the PCBS census, the population of Palestine in 2015 was estimated at 4.68 million, and approximately 1.28 million tons of solid waste was generated in the same year (MoLG & JICA, 2015). Hazardous materials are to some extent present in all of these wastes, and is a significant component of industrial and hospital waste. There is virtually no separation of hazardous waste in Palestine, except for some limited treatment of infectious waste. In fact, hazardous waste is mixed with municipal solid waste during both collection and disposal phases.

The average Palestinian household produces approximately 2.9 kg/day of solid waste (PCBS, 2015a). Rural Palestinians produce the least solid waste of 0.4-0.6 kg/day. Residents of refugee camps produce 0.5-0.8 kg/day, rural inhabitance produce 0.6-0.8 kg/day, and city inhabitance produce 0.9-1.2 kg/day (ARIJ, 2015c). **Figure 3.1** and **Figure 3.2** show the total amount of Solid waste generated in the West Bank and Gaza Strip according to the Locality Type.

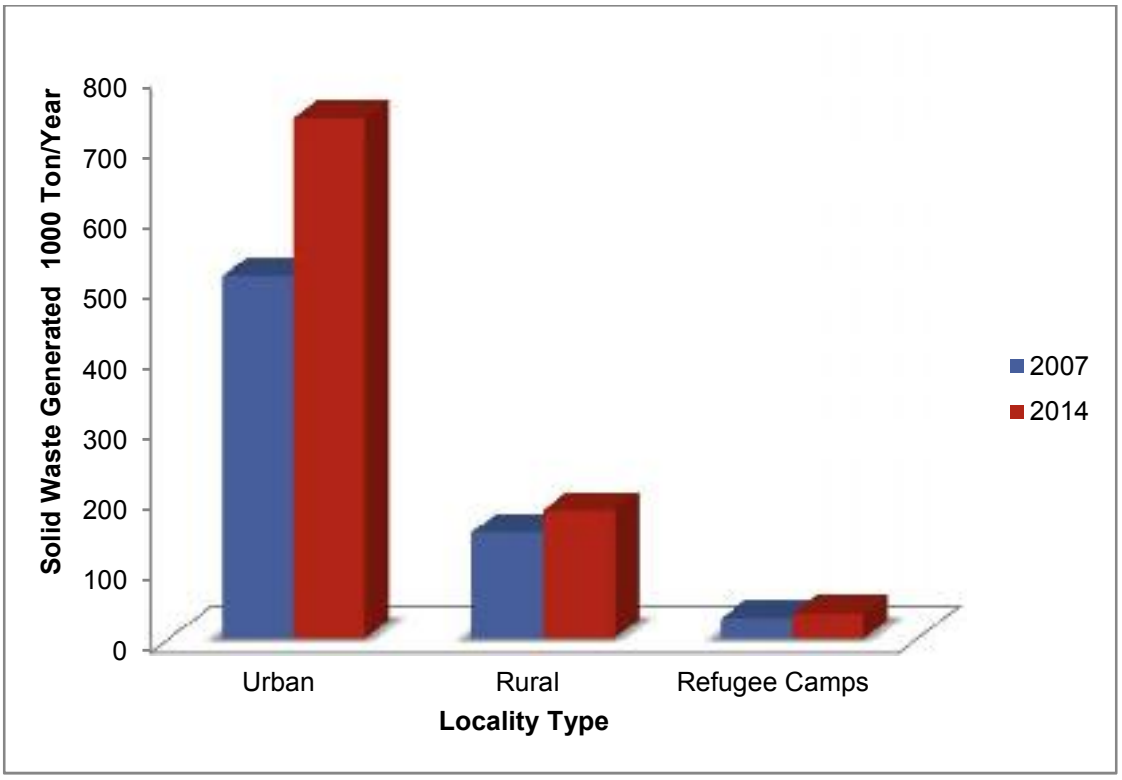


FIGURE 3.1: TOTAL AMOUNT OF SOLID WASTE GENERATED IN THE WEST BANK BY LOCALITY TYPE

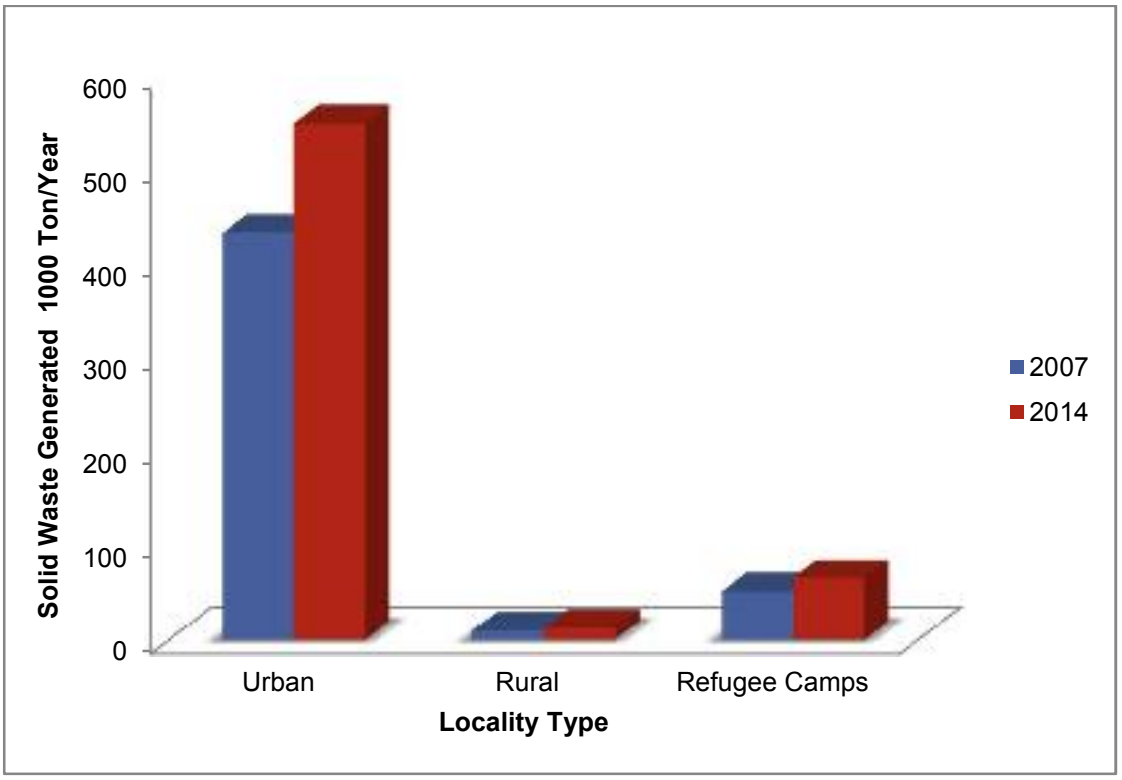


FIGURE 3.2: TOTAL AMOUNT OF SOLID WASTE GENERATED IN THE GAZA STRIP BY LOCALITY TYPE

BOX 3.2: INDUSTRIAL WASTE

Industrial waste includes many different waste streams arising from a wide range of industrial processes. According to the PCBS, the total number of the industries in Palestine was 16,201 for the year 2013. These industrial establishments produce approximately 400.98 thousand tons of waste in 2013, which contains hazardous solid waste (PCBS & EQA, 2014). (For more information regarding the Industrial waste please see **CHAPTER 4**).

The monthly estimated quantity of solid waste produced by the health Facilities (governmental and non-governmental) in Palestine in 2014 was 381 tons: including 277 tons in the West Bank and 104 tons in Gaza Strip (PCBS & MoH, 2014).

Table 3.2 shows the total amount of the generated solid waste in Palestine for the years from 2013 to 2015. A slight upward trend in the generation of Solid waste could be observed in these years which is in lieu with population growth (ARIJ, 2015c; MoLG & JICA, 2015; PCBS, 2007).

TABLE 3.2: SOLID WASTE GENERATION IN PALESTINE FOR THE YEAR FROM 2013 TO 2015

Region	Population (2013) (projected)	Total SW generation (Ton/day)	Population (2014) (projected)	Total SW generation (Ton/day)	Population (2015) (projected)	Total SW generation (Ton/day)
West Bank	**2,719,112**	**0.74**	**2,790,331**	**0.76**	**2,862,485**	**0.78**
Gaza Strip	**1,701,437**	**0.47**	**1,760,037**	**0.48**	**1,819,982**	**0.50**
Palestine	**4,420,549**	**1.21**	**4,550,368**	**1.25**	**4,682,467**	**1.28**

Increases in generated Solid Wastes in Palestine are mostly driven by municipal waste which basically comes from households. Household wastes account for about 45-50% of the total solid wastes, the construction and industrial sectors together account for 20-25% while the remaining 25-30% are generated by the commercial and institutional sectors (Al-Hmaidi, M., 2002).

Food waste or organic fractions represents the major part of the generated household wastes. These account for almost 59.1% of the generated SW. It should be noted however that other studies suggested a higher percentage of organics (GIZ, 2014). The remaining classes of solid waste consist of paper/cardboard (10.1%), plastics (14.2%), glass (2.4%), metals (2.7%), and other waste (11.5%) (GIZ, 2014).

3.2.3 COLLECTION AND DISPOSAL OF SOLID WASTE

According to article 15 of the Palestinian Local Authorities Law no. 1 (1997), solid waste management is the responsibility of the local authorities within their boundaries. They are responsible for the collection of waste from streets, houses and public stores as well as for the transportation and disposal of the collected waste. The Ministry of Local Government (MoLG) has the overall responsibility for the relevant functions of local authorities, including planning and provision of services, and is the primary body managing such responsibility in the State of Palestine.

In accordance with Article (15) of the Palestinian Local Authorities Law number (1) (1997), Join Councils were established to provide local authorities with one or more common services, with the aim of improving the quality of services in a cost effective manner; taking into consideration geographic

proximity and social acceptance amongst the various communities. With regards to solid waste management services, 21 Joint Services Councils for Solid Waste Management (JC for SWM) have been established in the West Bank, and two in the Gaza Strip (PNA, 2010). The JCs for SWM act in compliance with the Joint Services Councils Bylaw number (1) (2006), according to which each of them should develop its own internal bylaws and regulations that govern their work.

Whilst the MoLG and its local authorities play the major role in solid waste management practices in Palestine, other ministries on the national scale share environmental responsibilities with it (PNA, 2010). In this regard, the Environmental Quality Authority (EQA) is responsible for promotion of the sustainable environmental development of Palestinian society, development of standards and guidelines for environmentally sustainable conditions (although much subsidiary legislation is still not developed), licensing of sites, environmental monitoring, provision of expertise and ensuring environmental protection. The Ministry of Planning and Administrative Development (MoPAD) is responsible for the overall planning and fund- raising regarding the proposed projects. Also, the Ministry of Health is responsible for licensing the solid waste collection establishments, and how to treat and dispose the waste. In addition it has an Environmental Health Department which carries out research and data collection on water, air, hazardous waste and pollution.

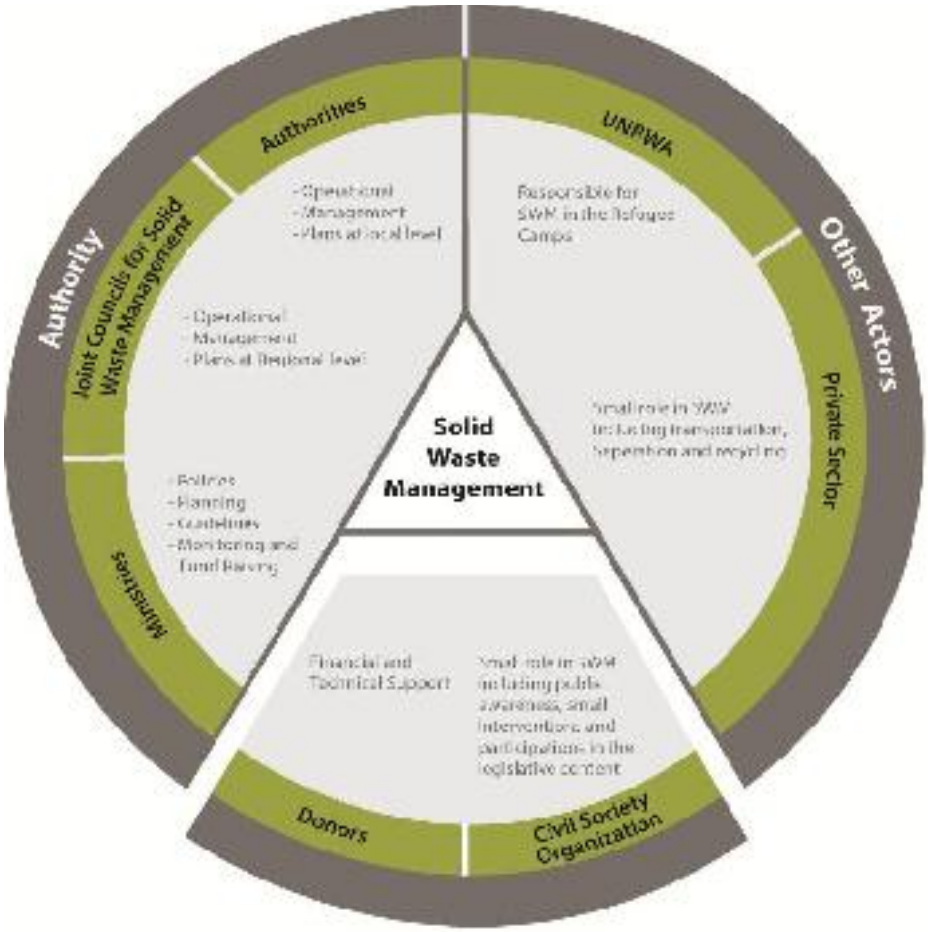


FIGURE 3.3: INSTITUTIONAL FRAMEWORK AND THE DIFFERENT PARTNERS RESPONSIBLE FOR THE SWM

Source: (PNA, 2010)

In the refugee camps, the UNRWA is responsible for most waste management; using its own equipments and materials, but normally uses disposal sites operated by local authorities. It is worth mentioning that the private sector in Palestine is still not involved in the solid waste collection services and management.

In the State of Palestine 95% of households are connected to solid waste collection services (MoLG & JICA, 2015). Local authorities (municipality, village council and or joint council) are responsible for the solid waste collection services in 78.8% of the households in Palestine (PCBS, 2015a), but in some localities private contractors or other entities such as UNRWA are responsible for the collection process (**Table 3.3**) (ARIJ, 2015c; PCBS, 2011, 2015a).

TABLE 3.3: NUMBER OF LOCALITIES BY ENTITY RESPONSIBLE FOR SOLID WASTE COLLECTION SERVICE IN THE YEARS 2010 AND 2015

Responsible Entity	2010			2015		
	West Bank	Gaza Strip	Palestine	West Bank	Gaza Strip	Palestine
Local authority	334	25	359	267	24	291
Contractor	26	0	26	26	0	26
UNRWA	20	8	28	20	8	28
Another local authority	50	0	50	36	0	36
Joint Services council	0	0	0	68	1	69
Others *	15	0	15	32	0	32
No collection service	79	0	79	75	0	75
Total	**524**	**33**	**557**	**524**	**33**	**557**
Note: *** Others are not specified in the PCBS**						

Although the solid waste service is available in most of the localities; there are still 13 locality not served with solid waste services, resulting in the accumulation of waste piles in the roadsides. The piled waste attracts several animals and insects which disturb people and cause several problems like spread of epidemics and diseases, bad odors, etc.

In cities and big towns, municipal solid waste is often collected in steel containers ranging in capacity between 800 - 1000 liters or dumpsters with capacities ranging between 5-6 cubic meters. These are distributed in the cities and towns and are transported by compactors or trucks to the dumping site or the transfer station. There are eight transfer stations in the West Bank. In the Gaza strip there is one transfer station and seven temporary storage areas (GIZ, 2014). In villages, the waste collection system is different from that of cities. In villages, there are neither containers nor compactors for waste collection. People in these communities use door to door collection, Wheelbarrows and tractors were used to collect the wastes at the door step of the households and to deliver the wastes to the collection point or transfer station, in most cases, once a week.

Solid waste management service providers collect fees from those receiving collection services to recover the management and operation costs. According to the Ministry of local government 85% of the solid waste fees are collected (PNA, 2010).

BOX 3.3: FEES COLLECTION SYSTEMS

Some Joint services Councils; such as Salfit JSC, Jenin JSC and Jericho JSC; have proved efficient collection fees system through the electricity bills in management cost recovery which reach close to 100% of the cost (PNA, 2010). Such fees collection systems requires building on its experiences and dissemination.

However, these fees often do not recover the costs (PNA, 2014). This has resulted in the accumulation of debts (PNA, 2014). For example, Ramallah municipality should collect 38% of solid waste management costs according to the charged levy but the collected revenues cover only 19% of the incurred costs. A part of the problem is that only 50% of the service recipients pay the charged fee (Hantash, 2014). Other contributory factors to debt accumulation are the high costs of solid waste transport from Ramallah and disposal in Zahrit al-Fingan sanitary landfill in Jenin estimated at 14 million NIS per year (Hantash, 2014).

The Dominant method of solid waste disposal in the majority of local authorities in Palestine is dumping of solid waste in open, uncontrolled, unmonitored sites (50% of the generated solid waste) (**Photo 3.1**). There are around 100 random dumpsites distributed in the West Bank and Gaza Strip (**Map 3.1**); none of them were constructed or follow the environmental regulations (Abu-Mfareh, 2015; Abu-Yaccub, 2015). Usually, burning is the standard practice used for waste volume reduction in these dumpsites regardless of the negative impacts of burning. **Map 3.1** shows the location of random dumping sites and the location of sanitary land-fill sites within Palestine.

PHOTO 3.1: DUMPING OF SOLID WASTE IN OPEN AND UNCONTROLLED SITES (AL UBEIDIYA RANDOM DUMPING SITE).

The waste often contains plastic, PVC, tires, electronic waste and other things that produce particularly dangerous air pollutants when burned and creates dangerous toxic smoke, which has many tiny particles which can get deep into lungs, potentially increasing the risk of asthma, lung and heart disease, cancer, and other cardiovascular problems (EPA, 2010). In addition the smoke typically contains "dioxins" which are highly toxic pollutants known to cause cancer, as well as hundreds of other contaminants which may cause or aggravate lung problems. This pollution can be blown by the wind for some distance. When the contaminants fall to the ground and settle on subsistence foods, there is another opportunity for people, animals and plants to come into contact with dangerous substances (EPA, 2010).

The construction of central sanitary landfills like Zahrit al Finjan, Jericho, Al Minyah, Deir El Balah, Rafah and Jahr Al Deek landfills has reduced the random dumping sites. For example, there were 18 random dumping sites in Bethlehem and Hebron governorates; 17 of which were closed and rehabilitated by the Joint Service council for solid waste management – South West Bank after the construction of Al Minyah landfill (**Photo 3.2**). The remaining open dumping site is Yatta dumping site. The central sanitary landfills currently receive 50% of the generated solid waste in Palestine (MoLG & JICA, 2015).

PHOTO 3.2: AL UBEIDIYA RANDOM DUMPING SITE AFTER REHABILITATION

BOX 3.4: REHABILITATION OF YATTA DUMPING SITE

The rehabilitation process for Yatta dumping site will start within few months; the plan is to produce the Gas from the site and in the first stage they will burn this gas and if the quantity is good they are planning to generate energy from it *(Al-Sari', 2015)*.

Zahrit al-Finjan sanitary landfill (**Map 3.1**) was established in 2007 in Jenin. The landfill is serving Jenin and Tubas governorates. The total area of the Landfill is 240 dunum with a total capacity of 2.25 million tons of waste. Currently, 900 dunum of the total area has been dedicated for waste cells to serve the northern governorates for about 15 years during the first stage of the project (Al-Sa'di, 2009). Currently the landfill receives around 600 tons of waste daily from Jenin, Tubas, Nablus, Tulkarm, and Qalqiliya governorates in addition to Ramallah and Al Bireh cities (Abu-Yaccub, 2015). The site was not originally designed to serve Ramallah and Al-Bireh. However, due to the closure of Ramallah dumping site by the Israelis, Ramallah and Al-Bireh are currently transporting their waste to Zahrit Al Finjan landfill. Thus depending on the current amount of solid waste dumped into Zahrit Al Finjan landfill during the 8 years of its life, it is estimated that around 1.75 million tons of solid waste have been dumped into the landfill. However this represents 77.8% of its total capacity, thus shorting the expected lifetime of landfill from 15 years to around 10.5 years. In addition this situation will increase the problem of the solid waste management in Ramallah and Al Bireh and will put more money on the people and the municipalities to cover the cost of transferring the waste to Zahrit al Finjan landfill. It is worth pointing out that around 85 open and uncontrolled dumpsites in Jenin and Tubas were closed and rehabilitated after the operation of the landfill (Al-Sa'di, 2009).

The second sanitary landfill in the West Bank is the **Jericho landfill** (**Map 3.1**), which is serving Jericho governorate, also established in 2007 with a total capacity of 0.0685 million m^3 and current annual capacity of 11500 ton/year (GIZ, 2014). An expansion of Jericho landfill is envisaged in the coming months (Abu-Halawa, 2015).

The Third sanitary landfill in the West Bank is **Al Minya Landfill** established in 2013 to serve the southern part of West Bank, mainly Hebron and Bethlehem governorates (**Map 3.1**). It replaced the current Yatta unsanitary dumpsite and other random dumping sites (**Photo 3.3**). The total area of the Landfill is 250 dunum, with a design capacity built of 2.65 million m^3 and the expected lifespan is around 20 years. It currently receives 600 – 700 ton/day of solid waste (Al-Sari', 2015). The municipalities pay around 30 NIS for each ton of solid waste to the Joint service council for Solid Waste Management – South West Bank as fees for dumping the waste into the landfill. The landfill is working well, however still there is a problem with the smell produced from the leachate. To overcome this problem the JSC started to build a treatment plant to treat the leachate and to reduce its concentration (Al-Sari', 2015).

PHOTO 3.3: AL MINYA LANDFILL

It should be noted that the Israeli occupation imposes a *fait accompli* the use of Al Minya landfill by "Gush Etzion" Settlement Bloc (11 settlements), Har Hebron Settlements (16 settlements) and Qiryat Arba' Settlement located in Hebron and Bethlehem governorates. The total amount of solid waste disposed monthly from these settlements into Al Minya Landfill are 1200 ton (Al-Sari', 2015).

Another planned sanitary landfill in the West Bank is **Ramoun Landfill**. It will serve all the communities (68 localities) in Ramallah and Al-Bireh Governorate. The total area is 208 dunums located to the east of the governorate near Ramoun village. The total capacity is 2.75 million cubic meter and divided into 4 cells, the designed lifespan of the landfill is 20 years (JSC for SWM, 2013). However, the landfill which is located in Area C has not received construction license from the Israeli Authorities despite submitting an application for construction permit since 2003 . It should be noted that the construction of Ramoun landfill will result in closing down 54 existing random dumpsites in Ramallah and Al Bireh governorate and will solve the problem of transferring the solid waste to Zahrit al-Finjan sanitary landfill.

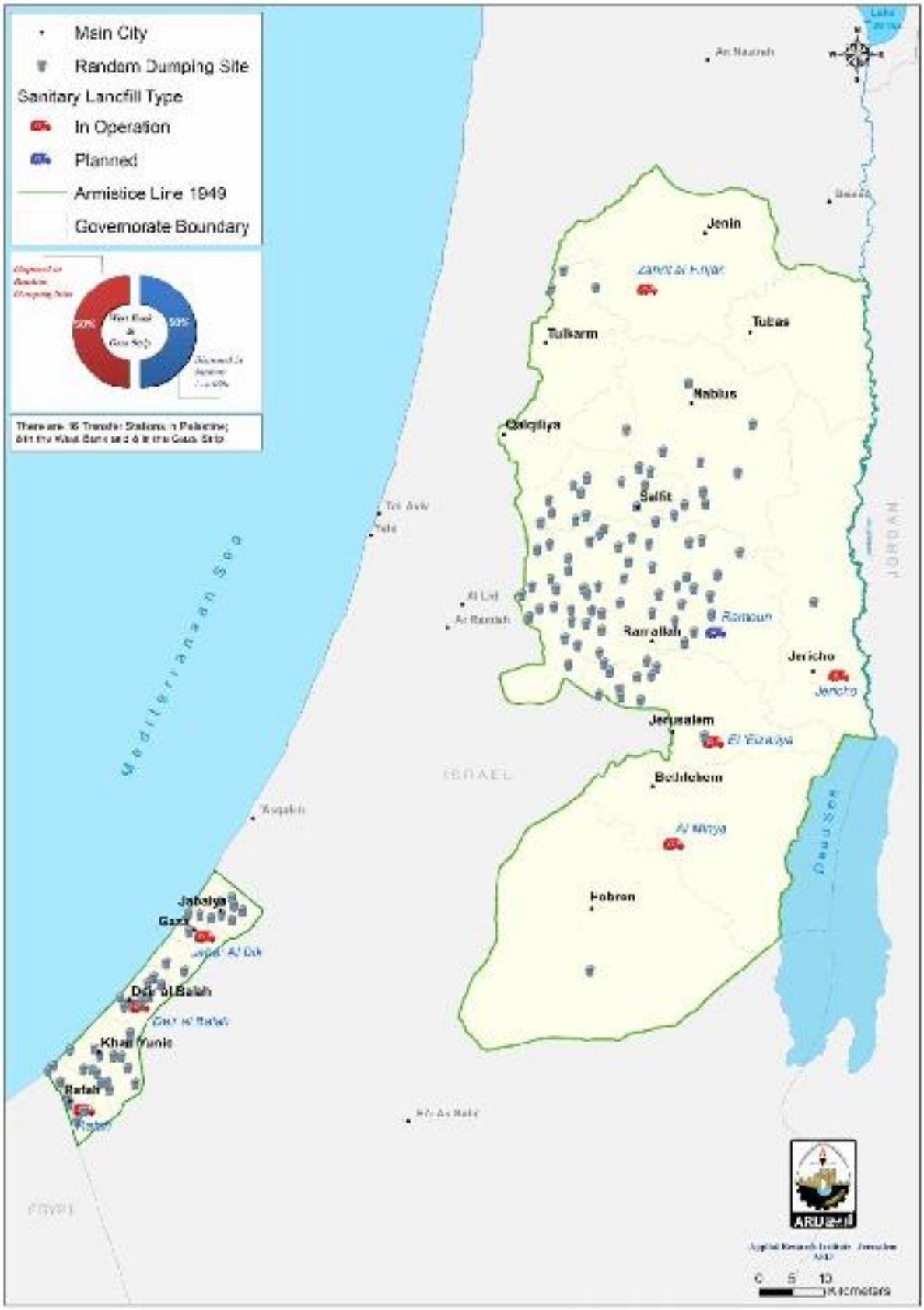
There is another Landfill in Jerusalem governorate called **El 'Eizariya landfill** (**Map 3.1**) which is managed by Israel and located between two Palestinian localities; El 'Eizariya and Abu Dis, almost a kilometer away from the closest Palestinian houses. The site is within Area C and was established by the Israeli occupation authorities in 1981 after the confiscation of lands belonging to residents of El 'Eizariya and Abu Dis (**Photo 3.4**). The total area of the landfill is around 430 dunum and According to the Israeli Civil Administration, between 1200 to 1500 tons of solid waste are delivered to the Landfill per day (PDF & Ir Amim, 2008). Although the safe lifespan of the landfill ended many years ago (around 14 years), Israeli authorities continue to expand the landfill and charter its management to Israeli contractors without taken into consideration the environment standards and criteria and the significant damage the landfill causes to the Palestinian public health when expanded improperly.

PHOTO 3.4: THE DAMAGE CAUSED FROM EL 'EIZARIYA LANDFILL

El 'Eizariya landfill overlays the infiltration area of the eastern sector of the West Bank Aquifer. There are no adequate measures to prevent leaching of organic wastes, toxic wastes and other pollutants to the groundwater and it is therefore one of the most significant major potential pollution sources of the Aquifer (**Photo 3.5**).

PHOTO 3.5: LEACHATE PRODUCED FROM SOLID WASTE - EL 'EIZARIYA LANDFILL

In the Gaza strip, the situation is different because of land scarcity which hampers the construction of new sanitary landfills. The currently central sanitary landfills in Gaza Strip are Jahr El Deek landfill (total capacity of 3 million tons), which is located southeast of Gaza municipality, Deir El Balah landfill (Capacity of 1.6 million tons), located east of Deir Al Balah municipality and Rafah (Sofa) landfill (Capacity of 300 thousand tons) located east of Rafah municipality (UNDP-PAPP, 2012). These sites are currently exceeding their maximum capacity, therefore local authorities there attempt to expand the existing ones as far as possible. In this regard, Rafah Municipality has been planning to add 10 hectares for its sanitary landfill and to construct a composting plant. The story is the same for Deir El Balah and Jahr Al Deek sanitary landfills, which are trying to expand their capacity. Unfortunately, no decision has been taken yet regarding such expansion. In addition the Jahr El Deek and Deir El Balah dumpsites face difficulties with the Israeli border military due to their location within the buffer zone next to Israel (**Map 3.1**).



MAP 3.1: SANITARY LANDFILLS IN WEST BANK AND GAZA STRIP AND RANDOM DUMPING SITES

3.2.4 RECYCLING OF SOLID WASTE

Two other waste volume reduction strategies (recycling and composting) have not been implemented to any significant degree at the national level in Palestine. This is despite their promise for not only reducing volume but also for conserving natural resources and saving energy used in manufacturing new goods. Pilot composting programs were started in conjunction with the landfill system in the Gaza Strip. There have been two attempts for composting in municipal waste in Deir Al Balah, and Rafah, and both failed due to damages caused to facilities by Israeli gun fire and lack of market for compost.

Additional obstacles are presented by the unwillingness of residents on the individual and community level to allow composting plants to be built near them. The population of Palestine is very dense, and the prospects are slim for finding locations to build waste management facilities where no one objects. Furthermore, Palestinian NGOs have failed to obtain permits from Israeli Authorities to establish compost and recycling plants in Area C. The main challenges for composting are: lack of standards, the need to develop market for locally produced compost, adaption of suitable technologies, and obtaining permits from relevant Israeli authorities to develop the facilities.

Today, the recovery of materials and recycling in Palestine is practiced at a very small scale. Around 6% of the waste generated (MoLG & JICA, 2015) is recycled and the recycled materials are hard plastics, cardboard, and Glass. Metals are informally collected and recycled prior to collection.

BOX 3.5: SOLID WASTE SEPARATION STATION IN NABLUS – AL SAIRAFE STATION

The Al Sairafe station is located in Area A in the Nablus governorate. Currently Nablus municipality is managing the station and they do separation for some types of waste such as Iron and Glass. Some of the separated materials are transferred to Israel for recycling. There was a plan to produce compost from the organic waste after separation inside Al Sairafe station, but this did not materialize due to rejection from neighboring communities of establishing a compost facility in their Neighborhood. In order to promote the success of such facilities, there is a need to concerted efforts to establish stable and strong partnership between the governmental sector, the private sector and the civil society (local community).

3.3 Israeli Practices and Solid Waste Management

The disposal of hazardous waste and wastewater from Israeli settlements and industrial zones located in the West Bank, causes serious environmental problems and results in grave harm to human health (For more details please see Chapter Four). Large amounts of Hazardous materials and wastes are either buried or openly disposed of in agricultural land, causing soil and groundwater pollution. More than 50 locations are used as dumping sites, which expose the Palestinian territories to the dangers of these wastes (PCBS, 2009b).

Approximately 718,000 Israeli settlers were illegally living in settlement in the West Bank (ARIJ, 2015a), and the total quantity of solid waste generated by settlers is around 446 thousand tons per year[11] (ARIJ, 2015c). In fact, information about the real quantities and composition of these wastes is not clear as Palestinians have no access to such information. this waste is being disposed of on

[11] Per capita solid waste generation in Israeli settlements is around 1.69 kg/day (Kawai & Tasaki, 2015).

Palestinian land and dumping sites, for example, in villages south Hebron governorate, Battir village in Bethlehem governorate, Ni'lin in Ramallah governorate, Jammai'n in Nablus governorate and Abu Dis dumping site. Additionally, waste generated from industrial zones in these settlements are also disposed of in the Palestinian land. The waste includes hazardous wastes generated from the Aluminum, leather- tanning, textile-dyeing, batteries, fiberglass, plastics and other chemical industries in the settlements. For example, the aluminum industry which is found in many Israeli settlements produces aluminum and acidic waste. Electroplating produces nickel, chrome and acidic waste. The battery industry produces lead in its wastewater. All of these inorganic substances are considered hazardous to health if accumulated in the human body.

Another problem is the unregulated transfer of e- waste from Israel and illegal Israeli settlements into the southern area of the West Bank mainly Idhna town, Beit Awwa, Al Kum and Beit Maqdum in Hebron governorate. Idhna has essentially turned into an electronic graveyard receiving 500-650 tons of e-waste and metal scrap every day (ARIJ, 2015c). There are around 25 big workshops in Idhna, 60-70 medium workshops, 100 small workshops and more than 200 are established next to households and 100 women also operate workshops inside their homes (ARIJ, 2015c). The total number of workers in these workshops are around 1500 permanent workers and more than 5000 non-permanent workers. In addition there are more than 100 workers under the age of 18 (ARIJ, 2015c). Workers process the e-waste to extract valuable materials such as nickel, copper and lead which is then sold and re-used. This process involves dismantling and/or burning components of electronic items in order to separate the useful materials. In addition, there are also burning sites on sporadic areas of land surrounding Idhna. E-waste is burnt, minerals are extracted, and the remaining non-valuable waste is left to contaminate the landscape (**Photo 3.6**).

PHOTO 3.6: E-WASTE BURNING SITE ADJACENT TO AGRICULTURAL LANDS (LEFT) AND A GROUNDWATER WELL (RIGHT)

The Illegal dumping and management of the E-waste in Idhna and the existence of the E-waste workshops in residential areas, next to households and schools has caused health and environmental hazards for residents especially children who are exposed to harmful materials and risk injury in the workshop (**Photo 3.7**). When active, burning sites release toxic black smoke which lingers for several hours. The chemicals released from burning include dioxins, benzene, PCBs (polychlorinated biphenyls), and mercury. ARIJ interviewed Dr. Saadi Al-Rajoub at the Palestinian Medical Relief Society Idhna medical center to obtain a deeper understanding on the extent to which e-waste disposal in Idhna is affecting human health. Dr. Al-Rajoub explained that cases of cancer are high in Idhna and

its rate of occurrence is increasing among young adults. He reported that 18 people in Idhna under the age of 35 have suffered from different forms of cancer within the year 2014. Dr. Al-Rajoub also noted an increasing number of women who suffer from miscarriages, which may relate to lead poisoning. He also noted other symptoms caused by exposure to e-waste such as skin ailments, headaches and memory problems. He also revealed that on average, out of those patients who visited the medical center every day, 30 people complain about symptoms that can be related to the existence of e-waste processing in Idhna (Al-Rajoub, 2014).

Israeli occupation forces and the political situation still represent a real obstacle for the development of a solid waste management system in Palestine. The Israeli blockade, checkpoints, curfews, and the construction of the Segregation Wall among other Israeli actions, have repeatedly prevented the development of sanitary landfills, access to dumping sites and proper collection of solid waste. These actions have not only restricted the provision of services, but have also resulted in a deterioration in the health and hygiene conditions; i.e. the prevalence of bad odours, spreading of litter, etc. The pressure on the Palestinian environment from solid waste management practices is further intensified by the considerable amount generated by Israel settlers which is dumped without restrictions on Palestinian lands and fields.

PHOTO 3.7: E-WASTE WORKSHOPS IN IDHNA

According to the Palestinian environmental law, imports of hazardous waste is a crime that is punishable with life imprisonment. However, compliance with environmental laws and regulations in matters related to hazardous waste management remains inadequate. Israel has taken advantage of this situation by transferring vast quantities of e-waste to, for example, the communities of Idhna, Al Yassaria, Al Kum and Beit Maqdum. These townships receive several hundred tons of e-waste imports from Israel per day. Illegal open burning is common in these townships and is often practiced as a quick means to collect the metals from e-waste causing previously fertile lands to be polluted with heavy metals. This is in clear violation of: 1) the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal; 2) the Palestinian Environmental Law; specifically article 13 that states that; *"it is forbidden to import any hazardous waste into Palestine"*; and (3) the UN General Assembly resolution 63/201 of 28 January 2009 which forbids dumping of all kinds of waste materials into the State of Palestine. Israel must therefore stop exporting and dumping hazardous waste into the State of Palestine. Furthermore, Israel must adopt the 'polluter-pays-principle' by compensating Palestinians for the damages caused to their land.

The onus to stop imports and illegal handling of hazardous waste also falls on the EQA and other stakeholders concerned with environmental protection. For example, taskforces should be established in collaboration with the police to enforce the Law by issuing penalties to those who violate it. The authorities should further establish a working group to monitor and regulate the flows of e-waste into the Palestinian territory with the aim to eradicate this practice.

BOX 3.6: THE ISRAELI ATTACKS ON THE GAZA STRIP

The Israeli attacks on the Gaza Strip since the 8th of July 2014 have resulted in a severe humanitarian crisis. The damages caused by this assault far exceed the destruction caused by the previous two wars, with significant civilian causalities, widespread destruction of civilian buildings and infrastructure throughout the Strip and massive displacement of people. These attacks have affected the Solid waste management and Infrastructure. Based on data reported by the Ministry of Public Works and Housing (MoPWH) on 18 August 2014, there was an estimated 2.5 million tons of rubble (Construction and Demolition Waste), as a result of the destruction of houses, main roads, and public buildings during the war on Gaza Strip. The MoPWH estimated the cost of rubble removal at $10/ton, thus a total cost of $25 million.

3.4 Conclusions

Palestinians have limited access to a large portion of their land and their natural resources. The Israeli occupation policies and practices which include settlement expansion, building the Segregation Wall, house demolitions, uprooting trees, destruction of the natural environment and biodiversity, dumping of solid and hazardous waste into the Palestinian land and its control on the Palestinian natural resources, all of these practices have posed a serious challenge and hindered the progress in environmental conservation and development. Despite these the Palestinian National Authority implemented some solid waste management projects including a sanitary landfill in southern West Bank to serve Hebron and Bethlehem Governorate, and closing a number of random dump sites. However the general situation remains far from satisfactory, and environmentally sound solid waste management still need more efforts and funds.

The improper handling of solid waste is a major cause of deterioration of landscapes, water quality, land degradation, air pollution, as well as aesthetic disturbance of the visual environment. The implementation of Solid Waste Management in Palestine is confronted with several challenges at the organizational, technical, environmental and financial levels. This situation is further complicated by the lack of statistical data needed for decision making, planning and operating operations (PNA, 2010). The National Strategy for Solid Waste Management (NSSWM) in Palestine has evolved in response to these challenges and to mitigate further damage to the environment. The severity of the solid waste situation in the State of Palestine can be attributed to many factors. These include:

- The continuing fiscal crisis, due to Israel's withholding of Palestinian tax revenues and the boycott on international aid;
- The lack of infrastructure for solid waste disposal, including sanitary landfills and recycling facilities;
- The physical damage caused to infrastructure and equipment by the Israeli occupation authority;

- The lack of public awareness on how to properly dispose of solid waste and the need for doing so;
- The weak and underfunded environmental institutions on the national level;
- The continual interruption of public civil services, by the Israeli Occupation, especially with respect to the constant military incursions, the Segregation Wall, and the Israeli settlements.

4. POLLUTION FROM INDUSTRIAL ACTIVITIES

4.1 Introduction

The Palestinian industrial sector plays an important role in the economic development process. The percentage contribution of the Palestinian industrial sector to total GDP is estimated at 15.7% for the year 2013 (PCBS, 2014b). Moreover, the value added reached 1712.4 million US$ representing 37.4% from total output for the year 2014 (PCBS, 2014a).

The major industries in the West Bank include quarrying, stone and marble, textiles and garments, food processing and beverage, metal industries, chemical industries, pharmaceuticals, construction industries, handicrafts, paper and printing, furniture, footwear and leather products, and plastics. According to the PCBS, the total number of the industries in Palestine was 16,201 for the year 2013; 11,655 of them are located in the West Bank and 4,546 are located in Gaza Strip (PCBS, 2014a).

Industrial pollution remains a serious problem in Palestine since hazardous wastes are either mixed with the domestic streams or discharged and dumped untreated landscapes polluting the environment and threatening the pollution of surface and ground water resources. Hazardous waste is any solid, liquid, or gaseous waste material that may pose substantial hazards to human health and the environment if improperly treated, stored, transported, disposed of, or otherwise managed (Weiner & Matthews, 2003). The wastes of all types; solid, liquid and gaseous can be a source of pollution of the environment, as it is disposed of into the water, soil and air. The pollution of the environment is often caused due to inefficiency in waste disposal. The issue of industrial pollution constitute a very grave danger to the population, as the long exposure to polluted air and water causes chronic health problems. Thereby, this type of waste should be given special priority in the Palestinian waste management plan.

4.2 Industrial Wastes

There are various processing methods for managing industrial wastes. In most Palestinian industries, there are no management systems or programs for industrial wastes. However, the waste management in these industries is limited to basic and often polluting practices such as, the collection of solid wastes and mixing it with domestic streams, open disposal in the streets and open random dumping sites, and the collection of the generated wastewater in cesspits or the sewage network. The industrial waste includes:

Solid waste: In Palestine the industrial waste is managed together with municipal solid waste and, therefore, often mixed with non-hazardous materials. It may be taken to a designated dumping site via municipal solid waste collection, or alternatively dumped onto open land or into wadis adjacent to such facilities. Some waste is burned on-site, as is the case with most textile and packaging facilities, or is stored and later transferred to dumping sites. Most flammable waste is openly burned at its final disposal site. Thus, many potentially toxic materials (e.g. PVC) are burned, releasing emissions such as dioxins and furans into the atmosphere.

As a result of the economic and social development that has occurred over the past years, there was an increase in the amount of generated industrial waste (**Figure 4.1**). Moreover, due to the lack of development of sound methods for waste disposal and the lack of law enforcement of environmental

regulations, the industrial waste is often accumulated and disposed of improperly. In the year 2014, the industrial establishments in Palestine produced approximately 400.98 thousand tons of hazardous solid waste (PCBS & EQA, 2014) compared to 327.19 in the year 2007.

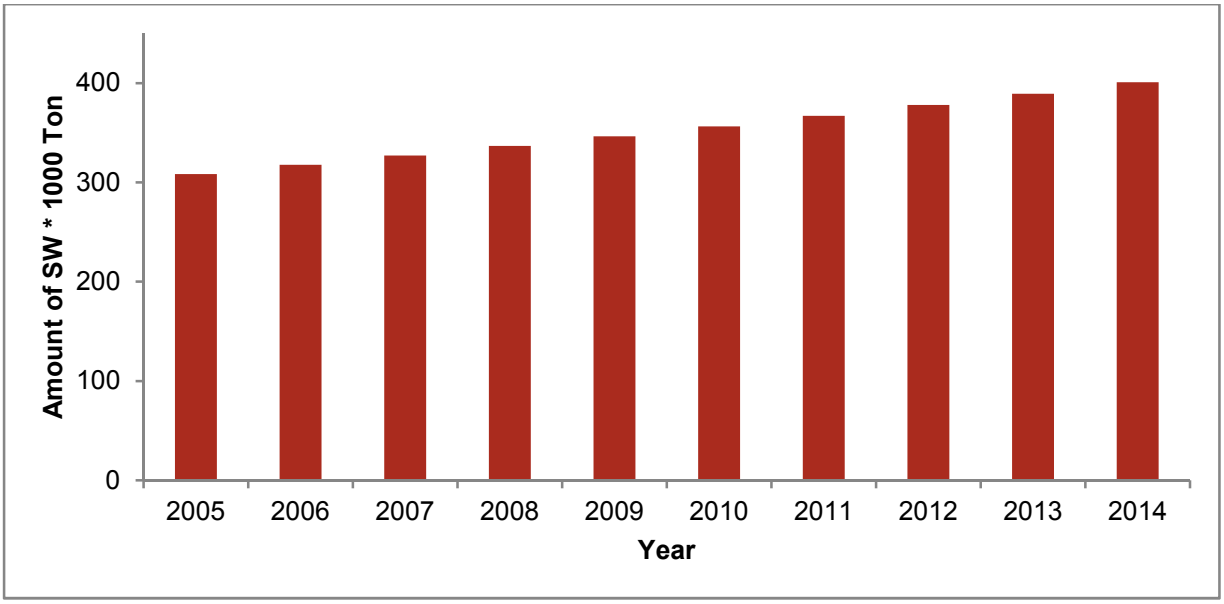


FIGURE 4.1: THE AMOUNT OF INDUSTRIAL WASTE PRODUCED IN PALESTINE - MID-YEAR, 2005 - 2014

According to the PCBS (2013), 79.2% of the industrial establishments in Palestine disposed of their solid waste in local authority dumping sites, 16.8 % in private dumping site, and the rest of the establishments disposed of their solid waste in other sites and/ or randomly (PCBS, 2013b).

In 2013, 82.3% of the industrial establishments in Palestine stated that their waste comprised paper and cardboard, 61.4% plastic and rubber and 50.9% soil and stones. **Table 4.1** shows the percentage of the industrial establishments by the type of solidwaste generated (PCBS, 2013b).

TABLE 4.1: PERCENTAGE OF THE INDUSTRIAL ESTABLISHMENTS BY THE TYPE OF SOLID WASTE GENERATED, 2013

Type of generated solid waste	% of industrial Establishments
Paper & cartoon	82.3
Plastic & rubber	61.4
Glass & metals	27.7
Soil & stones	50.9
Organic waste	17.4
Sharp waste	8.0
Infectious waste	0.6
Chemical waste	1.4
others	31.7

Only a small amount of industrial waste is separated (**Figure 4.2**). Organic waste, chemical waste and glass and metals are separated the most, as approximately 13% of the establishments that produce these types of waste have separation program for such waste (PCBS, 2013b).

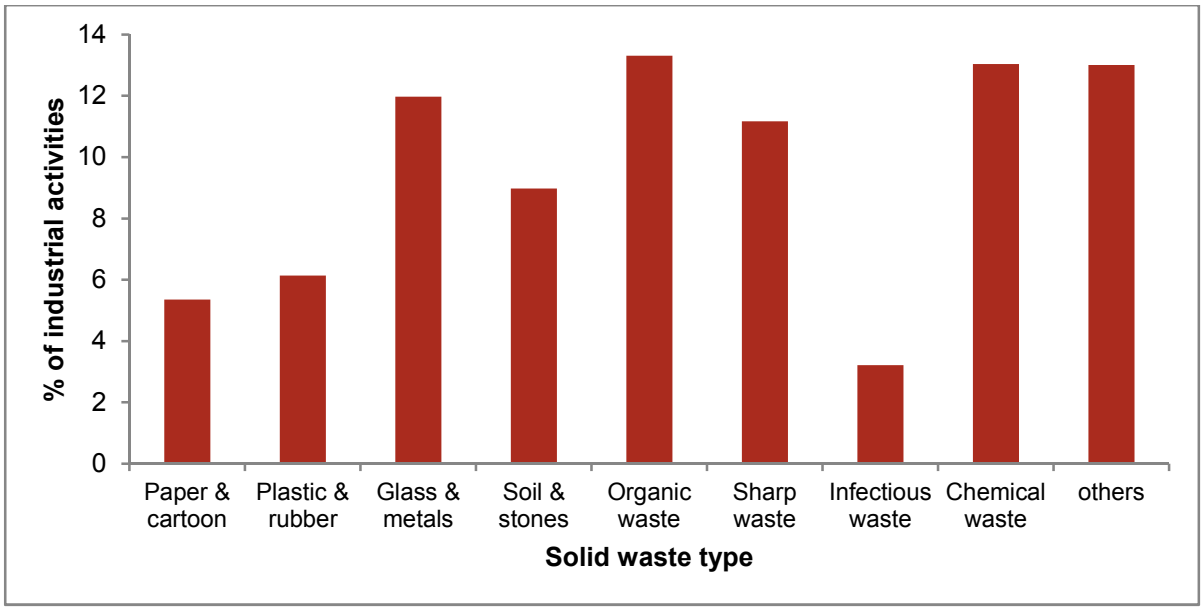


FIGURE 4.2: PERCENTAGE OF INDUSTRIAL ESTABLISHMENTS THAT GENERATE SOLID WASTE AND SEPARATE IT, 2013

It is important to mention that there is a few number of industries in Palestine that use specific measures in order to reduce the emissions of waste by reusing some of the waste materials. For example, the solid waste generated in the olive mills is being used as fuel for heating water. Also, the remaining stones from the stone factories is being crushed in order to produce construction materials (ARIJ, 2015c).

Liquid waste: Industrial wastewater contains different types of contaminants. Industries such as tanning (**Photo 4.1**), electroplating, batteries and metal finishing industries hold high concentration of non-degradable toxic waste and heavy metals such as chromium, copper and zinc. Moreover, some industries such as dairy industries generate wastewater with high concentrations of dissolved organic matter mainly protein, fat and lactose. In addition, one of the major environmental concerns associated with slaughterhouses is the discharge of wastewater which may have high concentrations of nitrate, phosphate, sulphates, fat and grease.

PHOTO 4.1: TANNING INDUSTRY IN THE WEST BANK

In Palestine, few industries have an on-site treatment facility to treat the wastewater to an acceptable standard prior to discharge. Where such facilities exist, they only consist of preliminary treatment processes. However, the partially treated or untreated industrial wastewater is disposed either through cesspits, septic tanks, open areas or public sewage network. According to the PCBS data for the year 2013, 60.8% of the industrial establishments dispose the generated wastewater through the sewage network (PCBS, 2013b). **Figure 4.3** shows the percentage of the industries by wastewater disposal method for the year 2013.

Some measures are used by few industries in order to reduce the liquid emissions. The stone crushers industries collect the water used in cooling the stone cutting machines in pools or Silo in order to reuse it again (ARIJ, 2015c).

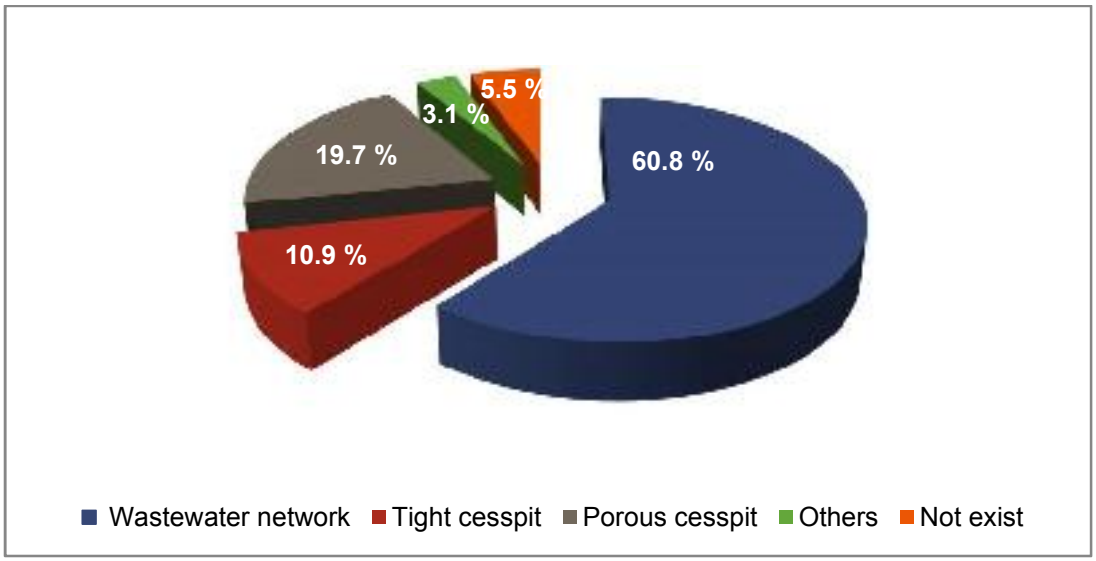


FIGURE 4.3: PERCENTAGE DISTRIBUTION OF THE INDUSTRIAL ESTABLISHMENTS IN PALESTINE BY WASTEWATER DISPOSAL METHOD, 2013.

BOX 4.1: OLIVE MILL WASTE

Despite the significant contributions of the olive oil sector in the economic and social development of Palestine, it is becoming a source of serious environmental problems to which urgent solutions have to be addressed. Olive Mill Waste Water is disposed untreated into the sewage network, cesspits or dumped in open areas without any consideration to its environmental impact on the groundwater, surface water or land. Similarly, large amounts of Olive Mill Solid Waste are accumulated during harvest season, discarded on neighboring lands or dumpsites or used as a fuel. In total 65,829.4 tons of olives were produced in the year 2013 in Palestine out of which 17,143.9 tons of olive oil was extracted (PCBS, 2014c). The waste generated by the olive oil processing is estimated to be about 98,744.10 m3 and it is disposed improperly into the environment (OLITREVA, 2014).

The majority of olive presses in Palestine used a tight cesspit to dispose of the waste water generated, without any treatment. About 93.6% of olive presses return olive cake, a byproduct of the pressing process, to owners (olive farmers). Olive cake (jeft) is considered as an important energy source, especially in rural areas (PCBS, 2014c)

Air emissions: The industrial activities also add to the air pollution problem through releasing large quantities of pollutants into the atmosphere. Air pollutants can be divided into two main groups; particulate and gaseous. The particulate group includes airborne particulates such as dust, fly, ash, smoke, fog and fumes. The second group includes pollutants such as carbon monoxide, hydrocarbon, oxides of sulfur and oxides of nitrogen (HAO & LI, n.d.).

The sources of those pollutants are different, as the smoke comes out from various industries such as: chemical industries and other manufacturing facilities. Quarries and stone cutting industries emit large amounts of dust into the air. Charcoal processing releases considerable amounts of particulate, carbon monoxide and dioxide, nitrogen oxides and volatile organic compounds (VOC) into the atmosphere. Moreover, landfills are another major contributor to air pollution which generates methane. For the case of the West Bank, the impact of industrial air emissions is increased due to the reason of the industrial facilities are located near the residential areas.

BOX 4.2: SOURCES OF AIR POLLUTION IN PALESTINE

The possible air pollution sources affecting the West Bank include; industrial activities, transportation, energy consumption, open burning of solid waste and trans-boundary air pollutants. As for the transportation sector, there are significant air pollution problems associated with vehicles especially that the total number of vehicles is increasing every year *(PCBS, 2015)*. The increased use of vehicles (especially the old ones) in Palestine emit tons of hazardous gases, such as carbon monoxide (CO), nitrogen oxides (NO_x), sulfur oxides (SO_x), and hydrocarbons (HC). Also burning vegetation and the increased amounts of fossil fuels used as a source of energy, emit large amounts of carbon dioxide (CO_2).

The PCBS has published a report that provided estimations and calculations of air emissions in Palestine for the year 2011 (PCBS, 2013a). The calculated emissions were: SO_2, NO_x, CO_2, CH_4, N_2O, CO, and NMVOC. The applied methodology for calculating the emissions depended on the source of pollution which were classified into: emissions from energy, emissions from agriculture, forestry and other land use and emissions from waste. The **Table 4.2** shows the emission quantities in Palestine from different sectors for the years 2007 – 2011 (PCBS, 2013a).

TABLE 4.2: EMISSIONS QUANTITY IN PALESTINE FROM ENERGY, AGRICULTURE AND WASTE SECTORS BY THE EMITTED TYPE, 2007-2011

Emissions	2007	2008	2009	2010	2011
CO_2	2,401,835	2,260,916	2,643,222	3,271,227	3,100,538
CH_4	13,584	13,198	13,120	13,983	14,852
N_2O	706	689	682	711	783
NO_x	26,815	29,229	28,223	31,412	40,112
CO	137,805	242,765	152,276	158,158	283,190
NMVOC	37,019	36,200	38,171	44,123	46,552
SO_2	1,722	3,903	1,966	1,515	4,480

The total emissions quantity from energy, agriculture and waste sectors in equivalent (TonCO_2 / year) from the year 2001 to the year 2011 is shown in **Figure 4.4**. The energy sector is usually the most important in greenhouse gas emission inventories and it contributes 87% of CO_2 emissions in Palestine (PCBS, 2013a).

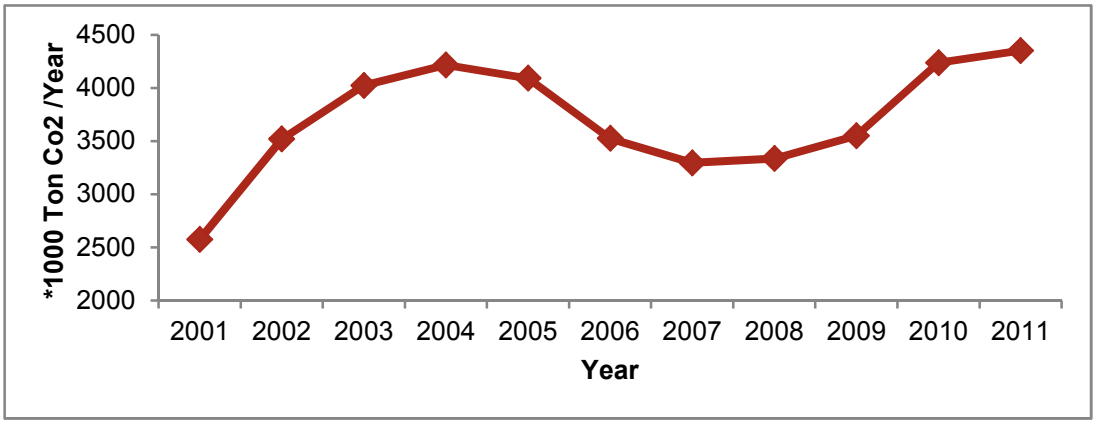


FIGURE 4.4: TOTAL EMISSIONS QUANTITY IN EQUIVALENT (TON CO_2/YEAR)

4.3 Pollution from the Palestinian Industries

4.3.1 INDUSTRIES AND INDUSTRIAL ZONES

Although there are many industrial zones in the West Bank, most industries are located outside these zones within or in proximity to residential or commercial areas. Even the Palestinian industrial zones in the West Bank are established without proper planning and are often located in geographic proximity to built-up areas (**Photo 4.2**). During the field survey that was conducted by ARIJ recently, the team observed that the environmental conditions in the existing industries and industrial zones are very poor.

However, there are currently six advanced industrial zones in construction and planning phases, five of them are located in the West Bank and one in the Gaza Strip. These industrial zones are being established by the Palestinian Industrial Estates & Free Zones Authority (PIEFZA) with the technical and financial assistance of many donors including U.S.A., Japan, France, Germany, European Union and the World Bank.

PHOTO 4.2: PLASTIC FACTORY LOCATED NEAR THE HOUSES IN BETHLEHEM GOVERNORATE

PIEFZA industrial zones include: Gaza Industrial Estate (GIE), Jericho Agro – Industrial Park (JAIP), Bethlehem Industrial Estate (BIE), Jenin Industrial Estate (JIE), Tulkarm Information Technology Park, and Hebron Industrial Estate. GIE has been established and operated for over a decade. JAIP and BIE are almost in the completion phase of the first stages. JIE is still in the planning and design phase, and the other two (Information Technology Park in Tulkarm and the industrial zones in Hebron) are in preliminary study phase. The aim of this industrial estates program is to stimulate foreign and domestic investment in Palestine that would promote productive industrial employment, by creating the necessary industrial infrastructure and enabling environment (Shaath, n.d.) However, there is a debit

as to the purpose of these establishments as some argue that the projects undermine real economic development and dangerously cement Israel's control over Palestinian economy (Kestler-D'Amours, 2013). Nonetheless, relocating industries to properly planned industrial zones with appropriate mitigation measures to any potential adverse environmental impacts will result in significant reductions of pollutants loadings throughout Palestine.

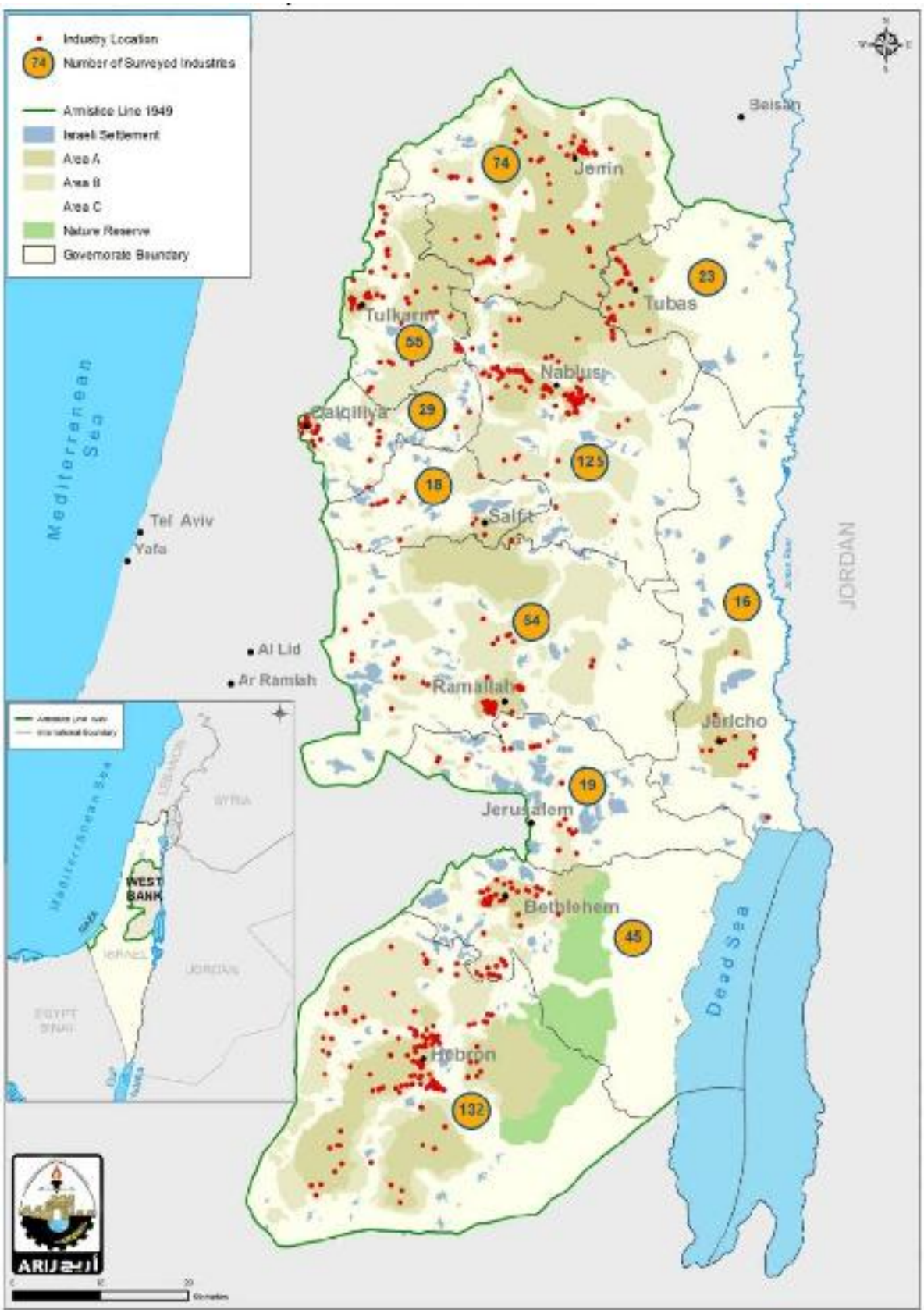
4.3.2 INDUSTRIAL POLLUTION IN THE WEST BANK (A CASE STUDY)

Recently ARIJ, jointly with the Canadian Company "ARCADIS" and in collaboration with the EQA have conducted a study entitled "Inventory and Mapping of the Industrial Pollution in the West Bank" (**Box 4.3**). The study targeted 600 industrial establishments in all the Governorates of the West Bank, and the establishments were classified into 25 sectors according to the International Standard Industrial Classification (ISIC) scheme (**Table 4.3**). **Map 4.1** shows the distribution of these establishments in each governorate and their number.

BOX 4.3: INDUSTRIAL POLLUTION DATABASE

One of the main activities of the "Inventory and Mapping of the Industrial Pollution in the West Bank" project was establishing industrial pollution database which contains information from a survey data of 600 industries as well as a preliminary pollution load assessment. The industrial pollution database was mainly developed based on an Inventory data entry form circulated among project stakeholders. The relational database consists of 43 tables that are harmonized together to ensure accurate entry of data and its retrieval.

The Industrial Pollution Database aims to strengthen the environmental monitoring framework in Palestine. It is expected to become the national clearinghouse for industrial pollution information that will provide the necessary support to the EQA administrators while they are formulating policy level interventions to abate any environmental impacts arising out of pollution hotspots. Moreover, it will help to create the country level database containing baseline information on different industry pollution sources.



MAP 4.1: THE DISTRIBUTION OF THE SURVEYED INDUSTRIES IN THE WEST BANK

TABLE 4.3: INDUSTRY SECTOR BREAKDOWN OF THE SURVEYED FACILITIES

No.	Industrial Sector	No. of facilities
1	Manufacture of food products	162
2	Manufacture of beverages	7
3	Manufacture of tobacco products	3
4	Manufacture of textiles	11
5	Manufacture of wearing apparel	11
6	Manufacture of leather and related products	20
7	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	8
8	Manufacture of paper and paper products	17
9	Printing and reproduction of recorded media	6
10	Manufacture of coke and refined petroleum products	5
11	Manufacture of chemicals and chemical products	56
12	Manufacture of basic pharmaceutical products and pharmaceutical preparations	3
13	Manufacture of rubber and plastics products	50
14	Manufacture of other non-metallic mineral products	120
15	Manufacture of basic metals	14
16	Manufacture of fabricated metal products, except machinery and equipment	16
17	Manufacture of machinery and equipment	16
18	Manufacture of motor vehicles, trailers and semi-trailers	2
19	Manufacture of furniture	17
20	Other manufacturing	28
21	Mining and quarrying	3
22	Crop and animal production, hunting and related service activities	9
23	Water collection, treatment and supply	1
24	Sewerage	9
25	Waste collection, treatment and disposal activities; materials recovery	6

The study classified the released pollutants into: gaseous and fine particulate emissions, liquid emissions and solid emissions. These emissions were calculated and estimated based on the collected data and based on a transparent methodology.

The results show that most industrial activities do not appear to have the potential to produce large scale emissions or highly impacting emissions as these activities are using everyday materials and processes that are inherently safe. However, Five percent (5%) of the industries, such as the slaughterhouses, plastic industries and paints industries have shown a potential for releasing air and water pollutants that will lead to health effects and environmental impacts.

The sections below present and discuss the key results of the study.

Gaseous and Fine Particulate Emissions

Air annual emissions were estimated for all of surveyed facilities for the following five air pollutants: TSP, PM10, NOx, SO2 and VOC. The analysis results illustrate that air emissions do not appear to be a problem in most cases as emission volumes are relatively small and processes do not use high temperatures and pressures or highly toxic materials that may cause emissions of toxic materials.

Table 4.4 presents a summary of the emissions by pollutant as totals for the 600 industries surveyed. It illustrates that TSP is the most prevalent pollutant in Palestine as a whole for the 600 industries surveyed. Maps of annual emissions by pollutant and by governorate are shown in **Appendix 1**.

TABLE 4.4: AIR POLLUTION EMISSIONS

Sum of Annual Air Emissions (tonnes/year)				
TSP	**PM10**	**NOx**	**SO2**	**VOC**
6,341	3,749	317	18	2,395

Moreover, and according to the study result, the largest potential sources for air emissions appear to be from:

- Stone grinding/aggregate industry which dominates the particulate matter emissions (PM10)
- Landfills that release VOCs due to no gas management systems at the sites
- vehicular emissions due to older and poorly maintained models of cars (not estimated in this study – based on professional judgment);
- re-suspension of dust (release of PM10) from sidewalks or shoulders of roads due to unpaved sidewalks / shoulders;

Liquid Emissions

A limited number of contaminants from industries were estimated based on literature. These included Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), Oil and Grease (O&G), Chemical Oxygen Demand (COD) and phosphorus (P). The discharge of selected contaminants through treated or un-treated effluent were estimated for the 600 surveyed facilities. Maps of annual emissions by pollutant and by governorate are shown in **Appendix 2**.

The result shows that untreated wastewater releases appear to be a problem as they have the potential to cause groundwater/surface water contamination. The industries that release these waters include the poultry/meat processing; slaughterhouses; and wastewater treatment facilities.

Estimated ranges of total load from each sector, based on the 600 industries surveyed, are provided in **Table 4.5**.

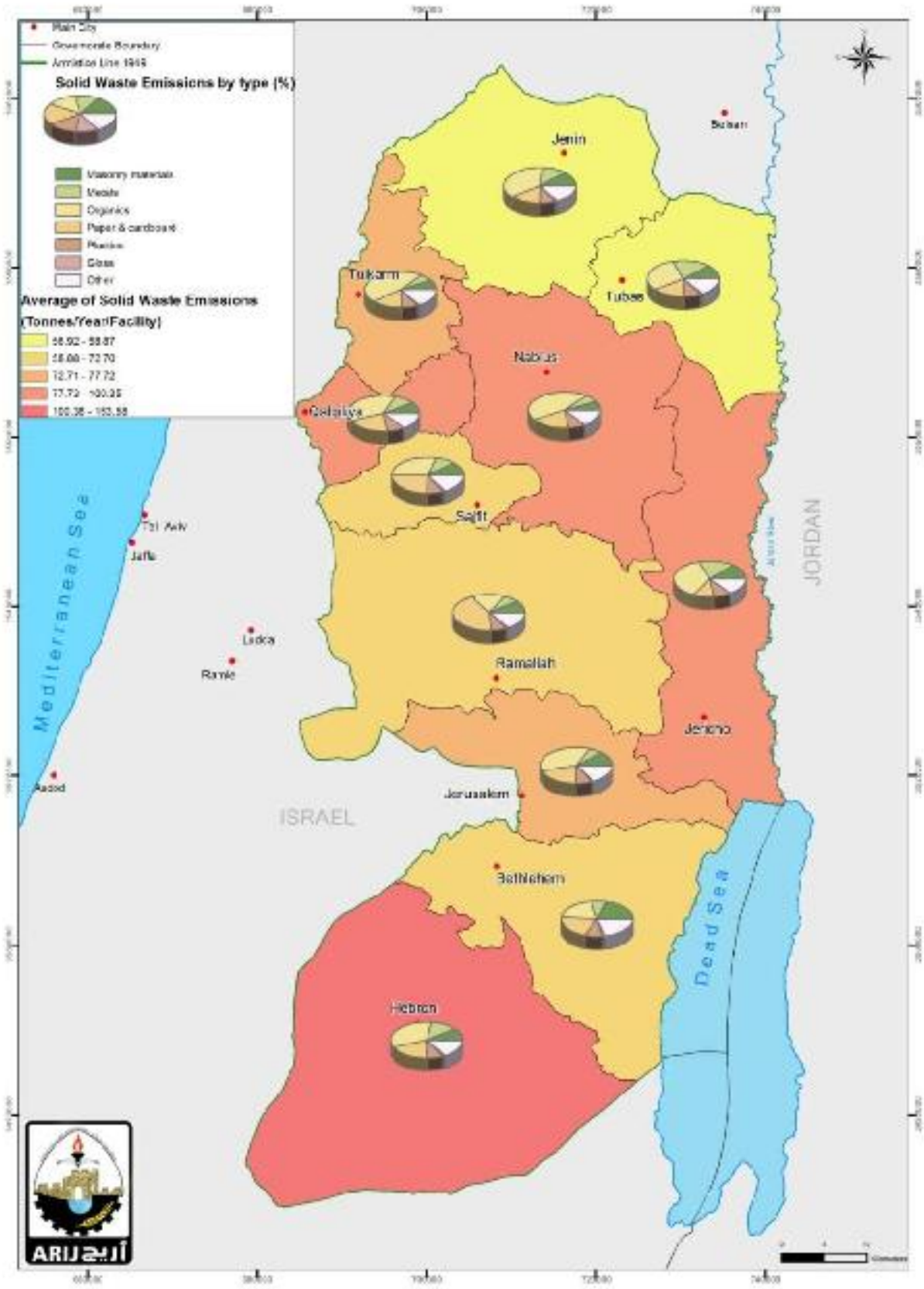
TABLE 4.5: ESTIMATED RANGES OF LOADS OF SELECTED CONTAMINANTS FOR DIFFERENT SECTORS

Sector	Total BOD (kg/month)	Total SS (kg/month)	Total O&G (kg/month)	Total COD (kg/month)	Total P (kg/month)
Food	2366-19358	1811-21406	683-11588	4153-32496	315-2004
Chemical	5409-14645	379-2089	65-629	40345-101013	19-347
Pharma	6-147	3-47	2-8	17-172	0.1-0.6
Metal	3756-7636	1955-3159	4249-4564	20710-21713	6133-6171
Mineral	7665-10654	15165-16093	3844-4121	9695-10467	8-82
Mining	395-432	788-799	198-201	495-504	0-0.2
Oil	104-237	44-86	998-1008	210-245	0.3-1
Paper	189-1907	90-623	45-178	494-938	7-16
Rubber	131-2234	99-753	59-249	276-997	5-36
Tannery	285-4728	478-5721	80-1104	1212-8845	1.6-7
Textile	37-1022	37-387	25-99	91-345	1.4-6.6
Water	0.1-1.9	0.1-0.6	0-0.2	0.2-0.6	0
Wood	76-2418	75-787	227-391	332-1821	3-15
Sewerage	34768-34858	34768-34796	9273-34774	34773-34796	2318-34765

Solid Emissions

The estimated and reported annual solid waste emissions for the surveyed industries were classified into seven categories: Masonry materials, Metals, Organics, Paper & cardboard, Plastics, Glass, and Other.

Map 4.2 presents a comparison of the average annual waste emissions per facility by governorate in the West Bank. It also shows for each governorate the percentage distribution of solid waste by type. The highest average annual waste per facility is found in Hebron Governorate.



MAP 4.2: AVERAGE ANNUAL SOLID WASTE EMISSIONS PER FACILITY AND BY TYPE

Industrial Hotspot

Several indicators including gaseous and fine particulate emission, liquid emissions and solid emissions were used to evaluate the impact of the pollutants released form the industrial facilities on the human health, environmental health and drinking water quality. Therefore, a comparative hotspot analysis was carried out based on United Nations Environment Program (UNEP) methodology (UNEP & WHO, 1999) and a hotspot grade calculation for each facility as the areas where potential impacts are expected from the industrial operation process. This grading system assigns low numbers for low polluting industries and higher numbers for polluting industries. **Appendix 3** provides the methodological steps of the technical guideline that was published by the UNEP.

The hotspot analysis results showed that a large number of facilities (131) have hotspot grades of 0 with more than 71% having hotspot grades less than 10. This indicates that the majority of Palestinian industries surveyed have little or no measurable environmental impacts.

Table 4.6 illustrates the distribution of hotspot grades across the facilities.

TABLE 4.6: DISTRIBUTION OF HOTSPOT RATINGS

Hotspot Grade	Number of Facilities	% of the total facilities number
0	131	21.7
0.1 – 5	117	19.5
6 – 10	182	30.2
11 – 15	85	14.1
16 – 20	56	9.3
21 – 25	25	4.2
>=26	6	1.0

Table 4.7 presents the results of the hotspot analysis by industry sector. The only shows the top five polluting industries. According to the hotspot grade, it can be noted that the industrial sectors of “Waste collection, treatment and disposal activities; materials recovery” and “Sewerage” have a potential of severe effects on health and environmental, impacts while the rest have a potential of major to moderate effects.

TABLE 4.7: ANALYSIS OF HOTSPOTS BY INDUSTRY SECTOR

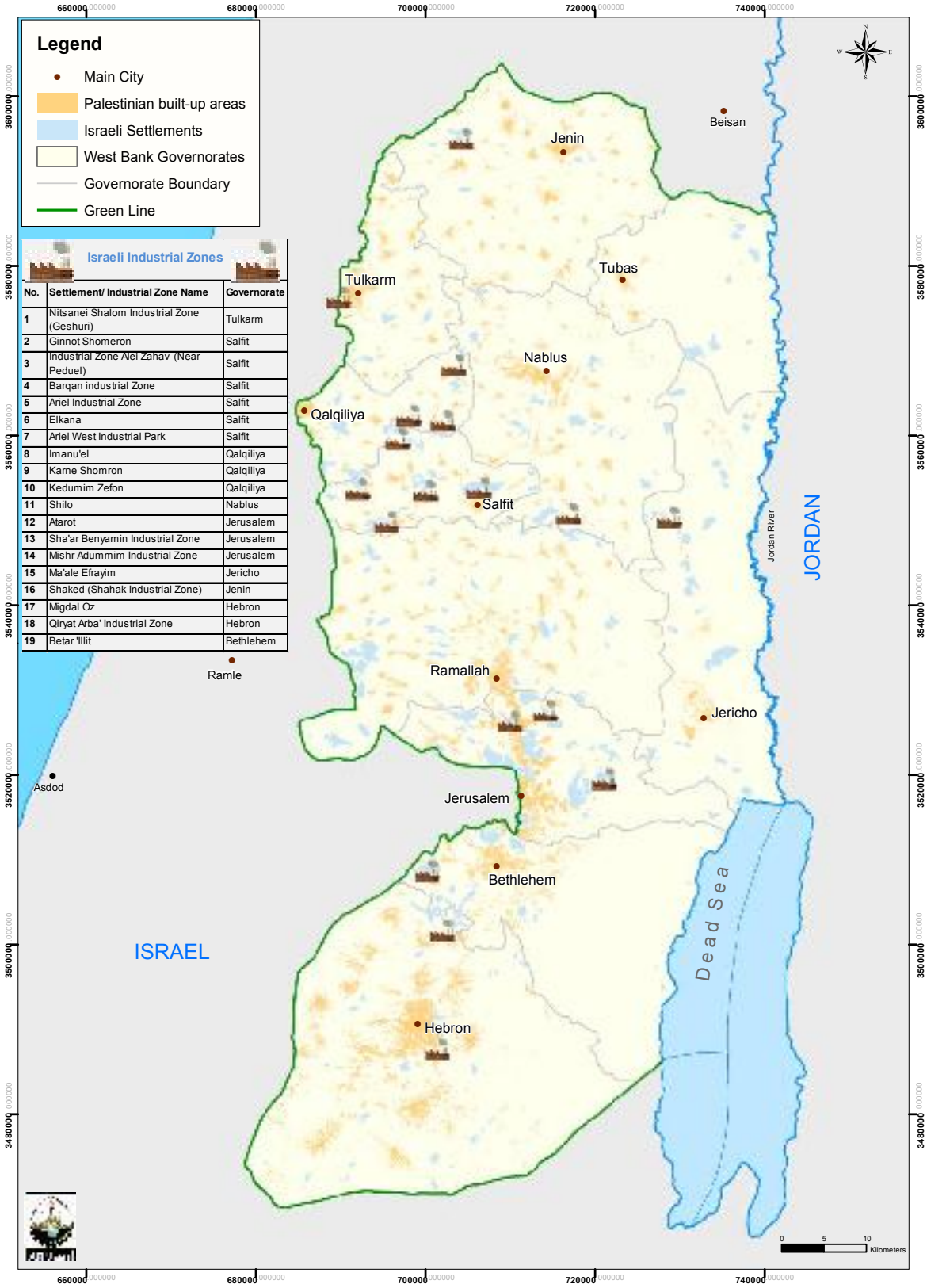
No.	Sector	Average Hotspot Grade
1	Waste collection, treatment and disposal activities; materials recovery	25
2	Sewerage	23
3	Manufacture of other non-metallic mineral products	17
4	Manufacture of rubber and plastics products	14
5	Manufacture of basic metals	13

4.4 Pollution from Israeli Industries

Many of the Israeli settlements in the West Bank have several polluting industries that produce hazardous wastes. At least, there are 19 Israeli industrial zones located within the West Bank (ARIJ, 2015a). These are located either inside residential settlements or near the settlement as a separated zone. **Map 4.3** shows the distribution of the industrial zones and their location inside the in the West Bank (ARIJ, 2015a). It is estimated that there are approximately 252 Israeli industrial facilities, ranging from small businesses to large factories inside the West Bank (WHOProfits, 2014b). Aluminum, leather-tanning, textile-dyeing, batteries, fiberglass, plastics and other chemicals are among the major Israeli industries. Wastes generated from these industries contain toxic elements, such as aluminum, chromium, lead, zinc and nickel. For example, the aluminum industry which is found in many Israeli settlements produces aluminum and acidic waste. Electroplating produces nickel, chrome and acidic waste. The battery industry produces lead in its wastewater. All of these heavy metals are considered hazardous to health if accumulated in the human body. Most of these industries discharge industrial wastewater and dispose solid wastes without any treatment in Palestinian lands in proximity to Palestinian residential areas causing environmental damage and health problems. Moreover, these industries emits huge amounts of smoke and fumes from burning hazardous wastes which cause many health risks.

A blatant example of Israeli violations of Palestinian Environmental laws is the case of Israeli industries in Salfit Governorate. It has 6 Israeli industrial zones within its boundary, two of them are large Israeli industrial zones in the West Bank, which are: Barqan industrial zone and Ariel industrial zone. The Barqan and Ariel industrial zones play a major role in polluting the Palestinian environment and in spreading diseases throughout the region. Since the year 1981 when Barqan industrial zone was established, and until today the Palestinians are suffering from the problem of discharging untreated wastewater from its factories onto Palestinian lands causing damage to the surrounding environment and to the public health (ARIJ, 2015c). According to a study that was conducted by ARIJ in the year 2001 that assessed the impacts of Barkan Industrial Park on the surrounding ecosystem and health, it was documented that the discharges industrial influent is causing diseases in the surrounding localities of Bruqin, Kafr ad Dik and Haris villages including but not limited to *Oxyuriasis, Amebiasis, Scabies, Herpes Sozter, Ascariasis, Giardiasis, and Leishm aniasis*. ARIJ documented 240 cases of these diseases in 2001 (ARIJ, 2001).

The policies adopted by the Israeli occupation ignored the Palestinian interest and violated the Palestinian environment. The Israeli Industrial settlements in the West Bank are attractive locations for many Israeli companies, because Israeli industries in the West Bank do not have to abide with the Israeli environmental laws and because of the inability of the Palestinians to enforcement their laws and regulations on Israeli industries. For this reason, Israel has transferred several of its polluting industries from places inside Israel to areas located in the West Bank. For example, in the year 1983 the polluting chemical factories that were built in Kfar Saba and Nethania were moved to an areas near Tulkarm city inside the West Bank, which was called later Nitsanei Shalom Industrial “Park”. This decision was taken after the Israeli residents living near these factories complained about the pollution, as they harm the environment and the human life (PENGON, 2012).



MAP 4.3: DISTRIBUTION OF THE ISRAELI INDUSTRIAL ZONES IN THE WEST BANK

The area of the Nitsanei Shalom Industrial "Park" is 150 dunums (ARIJ, 2015a). In addition to the confiscated land of the Palestinian, the industrial activities in this Park have a severe harmful effect on the health of the local communities (**Box 4.4**). For example, the noxious carcinogenic fumes from the chemical factories affect the health of the population. According to Tulkarm Municipality, respiratory problems and eye infections are the most commonly reported problems in the area, where there are more than 110 residential buildings located around these factories within 500 meters (ARIJ, 2015a).

Moreover, the industrial wastewater generated from the Park flows onto the Palestinian lands. These wastes have a high concentration of chemical materials leaching into the soil and groundwater resources in the area (**Photo 4.3**). According to ARIJ database, the area of degraded agricultural lands in proximity to this industrial zone was estimated at 200 dunums (ARIJ, 2015a). Furthermore, wind direction often carry air emissions from these industries into the West Bank, but when the winds change direction and carries the pollutants into Israel, the factories close down in order to ensure that the toxic fumes do not pollute the Israeli environment and do not harm the Israelis (Lorber, 2012).

PHOTO 4.3: INDUSTRIAL WASTEWATER GENERATED FROM THE NITSANEI SHALOM INDUSTRIAL ZONE

While the Palestinian are suffering from the harmful effects of the Israeli industrial zones, Israel continues to build new factories and expanding their industrial zones in the West Bank. In 2014, four new factories have been added to the Israeli industrial zone in Jerusalem Governorate (Sha'ar Binyamin) (LRC, 2014). In 2015, six new factories were built in Barqan industrial zone (LRC, 2015). Moreover, a new facility for solid waste treatment was opened last June in 'Atarot industrial zone (Kurzum, 2015). The facility will separate and recycle all type of wastes, where about half of the Jerusalem wastes will be separated and treated there (Kurzum, 2015).

BOX 4.4: NITSANEI SHALOM INDUSTRIAL PARK

Nitsanei Shalom Industrial "Park" which means *"Sprouts of Peace"* was built in the mid- eighties to the west of Tulkarm city. It lies on the border separating Israel from the West bank, located on the Palestinian side of the segregation wall, and is surrounded by an internal wall separating it from Tulkarm city, where there is a small iron gate allows the Arab worker to enter there.

"Keshet Prima" which manufactures chemicals for construction, and food additives for animals, was the first factory that was built in Nitsanei Shalom industrial zone and is owned by Geshuri family. For this reason, the zone is known as "Geshuri industrial zone". Originally, it (Geshuri factory) was located in Kfar Saba and it was shut by an Israeli court order in the year 1982 for pollution violations. In the year 1987, it was re-opened in Tulkarm.

Later, gradually other factories joined the first factory in the area, until the number of the factories reaches about 12 factories. **Table 4.8** lists some of the factories that are located in the industrial zone and describing their main activities (http://www.whoprofits.org/s?vid_7=1903).

TABLE 4.8: FACTORIES LOCATED IN NITSANEI SHALOM INDUSTRIAL ZONE

Company	Description
Atzei Shitim	Manufactures and rebuilds wood surfaces using recycled wood.
Keshet Prima (Geshuri Advanced Technologies & Geshuri and Sons Industries)	Manufactures chemicals for construction, and food additives for animals. Produces fertilizer mixes, chemicals for agriculture, construction and industry.
Hatehof	Manufactures specialized vehicles and specialized large metal constructions. Including: armored vehicles for military use, Riot control trucks, special fueling vehicles for military purposes.
Lotar	Imports and markets threads for the textile industry, supplies knitting services and knitted cloths.
Nitzanei Shalom Paper Industries	Manufacture and market disposable paper and nylon products to restaurants, to the catering and food industry. Presently probably inactive, and the space used by the company of Tal El Collection and Recycling.
Shai Key Metal Trade	The company collects, sorts and sells scrap metal.
Tal El Collection and Recycling	Specializes in waste collection, mainly paper, cardboard and plastics; shredding services; the transport, storage and supply of paper waste.
The Solor Group	A private holding group. Solor Gas Industries, of the group, manufactures petrol and LPG tanks and pressurized air tanks and provides heavy metal work, as well as logistical services.
Yamit Filtration and Water Treatment (Formerly: Yamit E.L.I.)	The company develops, designs and produces water treatment, waste-water treatment and filtration devices for industry, agriculture and private users.

It should be noted that the Israeli industrial activities in Palestine add further pressure on the Palestinian environment, as they do not apply the Israeli environmental law or the Palestinian law and dispose of the generated industrial waste without any treatment in nearby Palestinian lands.

BOX 4.5: GREEN HOUSE GASES (GHG) EMISSION INVENTORY

Lately, the EQA has made efforts to reduce the emissions released from many resources to the environment. Progress has been brought about through setting laws, empowering institutional frameworks and implementing projects by local or international institution with the support and cooperation of the EQA. In this context, a report of the Green House Gases (GHG) Emission Inventory is being prepared by international consultants and in cooperation with the EQA. The primary results of the report show that the emissions from the illegal Israeli settlement are greater than the released emissions from the whole Palestine. The report indicated that the Israeli control on the natural sources limits the Palestinians' ability to implement the national plans that aim to reduce the emissions.

The most important result reached by the report is that the overall emissions released in Palestine, which is estimated at 0.8 tons CO_2 equivalent per capita. This figure is very low when compared to what is released from other countries, where it is estimated at 5.1 in Jordan, 10.7 in Israel, 17 in the United States and 44 in Qatar. It is important to mention that the final version of the report will be finalized next mid-year (EQA, 2015).

4.5 Quarries

The quarrying and stone industry constitutes the largest manufacturing activity in Palestine, and it also plays an important role in supporting the Palestinian economy as it contributes about 25% of the industrial sector revenues and 4.5% of GDP (http://www.usm-pal.ps/en-all/industry/index.php).

According to the Union Of Stone & Marble in Palestine (USM), there are approximately 20,000 dunums of quarries in Palestine with more than half located in Area C (USM, 2011a). There are approximately 300 quarries and 1,000 stone cutting factory and workshop (USM, 2011a) distributed all over the West Bank, with concentrations in the areas of Hebron, Bethlehem, Ramallah and Nablus Governorates (**Map 4.4**). The Hebron Governorate has the largest quarries with (40-50)% of the total quarries area. The Governorates of Bethlehem, Nablus, Ramallah and Jenin, each have (10-20)% of the total area. It is estimated that approximately 75% of quarries products are exported to Israel (USM, 2011b). In Gaza Strip there are no quarries, while there are only a very small number of stone factories.

Despite the importance of this sector, it can be considered one of the industrial sectors that negatively affects the Palestinian environment. Stone quarries are often associated with reduction of tree cover, degradation of productive agricultural land, with adverse consequences on ecosystem services and the biodiversity of the area. The huge amount of stone that is being quarried has left a scar on the topography of the land. Quarrying processes produce large amounts of dust into the air. This dust severely damages the natural ecosystems and agricultural lands productivity when the dust settles on agricultural crops and trees. Moreover, quarries have a distinctive visual feature which produces major changes in the topographic structure of the land.

62% of the area of quarries are in Areas A and B, these are owned by Palestinians and licensed by the PNA. This remaining 38% of the quarries' area are in area C and are not licensed by the PNA. Before the Oslo agreement in 1994, Quarries located in area C were issued permits to operate, but later no new licenses have been issued by the Israeli Civil Administration, and only few permits have been renewed. The quarries located in area C continued operating without permits though but are subjected

to confiscations of equipment by the Israel Defense Forces (IDF) and their owners were often subjected tofines and threats of imprisonment (USM, 2011a).

Over the decades of occupation, Israel has exploited the Palestinian natural recourses to meet its needs. In addition to the stones taken from the Palestinian quarries, they also confiscate Palestinian land to establish Israeli quarries. The Israeli extensive quarrying activities in the West Bank caused the damage of landscapes and affected the health of Palestinians.

According to the research center "Who Profit", currently, there are nine Israeli operating quarries in the West Bank (**Map 4.4**) occupying an area of 3,388 dunums of land (ARIJ, 2015a). The largest Israeli quarry is located in the Governorate of Hebron, occupying an area of 650 dunums of land. The land confiscated for this quarry belongs to Edh dhahiriya city. Besides there are two quarries occupying an area of 770 dunums of Edh dhahiriya lands (ARIJ, 2015a).

Another four Israeli sites that are not operating anymore are: Barqan industrial zone and quarriesnear the settlement of Tzofim, the settlement of Modi'in Illit and near the city of Magdal Bani Fadel in Nablus. The following table (**Table 4.9**) provides a brief description of the operating Israeli quarries in the West Bank.

TABLE 4.9: LIST OF THE ISRAELI QUARRIES IN THE WEST BANK

Israeli Quarry	Area (dunum)	Governorate	Land confiscated from	Description of lacation
Yatir Quarry	174.4	Hebron	Edh dhahiriya	South of Edh dhahiriya city and west of the Teneh Omarim settlement
Meitarim Quarry		Hebron	Edh dhahiriya	Close to the settlement of Teneh Omarim
Beit Hagai/ Lahav Quarry (Medan Quarry)	650.17	Hebron	Edh dhahiriya	Near the settlement of Eshkolot, close to the Green Line from its eastern side.
Adora/Trans-Judea Quarry	223.72	Hebron	Dura	Near the settlement of Adora
Salit Haadumim Quarrying and Factory for Stone Works	248.61	Jerusalem	'Anata	North of the Mishor Adumim industrial zone
Nahal Raba Quarry	570.99	Salfit	Zawiya	Near the settlement of Elkana
Natuf Quarry	322.67	Ramallah and Al Bireh	Shuqba – Shabtin – Ni'lin	Near Nili settlement.
Beitar Illit Quarry	179.12	Bethlehem	Husan - Nahhalin	In the area of the Beitar Illit settlement.
Kochav Hashahar Quarry	423.23	Ramallah and Al Bireh	Kafr Malik	Near the settlement of Kochav Hashahar

Source: (WHOProfits, 2014a)

MAP 4.4: QUARRIES IN THE WEST BANK

BOX 4.6: LEGALITY OF QUARRYING ACTIVITY IN THE WEST BANK

According to the Article 55 of the Hague Convention, the occupying country is only permitted to administer public buildings, real estate, forest and the agricultural estates of the state it is occupying. Also, it must safeguard the capital of these properties, and administer them in accordance with the rules of usufruct.

In 2011, Israel's High Court of Justice established a new rule legalizing quarrying in the West Bank by Israeli enterprises. This rule came after the rejection of a petition brought by an Israeli human rights organization "Yesh Din" against Israel and 10 Israeli companies operating quarries in the West Bank. The court justified that the Israeli quarries don't affect the natural resources of the West Bank, but they are providing employment to Palestinians (B'Tselem, 2012).

The petition claimed that the quarrying activities were illegal under the international law because it exploited the natural resources of the occupied territory for the benefit of the occupying power. Yesh Din's petition said that *"West Bank is executed through brutal economic exploitation of occupied territory for the needs of the state of Israel, the occupying power".* The court ruled that the existing Israeli quarries are allowed to continue operating, but no new quarries must open.

Accordingly, Israel is benefiting from the natural resources of the West Bank and neglecting the rights of the Palestinians in these resources, which is absolutely prohibited under the international law.

4.6 Conclusion

The improper management of the solid, liquid and gaseous emissions released from the industrial facilities has adversely affected Palestinian environment. Furthermore, the ignorance of the Palestinian environment by the Israeli Authorities has resulted in destruction of environmental resources.

The Israeli factories and industrial zones located in the West Bank are contributing in polluting the Palestinian environment. The generated wastewater from the industrial zones flows towards the Palestinian lands located at the foothills of these industrial zones, the generated solid waste is dumped near and into the Palestinian lands without any treatment. All these practices result in damaging the water resources and soil, as well as polluting the air and affecting human health.

Palestinian legislations and laws to protect the environment and the standards and regulations to control the disposal of industrial and hazardous wastes exist or have been drafted and waiting ratification. Enforcement of environmental laws however does not meet expectations. It is essential to train an environmental police to monitor and enforce the laws and standards. There is a clear need for establishing adequate monitoring system to tackle the emission released from industries to air, water and soil thus the pollution levels can be identified. Moreover, it is important to formulate regulations to reduce emissions from industries.

Moreover, controlling pollution from the industries is essential, and this can be done through adopting policies that minimize the emissions. These include using renewable energy sources; adopting "best practices" to limit and control emissions from industrial facilities; treating the generated industrial wastewater; prohibiting open burning of solid waste generated from the facilities; recycling kinds of wastes; among other practices.

5. THE IMPACT OF CLIMATIC VARIABILITY AND CHANGE ON THE ENVIRONMENT

5.1 Introduction

Weather describes the conditions of the atmosphere at a certain place and time with reference to temperature, pressure, humidity, wind, and other key meteorological elements. Climate is the statistical description (average, variability, frequency, magnitude, persistence, trends, etc.) of atmospheric conditions over a period of time ranging from months to thousands or millions of years. The World Meteorological Organization classically averaged atmospheric conditions over a period of 30 years to describe the state of the climate (Stocker et al., 2013).

According to Intergovernmental Panel on Climate Change (Stocker et al., 2013), Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.

There is unequivocal evidence based on direct measurements and remote sensing from satellites and other platforms of changes in the climate system. Many of the observed changes are unprecedented over decades to millennia. Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. Almost the entire globe has experienced surface warming (Stocker et al., 2013) including the Eastern Mediterranean region (Stocker et al., 2013). It is also virtually certain that globally the troposphere has warmed since the mid-20th century. Over the period 1901 to 2010, global mean sea level rose by 0.19 [0.17 to 0.21] m and the rate of global mean sea level rise has continued to increase since the early 20th century. The rate of global averaged sea level rise was 3.2 mm yr^{-1} between 1993 and 2010 which is consistent with the sum of the observed contributions from ocean thermal expansion due to warming (1.1 [0.8 to 1.4] $mm.yr^{-1}$), from changes in glaciers (0.76 [0.39 to 1.13] $mm.yr^{-1}$), Greenland ice sheet (0.33 [0.25 to 0.41] $mm.yr^{-1}$), Antarctic ice sheet (0.27 [0.16 to 0.38] $mm.yr^{-1}$), and land water storage (0.38 [0.26 to 0.49] $mm.yr^{-1}$).

The drivers of climate change are **natural** and **anthropogenic** substances and processes that alter the Earth's energy budget. The strength of drivers is quantified as Radiative Forcing (RF) in units watts per square meter ($W.m^{-2}$). Radiative forcing (RF) is a measure of the net change in the energy balance of the Earth system in response to some external perturbation, with positive RF leading to a warming and negative RF to a cooling.

Anthropogenic substances and processes have changed and continue to change the Earth's surface and atmospheric composition. Some of these changes have a direct or indirect impact on the energy balance of the Earth. Anthropogenic emissions have driven the changes in well-mixed greenhouse gas (WMGHG) concentrations. The atmospheric concentrations of the greenhouse gases carbon dioxide (CO_2), methane (CH4), and nitrous oxide (N_2O) have all increased since 1750 due to human activity. In 2011 the concentrations of these greenhouse gases were 391 ppm, 1803 ppb, and 324 ppb, and exceeded the pre-industrial levels by about 40%, 150%, and 20%, respectively. Concentrations of CO_2, CH_4, and N_2O now substantially exceed the highest concentrations recorded in ice cores during the past 800,000 years. The RF from emissions of WMGHGs (CO_2, CH_4, N_2O, and Halocarbons) for

2011 relative to 1750 was 3.00 [2.22 to 3.78] $W.m^{-2}$ (RF of CO_2 was 1.68 $W.m^{-2}$; CH_4 0.97 $W.m^{-2}$; N_2O 0.17 $W.m^{-2}$; and halocarbons 0.18 $W.m^{-2}$).

The short-lived greenhouse gases (SLGHG) also contribute to anthropogenic forcings. Emissions of carbon monoxide (CO) and Non-methane volatile organic compounds (NMVOCs) are virtually certain to have induced a positive RF [0.33 $W.m^{-2}$], while emissions of nitrogen oxides (NOx) are likely to have induced a net negative RF [-0.15 $W.m^{-2}$].

Aerosols (e.g. mineral dust, Sulphate, Nitrate, Organic Carbon, and Black Carbon) and their interactions with clouds have offset a substantial portion of global mean forcing from well-mixed and short-lived greenhouse gases. The RF of the total aerosol effect in the atmosphere was -0.9 [-1.9 to -0.1] Wm^{-2}. Radiative forcings from changes in land cover and land use have also contributed in offsetting a portion of global mean forcing from well-mixed and short-lived greenhouse gases. Anthropogenic land use changes such as deforestation have increased the land surface albedo, which leads to an RF of –0.15 [–0.25 to –0.05] $W.m^{-2}$. The net anthropogenic radiative forcing of climate between 1750 and 2011 was therefore 2.29 [1.13 to 3.33] $W.m^{-2}$ compared to 1.25 [0.46 to 1.86] $W.m^{-2}$ in 1980 and 0.57 [0.29 to 0.85] $W.m^{-2}$ in 1950.

Since the 1850s, **natural** contributors to global climate change were mainly solar and volcanic forcings. Total solar irradiance (TSI) changes since 1978 show quasi-periodic cyclical variation with a period of roughly 11 years. The recent solar minimum appears to have been unusually low and long-lasting. This resulted a negative (cooling effect) but small solar RF change of –0.04 [–0.08 to 0.00] $W\ m^{-2}$ between the most recent (2008) minimum and the 1986 minimum. Volcanic eruptions, on the other hand, inject both mineral particles and sulphate aerosol precursors into the atmosphere. Sulphate aerosol precursors sometimes result in very large negative RF. Mt Pinatubo eruption in 1991 caused a 1-year RF of about –3.0 $W.m^{-2}$. Since 1991, several smaller eruptions have caused an RF averaged over the years 2008–2011 of –0.11 [–0.15 to –0.08] $W.m^{-2}$. Natural forcing changes over the last 15 years have likely offset a substantial fraction (at least 30%) of the anthropogenic forcing increase during this period. The positive net radiative forcing has created a small positive energy imbalance that has served to increase the global heat content of the earth system (Hansen, Sato, Kharecha, & Schuckmann, 2011; Murphy et al., 2009). More than 90% of the excess energy absorbed by the climate system since at least the 1970s has been stored in the oceans. From the deep oceans to the top of the troposphere, the evidence of warmer air and oceans, of melting ice and rising seas all points unequivocally to one thing: the world has warmed since the late 19th century.

5.2 Observed and projected climate change in the Eastern Mediterranean and Palestine

In the Eastern Mediterranean, surface air temperature data 1901-2012 from three global data sets (HadCRUT4, GISS and NCDC MLOST) indicate a positive trend 0.09[0.07-0.11] °C/ decade. Since the 1980s, positive trends in annual mean temperature in the region exceeded the global mean. In recent decades, upward surface temperature trends in Palestine were notable and robust (Pinhas Alpert, Krichak, Shafir, Haim, & Osetinsky, 2008; AlSarmi & Washington, 2011; Tanarhte, Hadjinicolaou, & Lelieveld, 2012). Shohami et al. (2011) analyzed the trends of station weather data (1964-2003) for daily minimum, mean, and maximum temperature. Highly significant positive trends in station temperature were evident especially for the summer season. Significant positive trends were found in

minimum daily temperature (0.2–0.9°C/decade), in mean daily temperature (0.2–1.0°C/decade) and in maximum daily temperature (0.3–0.7°C/decade). Moreover, mean daily temperature showed a steeper trend from the 1980s onward of1.3°C/decade (Shohami, Dayan, & Morin, 2011).

Temperature data for 1964 to 2011 from Jerusalem weather station (31.86 °N, 35.16 °E) shows a positive trend in mean annual temperature (**Figure 5.1**). It also shows significant annual variability over the 47 year period with temperature peaks observed every 8-10 years. Following a peak, the temperature cycle follows a pattern by gradually dropping, stabilizing and then peaking again. The highest annual temperature recorded in this period was 19.3ºC in 2010, and the lowest annual temperature was 16.1ºC in 1967. The calculated trend-line indicates an overall increase since 1964.

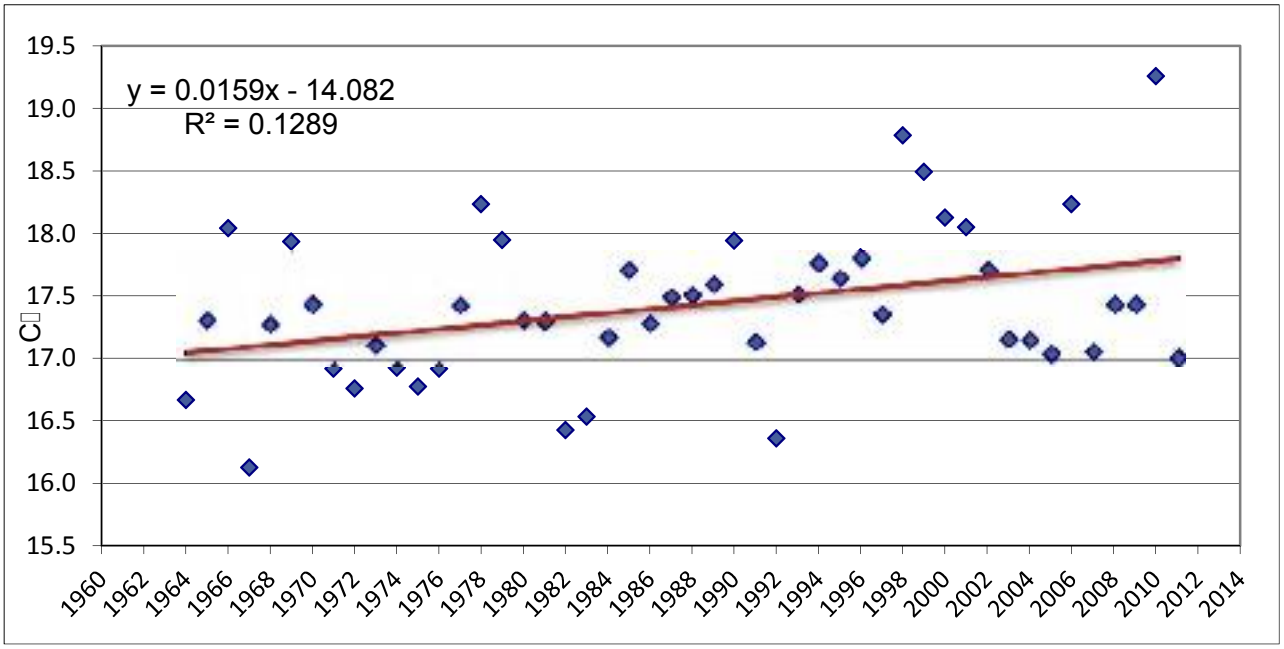


FIGURE 5.1: MEAN ANNUAL TEMPERATURE (1964-2011)

The Coordinated Modelling Intercomparison Project Phase 5 (CMIP5) results suggest that future summer warming over the Eastern Mediterranean (EM) will likely be more intense than winter warming and that the length, frequency or intensity of warm spells or heat waves are very likely to increase throughout the whole region. Observations from weather stations data support the findings of the CMIP5 modeling studies (Ben-Gai, Bitan, Manes, Alpert, & Rubin, 1998; Kafle & Bruins, 2009). Similarly and consistent with CMIP5 results, weather station data point to an increase of the number of warm days and nights, and decrease of the number of cold days and nights.

Analysis of Hadley Centre Sea Ice and Sea Surface Temperature (SST) data in the Eastern Mediterranean showed positive trends of 0.3°C/decade during the summer and the autumn seasons. The analysis of the Kfar-Blum station (33.5N, 34.5E to the North East of Tyre, Lebanon) sea surface temperature data, revealed however, stronger sea surface temperature warming since the 1980s (1.0-1.2°C/decade(Shohami et al., 2011). The same study also reported warming trends during winter months but these trends were not found to be statistically significant.

While the different studies agree on the temperature increase during summer, the reported changes relating to precipitation over the EM are less coherent, diverse in their findings, and the derived statistical trends, in spite of showing overall reduction in annual precipitation, are often declared as statistically insignificant (P Alpert et al., 2002; Ben-Gai et al., 1998; Yosefl, Saaroni, & Alpert, 2009). It is possible however that a multi-decadal drying trend was masked by the high variability in rainfall (Ziv, Saaroni, Pargament, Harpaz, & Alpert, 2014) especially by rainfall increases towards the early 1990s. Seasonal analysis of rainfall trends in Ziv et al. (2014) revealed a significant decreasing trend in rainfall during the spring season with an average rate of 15%/decade since the 1970s. This decrease and the decrease in the autumn precipitation, while insignificant, imply a shortening of the rainy season. Since the 1970s, the length of the rainy season showed a negative trend of 4 days/decade and the dry spells became longer (Ziv et al., 2014).

Hoerling et al. (2012) found a change in wintertime Mediterranean precipitation toward drier conditions for the period 1902–2010. They stated that the observed wintertime Mediterranean drying over the last century can be understood in a simple framework of the region's sensitivity to a uniform global ocean warming and to modest changes in the ocean's zonal and meridional SST gradient. According to their simulations, for a 0.5 °C SST warming confined to tropical latitudes only, a dry signal spanning the entire Mediterranean region occurs. The simulated Mediterranean drying intensifies further when the Indian Ocean is warmed 0.5 °C more than the remaining tropical oceans; an enhanced drying signal attributable to a distinctive atmospheric circulation response resembling the positive phase of the North Atlantic Oscillation (NOA).

The International Panel on Climate Change CMIP5 model projections for this century indicate reductions in winter precipitation. The modeled projected decrease in mean precipitation is due to northward shift in extra-tropical cyclones (Stocker et al., 2013) associated with the positive phase of the North Atlantic Oscillation (NAO) and wintertime blocking in the Euro-Atlantic sector. Blocking is associated with persistent, slow-moving high-pressure systems that interrupt the prevailing westerly winds of middle and high latitudes and the normal eastward progression of extra-tropical storm systems. Recent multi-model studies of NAO (E. HORI, Nohara, & L. TANAKA, 2007; Gillett & Fyfe, 2013; Karpechko, 2010; Yali & Huijun, 2010); reconfirm the small positive response of boreal winter NAO indices to GHG forcing noted in earlier studies (Kuzmina et al., 2005; Miller et al., 2010). This increases the likelihood of a shift in Extra Tropical Cyclones (ETCs) tracks north of the Eastern Mediterranean. Similarly, recent downscaling results (Dai, 2011; Evans, 2009; Jin, Kitoh, & Alpert, 2010) suggest that the Eastern Mediterranean will experience a decrease in precipitation during the rainy season due to a northward displacement of the storm tracks.

However, the various interacting dynamical influences on precipitation of the region (that models have varying success in capturing in the current climate) result in uncertainty in the magnitude of future precipitation change. In addition to the influences of the NAO and wintertime blocking, the region is at the fringes of the influence of different drivers of European, Asian and African climates. Price et al. (1998) and Ziv et al. (2014) showed a significant correlation between El-Nino years and rainy seasons. Alpert et al. (2004) associated the marginal increase in precipitation in southern Palestine with an increase in the frequency of occurrence of Red Sea Trough (RST) synoptic systems. The frequencies of RST, during 1970–2000 were doubled from 54 to 108. The RST is a low-pressure tongue extending from the southern Red Sea to the EM. This could be the reason for the general decreasing precipitation

trend in the north and higher rainfall amounts in some areas in the south. Kutiel & Paz (1998), (Kutiel & Benaroch (2002), Krichak et al. (2002), and Yosefl et al. (2009) found the rainfall in the Eastern Mediterranean to be significantly associated with the Mediterranean Index (MOI,(Conte, Giuffrida, & Tedesco, 1989)), the North-Sea Caspian-Sea Pattern (NCP), and the East-Atlantic–Western-Russia (EA-WR) large scale oscillations.

In summary, there is high confidence in model projections of mean temperature increases in this region. The CMIP5 results suggest that it is very likely that temperatures will continue to increase throughout the 21st century over the Eastern Mediterranean. It is likely that summer warming will be more intense than winter warming and that the length, frequency, and/or intensity of warm spells or heat waves will increase throughout the whole region. There is medium confidence in an annual mean precipitation decrease in the Eastern Mediterranean and, paradoxically, an increase in extreme rainfall events in spite of the decrease in rainfall totals thus suggesting longer drought periods. Furthermore, intra-seasonal variation in rainfall is expected to become more extreme, with fewer, but more intense rainfall events within the season. Likewise, inter-annual variation in rainfall is also expected to increase, with very wet years alternating with longer multi-annual droughts.

5.3 Magnitude of projected climate change in the Eastern Mediterranean and Palestine

The magnitude of projected changes in the climate of the Eastern Mediterranean is influenced by future emissions or concentrations of greenhouse gases, aerosols, and other climate variables. The scientific community has defined a set of four new scenarios, denoted Representative Concentration Pathways (RCPs). The RCPs are identified by their approximate total radiative forcing in year 2100 relative to 1750: 2.6 W m-2 for RCP2.6, 4.5 W m-2 for RCP4.5, 6.0 W m-2 for RCP6.0, and 8.5 W m-2 for RCP8.5. The RCPs represent a range of 21st century climate policies; a mitigation scenario leading to a very low forcing level (RCP2.6), two stabilization scenarios (RCP4.5 and RCP6), and one scenario with very high greenhouse gas emissions (RCP8.5).

CMIP 5 model results of future temperature change relative to 1986-2005 reference period project a further temperature increase for the RCP4.5 scenario of 0.5-1°C by 2035; 1.5-2°C by 2065; and 2-2.5°C by 2100. The annual and summer months CMIP5 multi-model mean time series of temperature change relative to 1986–2005 averaged over land grid points in the Mediterranean (30°N to 45°N, 10°W to 40°E) is shown in **Figure 5.2**.

The CMIP5 model projections for this century are for further reduction in annual precipitation in the Eastern Mediterranean (**Figure 5.3**). Recent downscaling results suggest average reductions of 50 mm in rainfall for the period 2031-2060 compared to the climatological period 1961-1990 (G Smiatek, Kunstmann, & Heckl, 2011). In the same period, downscaling results also suggest that rainfall in the areas to the North of Palestine contributing to water flow in the Jordan River headwaters will also suffer reductions in rainfall and the magnitude of these reductions might exceed 75 mm/year (G Smiatek et al., 2011). Terink et al. (2013) statistically downscaled an ensemble run of nine CMIP3 GCM results produced using the SERES A1B GHG emission scenario, which is a scenario of one of the four IPCC 2007 scenario families. Compared to current climate, the downscaled data suggest a further average reduction in precipitation [20 mm ± 17 mm] during the period 2040-2050. Forced with B2 GHG emission scenario, Önol & HM Semazzi (2009) reported simulated change in winter precipitation 2071–2100

relative to 1961–1990 for Palestine of −23.7% and for Jordan of −29%. While most global and dynamically and statistically downscaled models project future decreases in precipitation in Palestine due to global climate change, it should be noted that the various interacting dynamical influences on precipitation of the region (that models have varying success in capturing) results in uncertainty in the magnitude of future precipitation change.

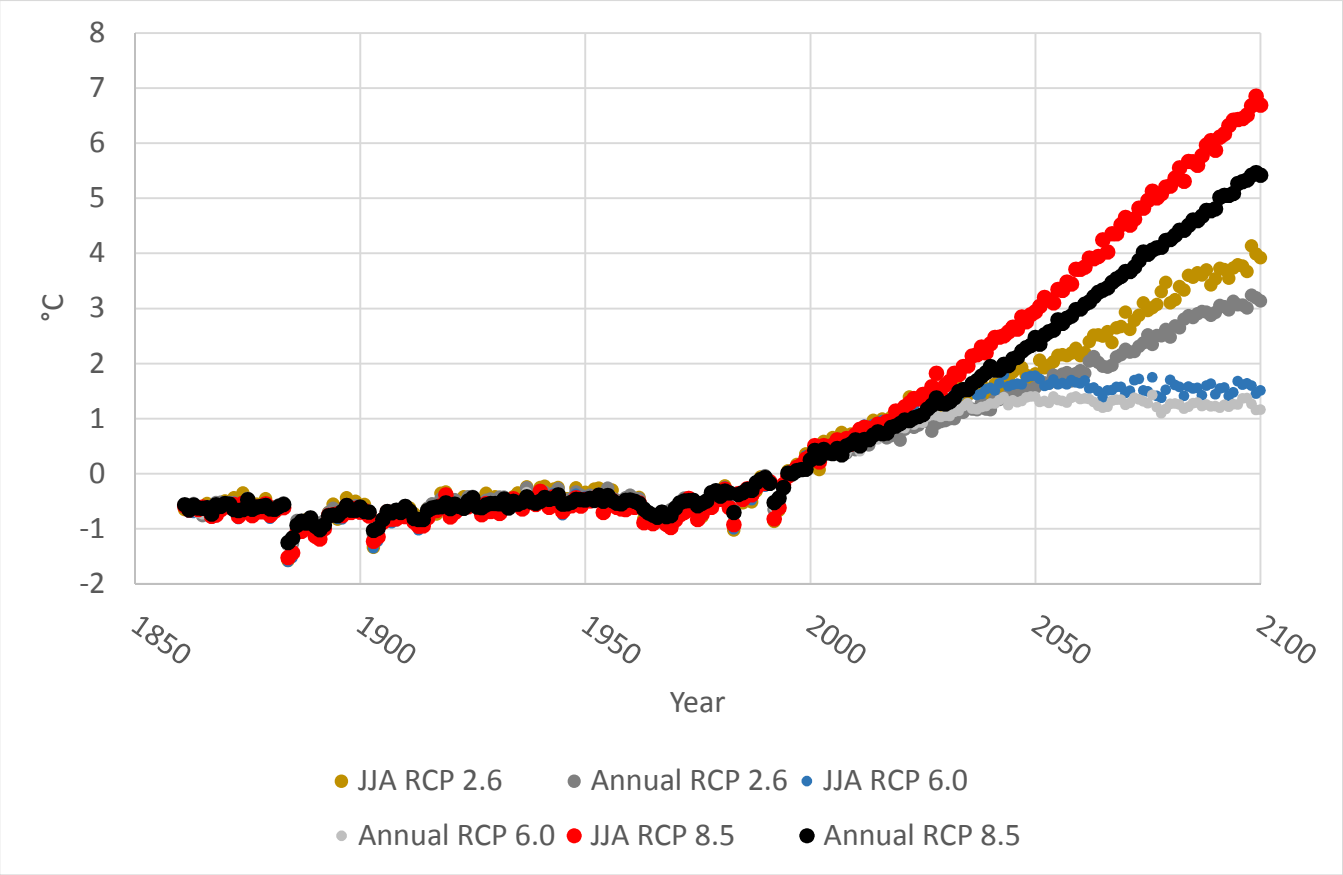


FIGURE 5.2: CMIP5 MULTI-MODEL MEAN TIME SERIES OF TEMPERATURE CHANGE RELATIVE TO 1986–2005 AVERAGED OVER LAND GRID POINTS IN THE MEDITERRANEAN (30°N TO 45°N, 10°W TO 40°E) IN THE SUMMER MONTHS JUNE-JULY-AUGUST (JJA) AND THE ANNUAL AVERAGE. MODEL PROJECTIONS FOR 2100 SUGGEST A SUMMER 7 °C INCREASE FOR THE RCP 8.5 SCENARIO, AND A SUMMER 4 °C INCREASE FOR THE RCP 6.0 SCENARIO. FOR THE RCP 2.6 SCENARIO, TEMPERATURES ARE PROJECTED TO CONTINUE INCREASING UNTIL THE YEAR 2050 (+2 °C) FOLLOWED BY NO SIGNIFICANT CHANGES FOR THE PERIOD 2050-2100. ***DATA SOURCE: CMIP5; IPCC 2014.***

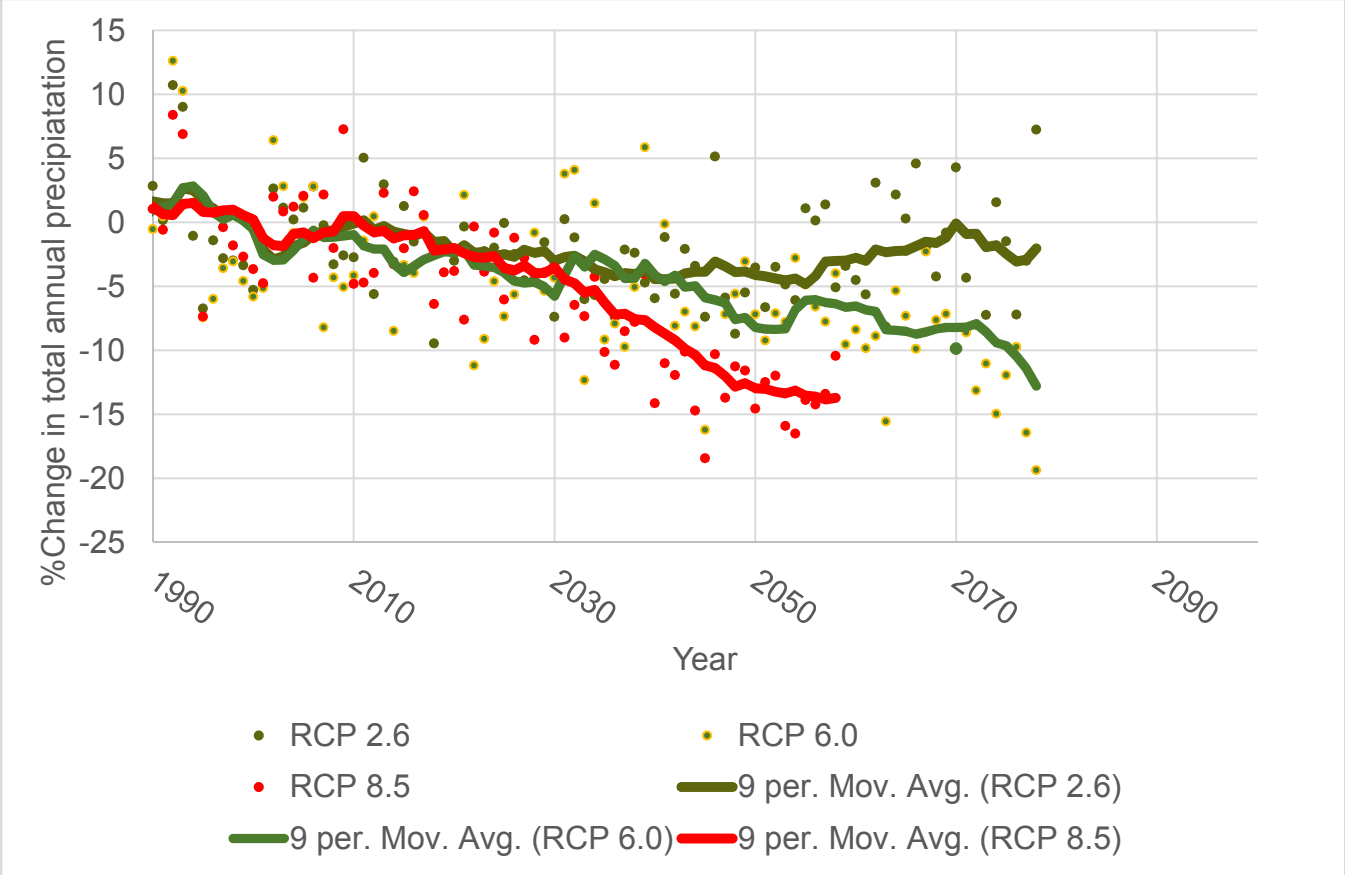


FIGURE 5.3: CMIP5 MULTI-MODEL MEAN ANNUAL TIME SERIES OF PRECIPITATION CHANGE RELATIVE TO 1986–2005 AVERAGED OVER LAND GRID POINTS IN THE MEDITERRANEAN (30°N TO 45°N, 10°W TO 40°E). MODEL PROJECTIONS FOR 2100 SUGGEST A 15% PRECIPITATION DECREASE FOR THE RCP 8.5 SCENARIO, AND AN ANNUAL 10-13% DECREASE FOR THE RCP 6.0 SCENARIO. FOR THE RCP 2.6 SCENARIO, ANNUAL PRECIPITATION VALUES ARE PROJECTED TO CONTINUE DECREASING UNTIL THE YEAR 2050 -5%) FOLLOWED BY FOLLOWED BY A MODEST RECOVERY FOR THE PERIOD 2050-2100. DATA SOURCE: CMIP5; IPCC 2014.

5.4 Impacts of projected climate change in the Eastern Mediterranean and Palestine

5.4.1 IMPACTS ON REFERENCE EVAPOTRANSPIRATION (ETref)

Since the Eastern Mediterranean is a primary climate change "hot spot", there is concern about the future state of the environment and societal consequences (Field, Barros, Mach, & Mastrandrea, 2014; Giorgi, 2006). Compared to the reference period 2000-2009, Terink et al. (2013) reported a potential increase in reference evapotranspiration (ET*ref*) in Palestine of 25 mm/yr [10 mm/yr – 35 mm/yr] by 2030 and of 60 mm/yr [50 mm/yr – 75 mm/yr] by 2050. The change in ET*ref* gives an indication of possible changes in water stress. Higher ET*ref* will enhance the actual water transpired by vegetation and the actual water evaporated from soils thus decreasing groundwater recharge and surface water runoff. Since precipitation is also projected to decrease, the increase in ET*ref* (associated with higher temperatures and a reduction in specific humidity) mean that water stress will become an even more severe problem in the future. The winter months of December, January and February are projected to show a relatively small change in ET*ref*, but a significant decrease in precipitation. The spring months of March through May are projected to show reductions in precipitation and an increase in ET*ref* reducing water availability and increasing water demand. The largest increases in ET*ref* are expected

in the summer months of June to September thus increasing water demand especially for irrigated agriculture.

5.4.2 IMPACTS ON SURFACE RUNOFF AND GROUNDWATER RECHARGE

The impacts of projected future climate change on surface runoff are exemplified in a study by (Peleg, Shamir, Georgakakos, & Morin, 2015). Peleg et al. (2015) modeled the impacts of climate change on the hydrological regime for two watersheds in the region for the RCP4.5 and RCP8.5 scenarios. They found that a reduction in rainfall by 15% and 18% would respectively result in a reduction in mean annual streamflow volumes by 45% and 47%. The amplification in reduction of streamflow volumes relative to rainfall amounts is related to the projected reduction in soil moisture which results from fewer rainfall events and longer dry spells between rainfall events during the wet season. This amplification event is evident in streamflow estimations under the current climate. For instance, total annual stream runoff volumes in Wadi Fara'h during the dry year 1998/1999 was estimated at 5.84 MCM compared to 14.32 MCM during the wet year1991/1992 (Gunkel, Shadeed, Hartmann, Wagener, & Lange, 2015). Based on these data, it is highly likely that the projected reduction in precipitation will almost half the average annual total water runoff volumes in the ephemeral streams of the West Bank thus reducing the potential of available runoff water from 196 MCM/yr to less than 100 MCM/yr by the year 2100.

Surface runoff in the Upper Jordan River (UJR) Catchments of the Dan, Hasbani, and Banyas are also projected to decrease. (Gerhard Smiatek & Kunstmann, 2015) used meteorology input from five dynamical downscaling experiments EURO-CORDEX and MED-CORDEX applying the RCP4.5 scenario. They performed hydrological simulations using the physically based distributed hydrological model WaSiM. The applied CORDEX models revealed increasing annual mean temperatures, 1.8 K above the 1971–2000 mean and 2.6 K higher for 2071–2100. The simulated ensemble mean precipitation projected an average reduction by 16.7% for 2031–60 and 22.1% reduction at the end of the century with the highest reductions -30% occurring in the spring season. Related to the 1976–2000 mean value, the discharge of the UJR was simulated to decrease by 7.4% for 2031–60 and by 17.5% for 2071–2100. Note that these results were obtained using the RCP4.5 scenario. The two higher GHG emission scenarios RCP6.0 and the RCP8.5 scenarios will most likely result in higher reductions in precipitation in the Dan, Hasbani, and Banyas and therefore will also most likely result in further reduction in water flow in the UJR. For instance, regional downscaling experiments in Alpert, Krichak et al. (2008) and Samuels et al. (2011) indicate possible reduction in precipitation of 30% by then of the century.

Climate change also influences groundwater systems both directly through replenishment by recharge and indirectly through changes in groundwater use. Over time, recharge is strongly influenced by climate variability — including climate extremes (droughts and floods). However, Land-surface models (LSMs), embedded in GCMs and RCMs, have neglected hydrological processes below the root zone such as deep percolation and lateral groundwater flow. While there has been recent attempts to couple more complete groundwater models to LSMs (Kollet & Maxwell, 2008), such models have not been employed yet to evaluate potential impacts of climate change on groundwater recharge for the groundwater aquifer systems in Palestine. Despite the lack of model simulations, it is likely that the projected reduction in precipitation along with higher interannual and intra-annual precipitation variability (e.g. long droughts and intensification of rainfall events) will, overall, reduce groundwater

recharge (R Samuels, Smiatek, Krichak, Kunstmann, & Alpert, 2011; Rana Samuels, Rimmer, & Alpert, 2009) while increasing interannual variability in groundwater recharge rates.

Historical data on precipitation and spring discharge provide further support to the argument in Samuels, R., et al. (2009). **Figure 5.4** relates total annual rainfall to the quantity of water that is discharged from springs. Below average annual precipitation resulted in significant reductions in spring discharge. Reductions in spring water discharge indicate lowering of the groundwater table especially when abstraction rates exceed recharge rates.

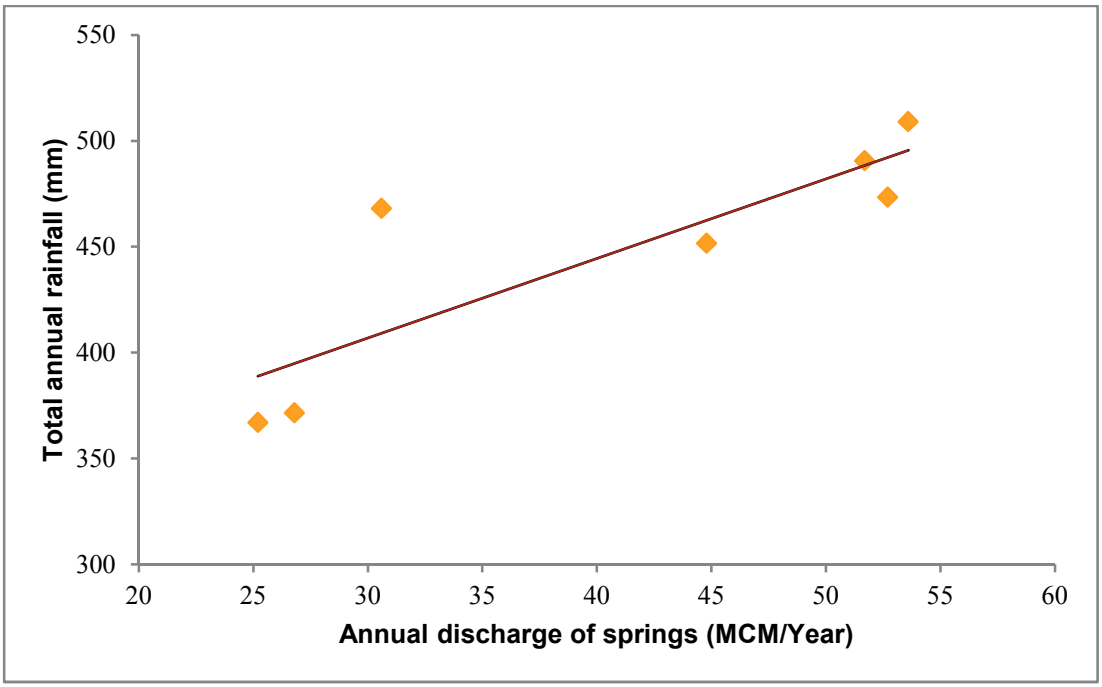


FIGURE 5.4: CLIMATIC VARIABILITY COMPARED TO THE ANNUAL DISCHARGE OF SPRINGS

5.4.3 IMPACTS OF CLIMATE CHANGE ON BIODIVERSITY

In general, the impacts of climate change on biodiversity include ongoing deterioration of freshwater habitats, decline of shrubland and woodland areas, and increased frequency and severity of forest fires. For the Mediterranean Sea, observations and modeling results predict further introduction and establishment of invasive species from the Red Sea and negative impacts on deep sea biota in the eastern Mediterranean due to dramatic changes in its hydrology associated with changes in temperature, salinity, stratification, and circulation of water masses (the Eastern Mediterranean Transient (EMT)).

Heat stress in the eastern Mediterranean Sea was found to trigger diseases at sea. Recent extreme temperature events are likely to have disturbed the normal functioning of biological systems. The taxonomic groups affected by such disease outbreaks are mostly sponges and corals, a high proportion of which are endemic to the Mediterranean, and some commercial and key species. For instance, several *Vibrio* strains isolated from necrosed gorgonian tissues were proven to induce tissue necrosis in experimental conditions at a rather high temperature. The introduction, spread and increased virulence of various pathogenic *Vibrio* strains might have been promoted by climate warming. The increase in atmospheric CO_2 levels, on the other hand, leads to seawater acidification, which may harm calcareous phytoplankton, such as coccolithophores (Coll et al., 2010), and other important primary

producers including macroalgae and sea grasses (Einav & Israel, 2007; Israel, Einav, & Seckbach, 2010).

Dorman, Svoray, Perevolotsky, & Sarris (2013), Dorman, Svoray, & Perevolotsky (2013) and Siegal, Tsoar & Karnieli (2013) documented several cases of desiccation and mortality of shrubs and trees in the last decade due to the high frequency of drought years. Anderegg, Kane, & Anderegg (2013) and Vicente-Serrano, Zouber, Lasanta, & Pueyo (2012) suggested that the increased frequency of consecutive dry years associated with climate change is likely to threaten the oak populations and other woodland species in the sub-humid Mediterranean. Desiccation-induced mortality of woody plants and increased frequency of forest fires may affect functioning of the entire ecosystem and provision of ecosystem services, including the water regime, pest and air quality regulation, soil erosion, primary productivity, carbon sequestration, and nutrient cycling (Anderegg, Kane, & Anderegg, 2013).

The biological diversity and ecosystem functions of the transition zones between the desert and the Mediterranean climates are often identified as the most susceptible to climate change impacts because they are rich in species and constitute the distribution limit of many species, which may disappear due to climate change (Pe'er & Safriel, 2000). Another highly susceptible system is the lentic system particularly temporary aquatic habitats where a shortened hydro-period is predicted to affect rare amphibian and crustacean species. In general, species with high habitat specificity will disappear and be replaced by more tolerant species, native or invasive.

5.4.4 IMPACTS OF CLIMATE CHANGE ON THE AGRICULTURAL SECTOR

Negative impacts of climate trends on crop and terrestrial food production have been more common than positive ones. Studies have documented a large negative sensitivity of crop yields to extreme daytime temperatures. These sensitivities have been identified for several crops and regions and exist throughout the growing season. In addition to heat stress, drought stress resulting from the combined effects of high temperatures, reduced precipitation and higher ETref will reduce crop productivity of major crops (wheat, barely, corn) with strong adverse effects on regional, national, and household livelihood and food security (Field et al., 2014).

Furthermore, Emissions of GHGs often are accompanied by ozone (O_3) precursors that have driven a rise in tropospheric O_3 that harms crop yields (Morgan et al., 2006; Mills et al., 2007). Elevated O_3 since preindustrial times has very likely suppressed production of major crops compared to what they would have been without O_3 increases, with estimated losses of roughly 10% for wheat and 3 to 5% for maize. Further changes in climate and CO_2 concentration will enhance the distribution and increase the competitiveness of agronomically important and invasive weeds making their control progressively more difficult.

Nevo et al. (2012) sampled 10 wild emmer wheat (Triticum dicoccoides) populations and 10 wild barley (Hordeum spontaneum) populations in Palestine and Israel in 1980 and again in 2008. They performed phenotypic and genotypic analyses on the collected samples and found profound adaptive changes of these wild cereals over the last 28 y in flowering time and simple sequence repeat allelic turnover. These included earlier flowering time and depletion of regulatory genetic diversity. The general depletion of regulatory genetic diversity may lead to deterioration of environmental adaptation. Furthermore, earliness in flowering time reduces reproductive success and has a major impact on grain yield and therefore is a red light that may result in the future extinction of these wild crop relatives.

Climate change impacts on wild-crop relatives necessitates the continuous efforts for in situ and ex situ conservation of these important genetic resources for future crop improvement.

Not all climate change trends result in negative impacts on crops and crop yields. For instance, significant reductions in frost occurrence since 1961 have been observed and attributed to greenhouse gas (GHG) emissions in nearly every region of the world reducing the probability of occurrence of frost damage to several important high-value crops. In addition, increase of atmospheric CO_2 by greater than 100 ppm since preindustrial times has enhanced water use efficiency and yields, especially for C_3 crops, although these benefits played a minor role in driving overall yield trends.

There have been several periods of rapid food and cereal price increases following climate extremes in key producing regions, indicating a sensitivity of current markets to climate extremes, among other factors (Field et al., 2014). Future climate change projections suggest, in addition to reductions in major crop yields, more frequent and severe region-specific occurrences of climate extremes such as heat waves, drought episodes, and intense rainfall events. Based on historic trends, these are expected to increase the frequency of periods of rapid food and cereal price increases thus increasing food insecurity and malnutrition especially amongst the least developed nations.

5.4.5 OTHER ADVERSE IMPACTS OF CLIMATE CHANGE

Other possible adverse impacts of climate change in Eastern Mediterranean region include:

- Changes in the incidence and geographic range of vector- and water-borne diseases due to changes in the mean and variability of temperature and precipitation, particularly along the edges of their distribution.
- Increased economic losses and people affected by extreme heat events with major impacts on health (increased risk of heat related mortality) and well-being, labor productivity, air quality, and increasing risk of wildfires.
- Higher home and workspace cooling energy consumption and costs. Worldwide power consumption for air conditioning alone is forecast to surge 33-fold by 2100 as developing world incomes rise and urbanization advances. Demand for air conditioning and refrigeration is growing so fast that it threatens to smash pledges and targets for global warming.

5.5 Adaptation Measures to Climate Change

There is a long record of practices to adapt to the impacts of climate change as well as natural climate variability on seasonal to interannual time-scales. These include proactive measures such as crop and livelihood diversification, seasonal climate forecasting, community-based disaster risk reduction, famine early warning systems, insurance, water storage, supplementary irrigation and so on. They also include reactive or ex-poste adaptations, for example, emergency response, and disaster recovery. The reactive approach however is often inefficient and could be particularly unsuccessful in addressing irreversible damages, such as species extinction or unrecoverable ecosystem damages.

Studies of impacts of climate change on biodiversity strongly argue for a rethinking of protected areas networks and of the importance of the habitat matrix outside of protected areas as a key to migration and long-term survival of species. The Palestinian Environmental Quality Authority is currently mapping areas rich in biological diversity in order to delineate a new set of protected areas. It is important to include protected corridors connecting the protected areas to allow for the Western and North-Eastern

migration of species. It should be noted however that, in the long term, some habitat types may disappear entirely due to climate change. Climates are projected to occur in the future that at least in some features do not represent climates that existed in the past. The impacts of habitat change on species abundance and extinction risk are difficult to evaluate because at least some species are able to adapt to novel habitats. The uncertainty in habitat specificity is one reason why quantitative projection of changes in extinction rates is difficult. Studies on species' habitat specificity and evaluations of extinction risks under different climate change scenarios are necessary for the proper design of protected area network that can potentially minimize the risks of extinction.

A societal consequence to climate change is the susceptibility to food insecurity and depletion of farmers' productive assets following multiple crop failures. The development of affordable crop failure insurance markets can provide a safety net to the Palestinian farmers. Index-based weather insurance is considered well suited to the agricultural sector in developing countries. The mechanism allows risk to be shared across communities, with costs spread over time. It can be integrated with other strategies such as microfinance and social protection programs. In addition, insurance policies can be risk-based premiums that encourage adaptive responses and foster risk awareness and risk reduction by providing financial incentives to policyholders to reduce their risk profile.

Investments in agricultural adaptation represent a cost-effective mitigation strategy: (1) Low- and no-till practices reduce soil erosion and runoff, protect crops from extreme precipitation, retain soil moisture, reduce biogenic and geogenic greenhouse gas emissions, and build soil organic carbon; (2) Planting legumes and weed management on pastures enhance both forage productivity and soil carbon sequestration; (3) Shade perennials increase soil moisture retention and contribute to local cooling; (4) crop diversification mediates the impacts of climate and market shocks and enhances management flexibility; (5) changes in diets and in farm buildings as well as targeted genetic improvement programs are needed to reduce the risk of cattle mortality during breeding; (6) in-situ and ex-situ conservation of wild crop and wild forage varieties is essential to preserve the genetic resources especially of the Mediterranean populations to breed more temperature and drought resilient crops and better adapted forage plant material for livestock production; (7) Epidemiological surveillance and increased coordinated regional monitoring and control programs of disease and vector outbreaks to reduce the incidence of vector-borne human and animal diseases.

Adaptation of freshwater resources to climate change can be identified as developing adaptive and integrated water resource management balancing water availability against increasing demand, in order to cope with uncertainty and change. Examples of adaptation options include: (1) developing water saving technologies in irrigation (e.g. drip and sub-surface drip irrigation); (2) water infrastructure development (e.g. surface water harvesting); (3) increasing water use efficiency and water productivity (e.g. by crop breeding); (4) changing cropping systems and patterns (adapting the crop calendar to the changing climate); and water reuse (e.g. municipal treated wastewater).

Other important adaptation mechanisms include: brackish and sea water desalinization; conservation agriculture and climate smart agro-ecology; food storage and preservation facilities; hazard and vulnerability mapping and monitoring; crop failure early warning systems; building insulation to increase energy savings in buildings (Building codes & practices); mechanical and passive cooling; diversifying water resources; and Transport and road infrastructure improvements.

In Palestine, a number of mechanisms have been established to facilitate proactive adaptation to climate change and to seasonal to inter-annual climate variability. These include adaptation measures in agriculture, wastewater management, water resource management, and food security. Examples of adaptation initiatives to present and future climate risks include: 1) the expanded use of traditional rainwater harvesting and water conserving techniques such as eyebrow terraces (**Photo 5.1**), contour bench terraces (**Photo 5.2**), cisterns as well as other macro and micro water harvesting techniques for supplementing agricultural water supply; 2) improve the resilience of rangelands by monitoring and controlling the number of grazing animals, introducing drought resistant plant species, and soil improvement; 3) improve water use efficiency by introducing water-saving irrigation technological solutions such as integral pressure compensating drip irrigation systems (**Photo 5.3**); 4) treatment and reuse of wastewater in irrigating fodder crops and fruit trees; and 5) small-medium scale desalination of brackish and sea water. However, these adaptation actions remain sporadic and are not framed within a national strategy. Therefore, there is an urgent need to develop a national strategy and action plans for climate change adaptation. The Environmental Quality Authority, using a participatory approach, is currently developing the Palestinian National Strategy for Climate Change Adaptation. At the same time, the National Committee for Climate Change has been reactivated and is currently drafting the first National Report on Climate Change.

PHOTO 5.1: RAIN WATER HARVESTING EYEBROW TERRACES. (PHOTO COURTESY ARIJ)

PHOTO 5.2: RAIN WATER HARVESTING CONTOUR BENCH TERRACES (PHOTO COURTESY ARIJ)

PHOTO 5.3: INTEGRAL PRESSURE COMPENSATING DRIP IRRIGATION SYSTEMS REDUCE WATER LOSSES BY APPLYING EQUAL AMOUNT OF WATER FOR EACH PLANT DESPITE THE DIFFERENCES IN WATER PRESSURE ACROSS THE FIELD. (PHOTO COURTESY ARIJ)

6. BIODIVERSITY IN THE STATE OF PALESTINE

6.1 Introduction

Palestine is known for its great wealth of biodiversity resources in terms of the number of species, ecosystems, and landscapes surviving there. Although considered small in terms of landmass, Palestine displays a wide variation in elevation, geology, climate leading to a broad range of habitats, which is reflected in a high diversity of plants and animals (ARIJ, 2007b). It lies at a bio-geographic crossroads between the European, Asian and African continents, the Mediterranean and Red Seas and a number of botanical zones. This bio-geographic convergence is reflected in the region's high biodiversity value. As well as a center of wild plant biodiversity, the region is also an historic center of crop diversity and cultivation, highlighting the importance of its agro-biodiversity.

Palestine is comprised of five main agro-ecological zones: the Jordan Valley, the Eastern Slopes, the Central Highlands and the Semi-coastal Plain (West Bank), and the Coastal Plain (Gaza Strip) (**Appendix 4**). Accordingly, the vegetation cover in the Palestine consists of a variety of plant formations, ranging from dense forests to thin patches of desert herbs, passing through different forms of woodland, such as maquis, garrigue and batha (**Appendix 5**). The presence of such a variable plant formation indicates the diverse genetic background that they possess.

Palestine inhabits 2076 species, whereby 1959 species in 115 families are growing in the West Bank and 1290 species in 105 families are growing in Gaza strip; of which 117 species are growing only in Gaza Strip. The most dominant families in the West Bank area are the Papilionaceae with 202 species, Compositae with 201 species, Graminae with 198 species, Cruciferae with 103 species. In addition, the most dominant families in the Gaza Strip area are Papilionaceae with 176 species, Graminae with 138, Compositae with 137 species, (**Figure 6.1**) (ARIJ, 2007b).

The families' composition and distribution differ from one geographical area to another since the ecosystems are different, however the highest number of species growing the West Bank and Gaza are those classified under Papilionaceae, Compositae and Graminae families. In addition, there are 16 families that grow in the West Bank but not in the Gaza strip such as Pinaceae, Lauraceae, Cynomoriaceae, Plantanaceae, Moringaceae, Menispermaceae, etc. There are also 5 families that grow in the Gaza Strip but not in the West Bank: Hydrocharitaceae, Ohphioglossaceae, Nymphaeaceae, Lentibulariaceae, and Callitrichaceae (ARIJ, 2007b).

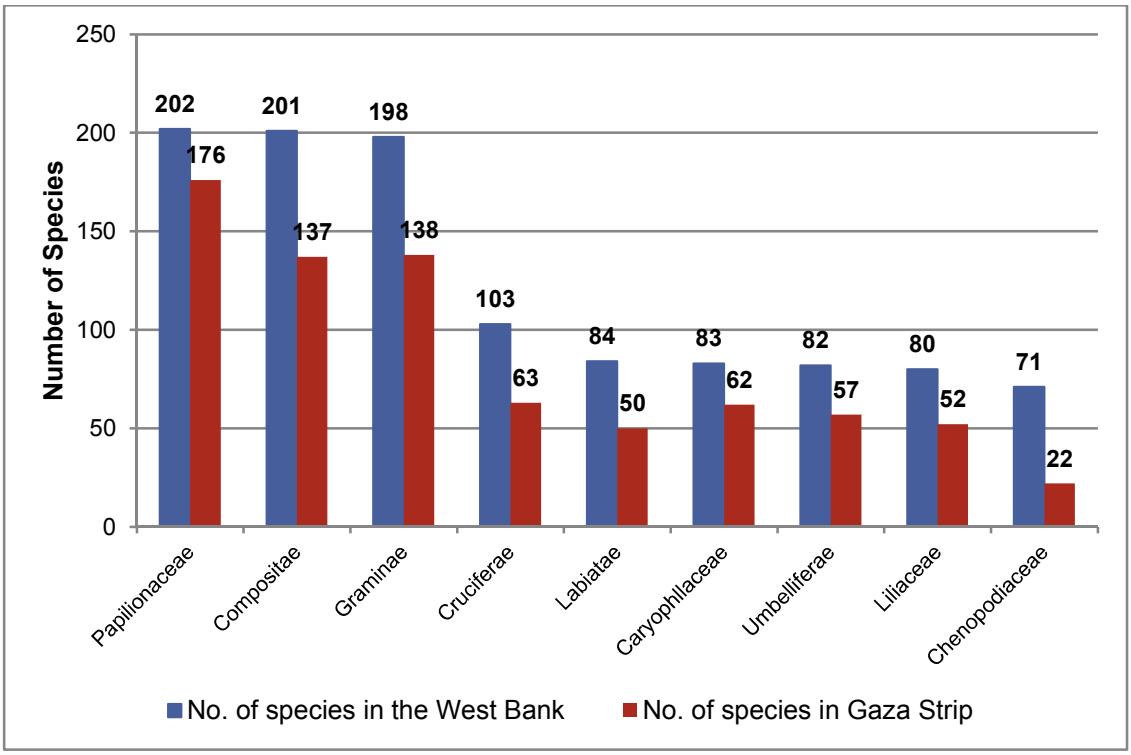


FIGURE 6.1: DOMINANT PLANT FAMILIES AND SPECIES INHABITING THE WEST BANK AND GAZA STRIP

As shown there are up to 102 endemic species of 28 families inhabit Palestine; forming 5% of total species in Palestine. There are additionally up to 92 endemic species of 26 families are growing in the West Bank (forming 4.7% of total species growing in the West Bank) and 30 endemic species of 18 families are growing in the Gaza Strip (forming 2.3% of total species growing in the Gaza Strip). Most of the endemic species growing in the West Bank belong to Compositae family. Most of the endemic species growing in the Gaza strip belong to Papilionaceae family. Examples of the endemic species growing in the West Bank are: *Capparis spinosa* (Capparaceae), *Iris haynei* (Iridaceae) (see **Photo 6.1**). *Suaeda palaestina* (Chenopodiaceae), *Origanum dayi* (Labiatae), and others. In addition, examples of endemic species growing in Gaza Strip are: *Erodium subintegrifolium* (Geraniaceae), *Iris atropurpurea* (Iridaceae), *Paronychia palaestina (Caryophyllaceae*), and others (ARIJ, 2007b).

PHOTO 6.1: PLANT SPECIES GROWING IN PALESTINE (*IRIS HAYNEI, CHRYSANTHEMUM CORONARIUM, CYCLAMEN PERSICUM* RESPECTIVELY). ARIJ PHOTO COURTESY

Fauna in Palestine, on the other hand, is of ecological, social and economic importance. Palestine has a vast variety of wildlife, since it is home for six main different groups of Fauna (**Table 6.1**); comprised of birds, mammals, reptiles, amphibians, fish, and invertebrates. The main zoogeographic origins of Palestinian mammals are: Palaearctic, Palaeotropic and Cosmopolitan.

TABLE 6.1: FAUNA SPECIES INHABITING PALESTINE IN NUMBERS

Fauna Species	Number
Birds	427
Mammals	92
Amphibians	7
Reptiles	81
Fish	297
Invertebrates	30,000
Total	**30,904**

According to checklist of the Birds of Palestine, which covers the last 155 years of birds in Palestine (1860 - 2015); up to 373 bird species where identified in Palestine; representing 22 Orders, 64 Families, 30 subfamilies and 186 genera. The largest order is PASSERIFORMES which consists of 22 families 6 subfamilies, 40 genera and 160 species. The second is CHARADRIIFORMES which consists of 10 families, 10 subfamilies, 26 genera and 67 species. The third is ACCIPITRIFORMES which consists of 2 families, 15 genera and 31 species. The largest family is Sylviidae which consist of 35 species. The second is Turdidae which consist of 32 species. The third is Accipitridae which consist of 30 species (Awad, Abu-Saada, Farhoud, & Khair, 2015).

There are 132 species of bird breeds in the State of Palestine, 52 species of which are considered as exclusively resident breeders (RB) including the three introduced breeder species (IB); namely: Rose-ringed Parakeet *(Psittacula krameri*), Common Myna (*Acridotheres tristis)* and Indian Silverbill (*Lonchura malabarica),* (These species spend the entire year within the borders of their breeding site with some seasonal dispersal). 38 species are considered as complex resident breeders, which are species with different categories of birding population, each exhibiting a different seasonal behavior. Further another 42 species are consider as complex summer breeders (Awad et al., 2015).

Sixteen of these breeding birds are threatened species, and their population are declining globally and locally. Four of those species are listed on the IUCN red list: the Egyptian Vulture (*Neophron percnopterus*) as an endangered species, Macqueen's Bustard *(Chlamydotis macqueenii)* as a vulnerable species, and the (European) Roller (*Coracias garrulus*) and Sooty Falcon *(Falco concolor)* as Near Threatened species (Awad et al., 2015).

There are 277 birds species that migrate through Palestine, 71 bird species of which are considered as exclusively Passage migrant (PM). These include a high percentage of the world population of Levant Sparrowhawk (*Accipiter brevipes*) pass along this flyway twice annually, along with Lesser Spotted Eagle (*Aquila pomarina*), (European) Honey Buzzard (*Pernis apivorus*), and Steppe Buzzard (*Buteo Vulpinus*). There are 127 species that migrate through and winter in Palestine. Also 194 species are considered a complex winter visitors (WV), 10 of which are considered exclusively winter visitors. 22 species are considered Accidental Visitors, or Vagrant (AV, V): These birds are accidental visitors to

Palestine; some of them are recorded rarely and unexpectedly while others are seen rarely but at predicted times. There are three invasive alien species; Rose-ringed Parakeet *(Psittacula krameri*), Common Myna (*Acridotheres tristis)* and Indian Silverbill (*Lonchura malabarica)* which will affect the other breeding bird species population and this need more study (Awad et al., 2015).

Mammals in Palestine represent the second largest class after birds. Up to 92 terrestrial species have been recorded in Palestine, belonging to 7 orders: Insectivora (example is Hedgehogs family), Chiroptera (examples is Pteropodidae family), Carnivora (example is Canidae family), Hyracoidea (example is Procaviidae family), Artiodactyla (example is Bovidae family), Lagomorpha (example is Leporidae family), and Rodentia (example is Sciurdae family) (Mendelssohn & Yom-Tov, 1999).

Amphibian and reptiles make up an important component of the Palestinian ecosystem. The amphibians are represented by 2 species in Palestine belonging to the order Urodela, and 5 species belonging to the order Anura. Recently, amphibian population is decreasing as a result of habitat loss, particularly swamps drainage. Reptiles are represented in Palestine by 81 species classified into three orders, Testudines (Turtles), Sauria (Lizards), and Ophidia (Snakes). The order Crocodila was extinct in Palestine in the beginning of the 20th century (ARIJ, 2007b).

Around 30,000 species of invertebrates have been estimated to occur in Palestine. Invertebrates vary from simple organisms such as sponges and flatworms to complex animals such as arthropods and mollusks. These diverse fauna of worms, butterflies, beetles, bees, ants, spiders and snails are considered of great direct or indirect importance to the ecosystem. Some are part of the food chain to other living organisms or an agent in different biotic processes.

Up to 297 species of fish are recorded in Palestine. Of these, 12 Freshwater species have been stated to occur in River Jordan and Inland water-bodies. Sixteen fish species from the Red Sea have become established in the Mediterranean Sea after migrating through Suez Canal, and around 186 species of Mediterranean Origin (PCBS, 2005). These fishes belong to around 22 Orders of the Classes Actinopterygii (ray-finned fish) and Elasmobranchii (skates, rays and sharks). The largest Order is the Perciformes which comprise fishes of both marine and freshwater.

The State of Palestine enjoys the diversity of ecosystem of which the forested areas are the most diverse; where both floral and faunal species are coexisting. Of the woodland derived types; forests and maquis are the most dominant types. The covered forested areas in the West Bank and the Gaza Strip, compromise 78.3 km^2-[12] (ARIJ, 2015a) and 1.76 km^2 respectively (ARIJ, 2008)[13]. Forests cover approximately 1.38% of the total area of the West Bank and 0.48% of the Gaza Strip (**Appendix 6**)[14]. Most of these forests are located on fertile soil types (*Terra Rossas*, Brown Rendzinas, and Pale Rendzinas) and in areas enjoying favorable climatic conditions for agriculture (ARIJ, 2015a).

[12] According to ARIJ-GIS Land Use/Land Cover analysis for West Bank 2010 (1.38% of total West Bank area). According to ARIJ-GIS Land Use/Land Cover analysis, 2008, the covered forested area formed 78.9 km^2 in the West Bank and thus the analysis shows a reduction of almost 1 km^2 in the forested areas in the West Bank between the year 2006 and 2010 (for more details see chapter Landscape).

[13] According to ARIJ-GIS Land Use/Land Cover analysis for Gaza 2005 (0.48% of total Gaza Strip area).

[14] The designated forested area in the West Bank and the Gaza Strip forms a larger area than covered forested areas, in which the designated forests covered 229.6 km^2, and 2 km^2 respectively according to ARIJ-GIS Land Use/Land Cover analysis 2007.

PHOTO 6.2: ANIMAL SPECIES INHABITING THE OPT (EGYPTIAN VULTURE, CHAMELEON, HEDGEHOG). ARIJ COURTESY

Maquis in Palestine is often in areas where the true forest has been previously destroyed, sometimes where just the larger trees have been removed. It can recover from burning, provided the area is not cleared by man or heavily grazed thereafter. Of the common maquis species are *Quercus calliprinos* (Oak), *Pistacia lentiscus* (Mastic tree, or Lentisc), *Ceratonia siliqua* (Carob), *Arbutus andrachne* (Eastern Strawberry Tree), *Pistacia palaestina* (Palestinian Pistachio), *Styrax officinalis* (Storax), *Crataegus azarolus* (Mediterranean Medlar) and *Prunus ursina* (Bear Plum) (Abu A'yash, Adel, et-al, 2007). Garrigue is also widespread in Palestine and is characterized by many aromatic small shrubs, colourful in flower. It is more open than maquis, allowing a great variety of smaller herbs to associate with the shrubs, and is richer in annuals, orchids and bulbs. Grazing by livestock especially sheep and goats, cutting of the large trees and bushes for fuel and charcoal, clearance for cultivation (especially for orchards and olive groves) and fires (both natural and man-induced to produce grazing land), all help to prevent large evergreen trees re-establishing and to promote the dwarf shrub communities. In a few areas where these elements have been eliminated the natural evergreen forest (sometimes called the primary maquis) can re-establish itself quite successfully.

These plant communities and associations that inhabit Palestine can be grouped and briefed into the following vegetal landscapes: Coniferous Forests Deciduous, Broad-leaved Oak Forests, Evergreen Park-Maquis (*Ceratonia siliqua*), Deciduous Steppe-Maquis and Steppe-Forests (*Pistachia atlantica, Crataegus azarolus*, and *Amygdalus communis*), Decicuous Thermophillous Scrub (Predominatly *Ziziphus lotus*), Halophytic Forests (*Tamarix spp.* and *Suaeda spp.*), Riparian Woods (*Salix spp.* and *Populus spp.*), Savannah Forest (tropical trees: *Ziziphus spina-christi, Moringa aptera* and *Salvadora persica*), Mediterranean Batha and Garrigue (*Cistus spp., Phlomis spp.,* and *Salvia spp.*), Dwarf Shrub Steppes (*Artemisia herba-alba, Noea mucronata*, and *Helianthemum spp.*), Leaf and Stem Succulent Dwarf Shrub Formation (*Salsola spp.* and *Atriplex spp*) and Rush and Reed Vegetation (Abu A'yash, Adel, et-al, 2007).

Natural, planted, and bare forests are the types of forests distinguished in Palestine. Natural forests form 79.1% of the total forested area in the West Bank, where most of them (85.3%) are located in the North-Eastern part of Tubas governorate. On the other hand, the planted forests cover 12.1% of total country forested area, being mostly concentrated in Hebron governorate (28.9% of total planted forests in the West Bank). Gaza includes only planted forests, which represent 0.9% of the total forests in Palestine (ARIJ, 2008).

PHOTO 6.3: NATURAL AND PLANTED FORESTS IN THE STATE OF PALESTINE (EZZ AL DEIN, UMM AT TUT, AL QARIN FORESTS, RESPECTIVELY)

A major reason behind the reluctance and slow rate of forestation is the relatively high investment (at least US$ 2,500-3,000 per hectare) and risks in terms of uprooting or overgrazing, which adds costs to the maintenance of such plants. In open areas, expansion in forestation is significant and sustainable only when implemented in marginal areas, which need reclamation. Forestation is economically unattractive and cannot withstand competition with other agricultural crops, even to those of low economic return in the short run. Reclamation of marginal areas and its forestation requires relatively high infrastructure rehabilitation, upgrading works and labor force training.

Despite the recent afforestation efforts, forests in Palestine are limited in areas and are not expected to be of significant commercial uses, at least not in the short or medium term. Annual wood production of natural forest ranges from 1.0 to 3.3 m^3 per hectare for Oak forests and around 4.3 m^3 per hectare for moderately dense Pine forests. Artificial planted pine forests grow on average 3 m^3 per hectare annually However, the annual growth rate of wood in natural forest like the one in Palestine amounts only to 0.2 m^3 per hectare, which is much less than the threshold for commercial forests (1m^3 per hectare) (Abu A'yash, Adel, et-al, 2007).

6.2 Legislation, Policies and Institutional set up

The Oslo I and II accords provided framework for the creation of institutional structures by the PNA (Palestinian National Authority), such as the Palestinian Legislative Council (PLC) as well as civil departments and ministries for many sectors; including the environment portfolio. As a result of the Oslo I and II accords, moreover, the Environmental Quality and several other ministries have been formed (the year 1996). Some of these ministries and authorities have environment- related tasks. Accordingly, ministries were requested to prepare subjects and elements of relevant policies, strategies and laws falling within their authorities.

Environmental legislation, policies and planning are the responsibility of the EQA in cooperation with other relevant ministerial bodies such as the Ministry of Planning and Ministry of Agriculture. Accordingly, EQA issued the Environmental Law in 1999, (finalized in 2003), the Palestinian Environmental Strategy (1999), and the National Biodiversity Strategy and Action Plan for Palestine (1999), the Gaza Coastal and Marine environment Protection and management Action Plan (2005). The Ministry of Agriculture (MoA) also finalized Agricultural law (2003), including forestry and rangeland sectors and the Palestinian Agro-biodiversity strategy, (2005). The Palestinian National Biodiversity and

Agro-biodiversity strategies and action plans are considered the basic legislations for the Biodiversity in Palestine.

It is worth mentioning that the national policies relevant to biodiversity conservation and environmental protection lack the adequate coverage of certain policies that cover integrated aspects of mainstreaming biodiversity conservation. Such aspects could be regulations related to species – specific and habitat-specific protection, natural heritage -specific and whether they meet with the international standards. In addition, specific regulatory tools and incentives to promote and reward conservation of the above-mentioned aspects are not well formulated within the national policies.

The state of Palestine has signed both the 'Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and their Disposal" and the "Convention of Biological Diversity" on the 2nd of April 2014. The UNFCCC, on the other hand, will enter into force for the State of Palestine on 17th of March 2016. Hence, EQA staff have already started communicating with partners to prepare for this full membership, mainly by reviewing laws and bylaws to make sure they are in alignment with the convention. For this purpose, In terms of biodiversity, the EQA is in the final stages of producing the 5th Annual Report on Biodiversity, which will be available soon. The EQA, in joint efforts with its partners, has determined 51 protected areas, which have been reflected in the National Spatial Plan. In addition, the EQA and its partners have classified another 51 areas as rich biodiversity areas, and the EQA is now in the final stages of fieldwork to evaluate those areas. Moreover, the Palestinian authorities still needed to work on the updating of the NBSAPP, the endorsement of the Environment bylaw, the National Report on Biosafety for Palestine and Climate Change 1st National Communications Report and others.

6.3 The Challenges and Opportunities of Conservation in the Palestinian Nature Reserves

At the 1992 Earth Summit, the governments of the world agreed on a new agenda for sustainable development. This agenda included a bold new Convention on Biological Diversity (CBD) which calls on governments to establish systems of protected areas and to manage these in order to support conservation, sustainable use, and equitable benefit sharing. The governments recognized nature reserves as economic institutions that have a key role to play in the alleviation of poverty and the maintenance of the global community's critical life-support systems.

Nature Reserves are places for people to get a sense of peace in a busy world places that invigorate the human spirit and challenge the senses. While protected landscapes embody important cultural values, some of them reflect the heritage value of countries, they are important for research and education, and they contribute significantly to local and regional economies, most obviously through tourism and recreation. The protection purposes are to house a diversity of plant and animal species in a delicate balance and in places where human influence is small, and to provide shelter, allow species to move freely, and ensure that natural processes can shape a landscape.

Well governed and effectively managed protected areas are a proven method for safeguarding both habitats and populations of species and for delivering important ecosystem services (Ervin, Mulongoy, & Lawrence, 2010). The Palestinian Nature Reserves (NRs) harbor a rich base with many species.

When applying the precautionary principle[15] for the analysis of Key Biodiversity Areas (KBA) on the Palestinian NRs, we find numbers of them identified as KBAs,[16] which highlights the outstanding biodiversity value that is represented by the Palestinian reserves[17]. Thousands of people are dependent, at least partially, on the resources and ecosystem services provided by the NRs, which underlines the importance of these areas as part of the environmental infrastructure of Palestine. Additionally, Palestinian NRs are important habitats for several species that are listed as endangered, or even critically endangered, at the global level on the Red List of Endangered Species of the International Union for the Conservation of Nature (IUCN).

The first nature reserves in Palestine were designated under the British Mandate 1917-1948. Additional NRs were declared under Israeli occupation, currently a total of 576,491 dunums Israeli designated nature reserves were counted by ARIJ[18]; forming 12.2% of the West Bank region.

According to the National Spatial Plan (NSP) set forth by Palestinian partner ministries,[19] approximately 9% of the West Bank Region is designated as nature reserves, forming 511,578 *dunums* (51,158 hectares).[20] Most of these reserves are situated in the Eastern Slopes region (52.9% of total NR area), followed by the Central Highlands (34.5%), the Jordan Valley (11.9%) and the Semi-Coastal Region (0.7%). The location of the nature reserves within the four eco-geographical regions determines the precipitation that they receive, the habitat types that dominate there, and other environmental characteristics.

According to the Oslo Accords I and II (1994/95) and the Wye River Memorandum (1998), only nature reserves that are at least partly contained within Areas A and B were handed over to the Palestinian National Authority. They form a total of 83,762 *dunums*, equal to 16.4% of the total NRs area in the West Bank region (**Map 6.1**). Among the most famous and of high biodiversity value NRs are in Area A Siris, Jenin Governorate, and in Area B Deir Ammar, Ramallah Governorate. Nature reserves that are partly situated in Area C such as Al-Mughayyir, Jenin Governorate; Suba, Hebron Governorate; Tammun, Tubas Governorate; and others are also partly managed by the PNA ministries, and the

[15] Key biodiversity areas are places of international importance for the conservation of biodiversity through protected areas and other governance mechanisms. The KBA concept was set by the international Union for the Conservation of Nature and published under (Langhammer, P.F., Bakarr, M.I., Bennun, L.A., Brooks, T.M., Clay, R.P., Darwall, W., De Silva, N., Edgar, Eken, G., Fishpool, L.D.C., Fonseca, G.A.B. da, Foster, M.N., Knox, D.H., Matiku, P., Radford, & Rodrigues, A.S.L., Salaman, P., Sechrest, W., Tordoff, 2007) Identification and Gap Analysis of Key Biodiversity Areas: Targets for Comprehensive Protected Area Systems. Gland, Switzerland: IUCN).

[16] Seven NRs correspond to KBA Category I, two NRs to Category II, and eight sites to KBA Category IV.

[17] International Union for the Conservation of Nature (IUCN), (2010), *The Palestinian Forest and Natural Resource Assessment*, Palestine. *Unpublished.*

[18] The Israeli Trail Committee, 2007. Topographic Hiking Maps – Northern Judean desert.

[19] The National Spatial Planning is a comprehensive scheme that takes into consideration the spatial dimension in directing development, and the geographical distribution for economic and social activities. This plan was set by partner ministries including: Ministry of Planning, Ministry of National Economic, Ministry of Local Government, Ministry of Public Works and Housing, Ministry of Transportation, Ministry of Tourism and Antiquities, and Ministry of Agriculture.

[20] These areas overlap the nature reserves area declared by the Israel occupation with a difference of 187, 817 *dunums* for the Israeli declared nature reserves.

personnel employed by the Israeli administration are engaged to coordinate management with their Palestinian counterparts.

However, most of the protected areas are located within Area C,[21] where control continues to be under the exclusive authority of Israel. According to the NSP they amount to 81.6% of the nature reserves in the West Bank region[22], forming 418,570 *dunums*, with the largest being the Ein Fash'ha-Ein Jedi cluster and the Fasayil nature reserve that form 93,035 and 86,750 *dunums* respectively (**Map 6.1**). None of the nature reserves located in area C is accessible for the Palestinians, not even for management and conservation purposes. It is also worth noting that 36.2% of the designated nature reserves overlap with Israeli settlements and 39.5% overlap with closed military areas and bases (ARIJ, 2015a). Such utilization of a nature reserve confirms that their declaration does not respond to the international definition of a nature reserve, which calls mainly for biodiversity conservation (A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature, as defined by the international Union for Conservation of Nature (www.iucn.org)).

The segregation zones[23] (eastern and western) along the western and eastern parts of the West Bank within Area C are another concern for conservationists, which isolate and/or fragment approximately 68.5% of the natural reserves in the West Bank (ARIJ, 2015a). In view of the size of land confiscated from the West Bank, and the commensurately greater development pressures, the Segregation Zone is causing major challenges in conserving representative ecosystems, landscapes and habitat linkages especially between protect areas, and forests. The Segregation Zone poses a great threat to the biodiversity in the West Bank, due to the negative impacts on the movement of terrestrial fauna by adding further to the fragmentation of ecosystems and habitats in both Israel and the West Bank and by cutting the natural ecological corridors. Not forgetting the effect of segregation wall erected on Palestinian lands by the Israeli occupation which cut off number of nature reserves such as Um Al Riham NR. These nature reserves lack any access of management personnel to nature reserves; the same happens to those situated within the Israeli settlements in the West Bank region such as Deir Dibwan NR.

It is worth noting that under the Wye River Memorandum, land reserves amounting to approximately 3% of the West Bank (of which Al Kanoub – Bani Naim nature reserve is part of; forming 2% of total area of NRs in the West Bank region), were supposed to be handed over to the PA to be set aside as a

[21] Area C was defined under the Oslo Accords as areas where Israel was to exert civil and security control on an interim basis. While the 1995 Interim Agreement called for the gradual transfer of power and responsibility in the sphere of planning and zoning from the Israeli Civil Administration (ICA) to the Palestinian Authority (PA), this transfer was never implemented. As a result, any construction in Area C, whether a private home, an animal shelter, or a donor-funded infrastructure project, requires the approval of the ICA that operates under the Israeli Ministry of Defence. Area C compromises of 3,459,000 *dunums* (61% of Total West Bank Area) (ARIJ, 2015a).

[22] Excluding the 3% of the West Bank that were supposed to be handed over to the PA to be set aside as a Green Area/Nature Reserve in Wye River Memorandum of 1998.

[23] As sourced from ARIJ- GIS Land Use/Land Cover analysis 2008; The eastern segregation zone is an area of 1,664 km square (only 5% of which under Palestinian control) located along the eastern terrain of the West Bank that stretch for 200 km from south to north, most of which declared as closed military area, and is of limit for Palestinians. Western Segregation wall is an area of 774 km located along western terrain of the West Bank.

Green Area/Nature Reserve, with the stipulation that no changes to the land (i.e. no construction) were allowed. To date, the PA has not been allowed to utilize this area.

It should be noted that the declared NRs were not designed as a consistent, representative NR system or ecological network; instead, it represents a corporation of areas that were designated at various stages by various administrations, and for various purposes. Neither the concept for the integration of individual NRs into a functional ecological network (Geneva Initiative, 2003), nor the Pan-European Ecological Network, are reflected in the current set of NRs. While the abovementioned network concept has also aimed at an integration of the Palestinian NR system. This is especially with the ongoing construction of the "separation wall" by the Israeli occupation which counteracts such efforts, by reducing ecological connectivity. Hence the current set of designated nature reserves that is under Palestinian control or not is the result of a historical development that was not planned with biodiversity conservation in mind, and is hence not fully functional as a conservation tool.

Here is call for Palestinian Authority, namely the Environment Quality Authority (EQA) to take the lead to re-evaluate those area and initiate a new system for the declaration/initiation of Nature Reserves in Palestine based on scientific evidence. In doing so, the Ecosystem Approach should be applied taking into account ecological connectivity and the concept of ecological networks, including connectivity for migratory species (through, for example, "fly-ways" for migratory birds). Protected areas should also be established and managed in close collaboration with, and through equitable processes that recognize and respect the rights of indigenous and local communities, and vulnerable populations; in addition to particular elements concerning governance, participation, equity, and benefit-sharing.

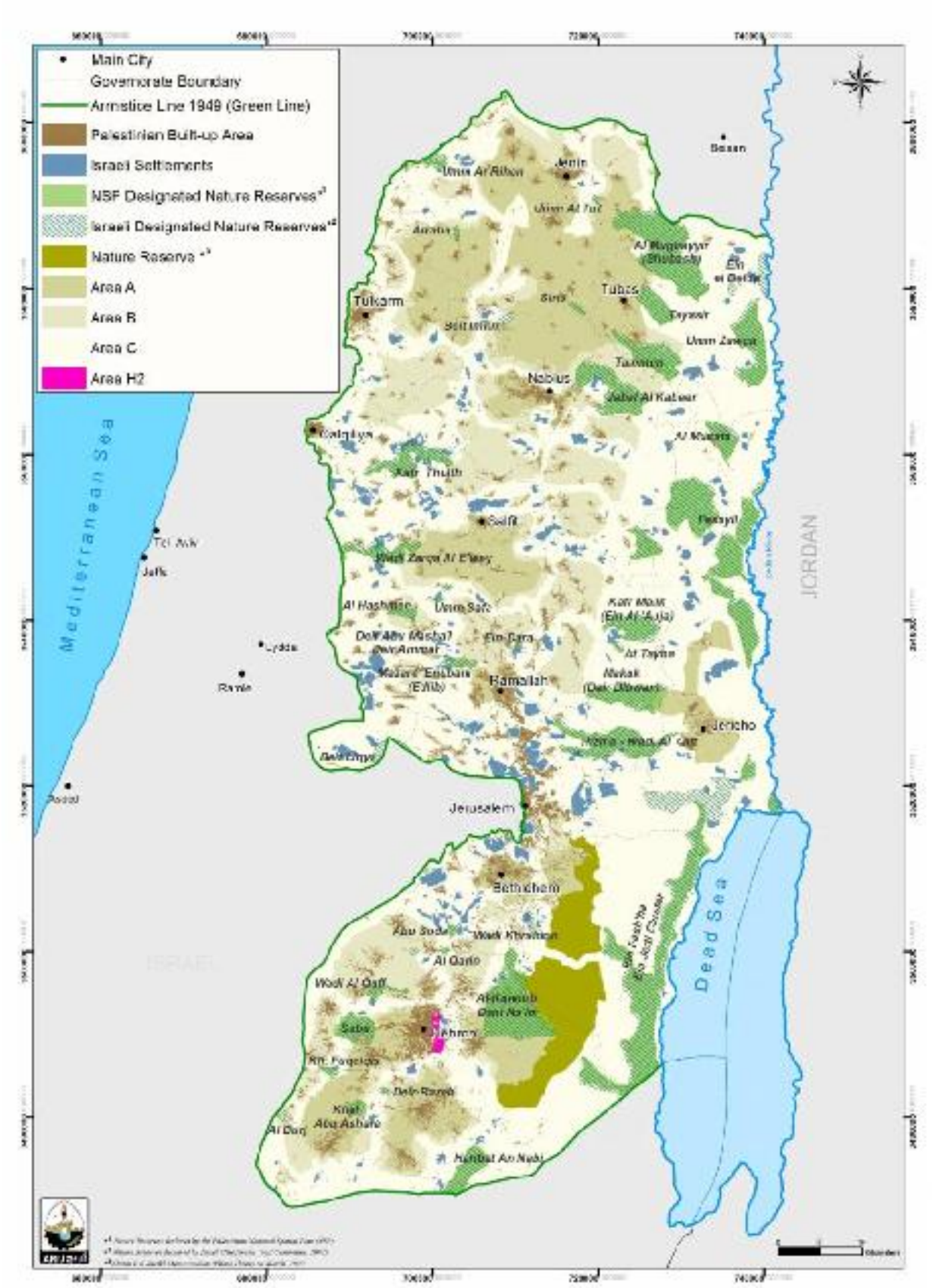
The main typology of available nature reserves in Palestine includes two types: (1) Wetland Reserves containing springs, rivers, streams, etc., such as Fasayil, Ein Al-Beida, Ein Fash'ha, Wadi Al Qilt, Ein Turba, and Ein Ghwair and many others. (2) Dryland Reserves contain man-made forest, mixed and natural forest, scrubland, and open spaces with little vegetation, such as Umm At-Tut, Siris, Um Ar-Rihan, Kafr Thulth, Umm Safa, Beit Liqya, Al-Qarin, Abu Soda, Khal Abu Ashara, Al-Alamieh, Wadi Al-Quff, Suba, and many others (**Map 6.1**).

Both types of nature reserves are rich with a diverse base of plant species. For example, the wetland reserves are famous for *Populus spp.*, *Tamarix spp., and Zizyphus spp., s*uch as the Euphrates Poplar, Tamarisk, and Christ Thorn, respectively. In some other reserves, water is more saline; therefore they are famous for *Phragmites spp., Suaeda spp.,a*nd the *Salsola spp.,* such as the Common Reed, Seepweed, Seablites, the Prickly Saltwort and others.

The dryland reserves are dominant with natural Mediterranean wood and shrub forests which are famous for Aleppo Pine and Evergreen Oak Maquis. Main tree and shrub species are Oak, Carob, Pistachio, and Lentisk trees which are associated with other plants, such as Thorny Burnet, Rockrose, Jerusalem Sage, Persian Hyssop, Palestine Lupine, and many others. Planted forests are famous for Pine, River Red Gum, Cypress, and Acacia trees, as well as and many others.

The Palestinian NRs are known for their importance in supporting the growth of endemic and endangered species (listed on the IUCN Red List), such as the Dark Brown Iris /Jal'ad Iris, and Betony/Wounwort as endemic species, as well as Syrian Sage/Spiny Calyxed Sage, and Buplever as potentially rare, and Hare's Ear as very rare species (Ali-Shtayeh & Jamous, 2002).

The Aichi Biodiversity targets, issued by the Convention on Biological Diversity (CBD) as part of “The Strategic Plan for Biodiversity 2011-2020”, defined in its Target 11 (Secretariat, 2013). that good progress would be made if 17% of the land could be made a protected area. At the moment, and including all aforementioned nature reserves in the West Bank region, only 9% of the total land area of the West Bank is designated as nature reserves. Since Palestine has already ratified the Convention on Biological Diversity in the year 2014, thus it would create potential economic opportunity to declare valuable and well-studied nature reserves (upon revision of existing ones) and to set up a number of plans, such as on eco-tourism development, recreation and education, forest restoration, rangeland management, and others to benefit the biological components and local communities at both individual and national levels, and to take into consideration conservation measures.



MAP 6.1: DESIGNATED PALESTINIAN NATURE RESERVES BY GEO-POLITICAL REGION

6.4 Biodiversity Challenges towards Sustainability

Sovereignty over natural resources is one of the key elements for any nation to achieve sustainable development and sound environmental management. Currently, the Palestinians have no ability to regulate land use over a contiguous piece of land and accordingly Palestinian natural ecosystems cannot be maintained, the status of the environment cannot be properly monitored, and environmental protection cannot be implemented. Due to the prolonged occupation and political conflict- lack of control over planning and implementation, the existence of accessible areas and inaccessible areas for Palestinians and the fact that the occupation power has neglected the development of Palestine have led to the deterioration of biodiversity made the management, conservation and restoration of natural resources a very difficult job.

Biodiversity is under threat from a variety of pressures, which are further worsened by the ongoing conflict including: unplanned urban expansion, unorganized establishment of industrial factories, overgrazing, over-exploitation, overfishing, over-fragmentation, deforestation and unplanned forestry activities, desertification and drought, invasive alien species, pollution and contaminants, excessive use of pesticides and chemicals, accidental mortality, hunting, climatic and environmental changes. In addition to this political status issues including the division of Palestinian accessible areas, land confiscation, and expansion of the Israeli segregation wall effect biodiversity in Palestine. Such factors are causing direct changes in plant and animal species composition, distribution and density and thus the loss of such valuable heritage.

As a result, common floral and faunal species in Palestine are under threat of becoming rare and very rare species disappearing altogether. Over the last 40 years, up to 636 species were found endangered of the 2,076 recorded plant species growing in Palestine (ARIJ, 2007a).

Up to 391 species are classified as ‘rare,’ whilst 68 species are ‘very rare;’ forming 20% and 3.5% of total plant species growing in the West Bank, respectively (ARIJ, 2007a). Up to 155 species growing in the Gaza Strip are considered ‘rare’ and 22 species ‘very rare;’ forming 12% and 1.8% of total plants in the Gaza Strip (ARIJ, 2007a). Among the rare species are weed silene *(Silene conoidea),* Indian mallow *(Abutilon fruticosum),Russian tamarisk (Tamarix aravensis)and others.*

During the Last 40 years, It was found that 303 plant species growing in the West Bank and Gaza have changed their status from being abundant to become rare forming 14.7% of the total plant species growing in the West Bank and Gaza. On the other hand, 51 plant species have changed their status from abundant or frequent to become very rare and 16 plant species changed their status from being rare to very rare (**Figure 6.2**).

Comparing those plant species, which have changed their abundance status to rare or very rare, with their eco-geographical distribution, it appears that 35% of those species are located in Central Highlands, 27% of them are in the Jordan Valley, 20.5% of them are located in the Eastern Slopes and 17.7% of them are located in the Semi-coastal region.

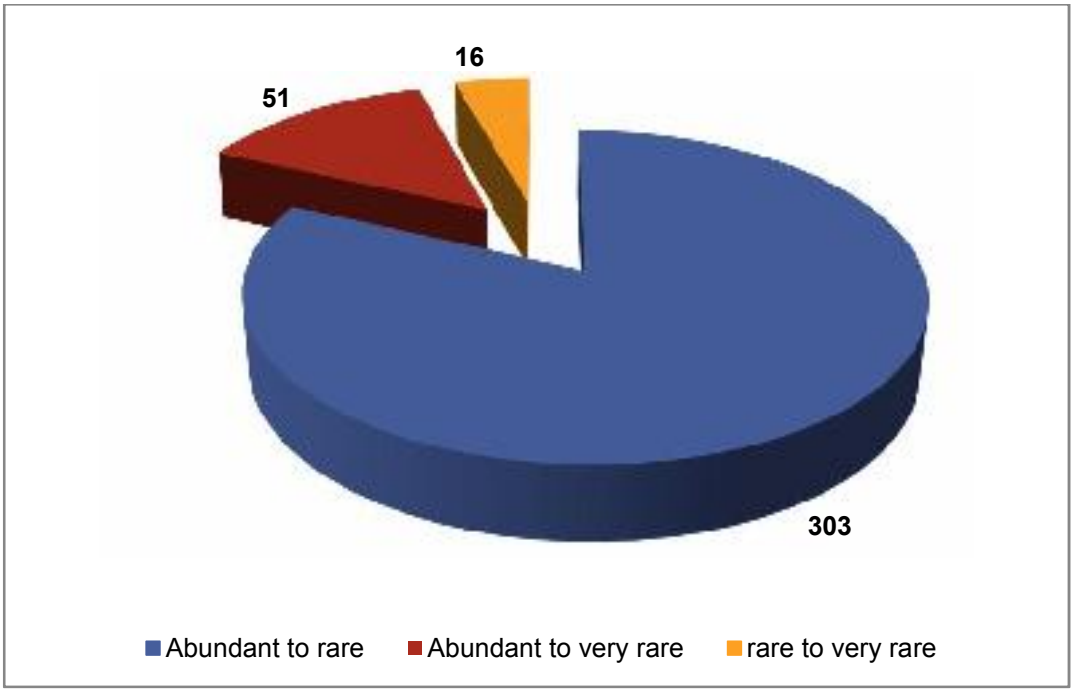


FIGURE 6.2: CHANGES OF FLORAL SPECIES STATUS IN PALESTINE DURING THE LAST 30 YEARS

A number of vertebrate and invertebrate species are also considered to be undergoing decline in numbers, and is some cases possible extinction due to over -hunting, habitat loss and habitat fragmentation. Around 22 terrestrial animal species are under the threat of extinction. They include 5 species of mammals, 5 species of the Palestinian Herpetofauna, and 12 species of birds (PCBS, 2005). Also, around 56 Mediterranean fish species (26% of the total fish fauna of Gaza Strip) is considered to be threatened (Ali, 2002). Among the endangered and threatened species are the True Toad (*Bufo viridis*), Banded newt (*Triturus vittatus vittatus*), Marsh frog (*Rana ridibunda*), Freshwater Turtle (*Clemmys caspia*), Sturgeon Fish (*Acipenser sturio*), the Butterfly (*Apharitis cilissa),* Palestinian Viper (*Vipera palaestinae*), Egyptian mongoose (*Herpestes ichneumon*), Wild Cat (*Felis silvestris*) and the Wolf (*Canis lupus*). Endangered birds represents some bird species of key concern in the Palestinian Territory which was published by Birdlife International and World Conservation Union Red List (IUCN, 2011); one bird species is critically endangered and facing high risk of extinction in the wild (*Numenius tenuirostris*), and three other birds are considered vulnerable as they are undergoing a rapid declining rate and are susceptible to extinction in the wild if the involving causes persist.

ARIJ has found in its surveys that 47.1% of endemics in the West Bank and Gaza are low frequent species, 11.8% are rare species and 5% are very rare species (**Table 6.2**). The endemic rare species exist mainly in the Dead Sea and lower Jordan Valley areas forming 66.6% of rare species.

TABLE 6.2: ENDEMIC RARE AND ENDEMIC VERY RARE PLANT SPECIES IN THE WEST BANK & GAZA STRIP

Endemic Species	Family	Agro-ecological region	Status
Alcea rufescens	Malvaceae	JV	**R**
Anthemis edumea	Compositae	JV	**R**
Filago inexpectata	Compositae	CH, SC, JV	**R**
Centaurea ascalonica	Compositae	CH, ES, Gaza	**R**
Iphiona maris-mortui	Compositae	JV	**R**
Cephalaria tenella	Dipsacaceae	CH	**R**
Iris haynei	Iridaceae	CH, ES	**R**
Bellevalia zoharyi	Liliaceae	ES	**R**
Galium heirochuntinum	Rubiaceae	JV	**R**
Kickxia judaica	Scrophulariaceae	ES, JV	**R**
Reseda urnigera	Resedaceae	ES,JV	**R**
Reseda maris-mortui	Resedaceae	ES, JV	**R**
Salvia eigii	Labiatae	CH, SC	**VR**
Stachys zoharyana	Labiatae	CH	**VR**
Orchis israelitica	Orchidaceae	CH	**VR**
Amygdalus ramonensis	Rosaceae	CH	**VR**
Ferula samariae	Umbelliferae	CH, ES	**VR**

Note: R: Rare, VR: Very Rare. CH: Central Highlands, SC: Semi-coastal, ES: Eastern Slopes, JV: Jordan Valley.
Source: (ARIJ, 2007b)

Not forgetting the diverse encroachments on the forested areas all over the West Bank as a results to Israeli confiscation of land, cutting of trees by local people for timber and fuel and other uses, overgrazing, overexploitation to medicinal and aromatic plants, expansion of built areas and agricultural lands at the expense of forested lands. This is highly effecting the forests especially that no effective legislation are enforced and thus no sanctions or penalties are taking place (**Box 6.1**).

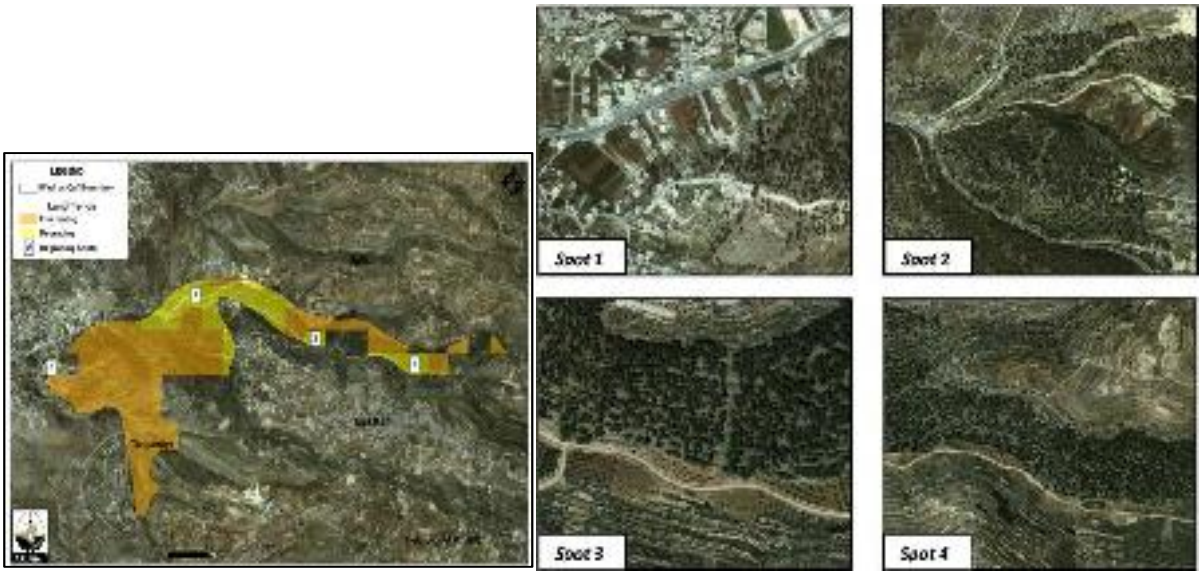
The problem is especially acute in Palestine, whose limited size, momentum of development, population growth, political conflict, and economic status; causing limitations in conservation of biological resources. Palestine has not yet set up its own national parks, nature reserves and

landscape reserves makes the protection of precious natural resources and open space landscapes especially difficult. The following is a study case for causes behind biodiversity loss.

BOX 6.1: WADI AL QUFF PROTECTED AREA

Wadi Al Quff Protected area is subjected to land degradation, upon a study conducted by ARIJ in the year 2013, there are on-going degradation occurring in multiple and scattered spots throughout the forest. land under an active degradation processes is 20% of Wadi al-Quf Area. The most degraded spots are concentrated in the northern parts of Wadi Al Quff forest (see maps below). In general the degrading spots are associated with many socio-economic, cultures, political and geographical factors of the West Bank. The main causes of land degradation identified in Wadi Al Quff forest are the following :

- Agriculture expansion on forest area especially in Spots 1, 3 and 4, by the neighborhood localities (Tarqumiya and Bayt kahil).
- Urbanization problem of Tarqumiya village (Spot 1) where part of its built up area exist on the Western borders of the Forest, Bayt Kahil village (Spot 2).
- Israeli occupations represented by checkpoints (Spot 1), Israeli military and bypass roads, which passed in the northern part of the forest and Israeli military (Spot 2).
- Localized Spots of Ongoing Degrading in Wadi Al-Quf Forest



MAP 6.2: LOCALIZED SPOTS OF ONGOING DEGRADATION IN WADI AL-QUF FOREST

6.4.1 THE POLITICAL CONFLICT

The fragile Palestinian environment has been the first casualty of the political conflict. The Israeli occupation has contributed to changing the environmental features of Palestine through the strict control over the Palestinian land; land confiscation for implementing the Israeli colonization policy and unilateral segregation plan; as well as the control over water resources; and the exploitation of natural resources. All these practices have created geographical discontinuity at the lands under the Palestinian control and resulted in a major physical impediment towards achieving sound environmental management in Palestine.

The fragmentation of the Palestinian landscape has had a significant environmental impact. Overall, 61% of total land area in the West Bank is considered Area C; controlled by the Government of Israel for settlements, military use, checkpoints or road closures, western segregation zone and the West Bank Segregation Wall [24]. The intrusive route of the West Bank Segregation Wall through 8 of the 11 West Bank governorates isolates and fragments the farms, forests, grazing lands and water resources. The segregation zones[25] (eastern and western) along the western and eastern parts of the West Bank within Area C are another concern for conservationists, which isolate and/or fragment approximately 68.5% of the natural reserves in the West Bank (ARIJ, 2015a), 55.5% of the total covered forested area of the West Bank and more than 80% of the Palestinian rangelands areas where the herders are usually taking their sheep and goats to graze (**Appendix 6**) (ARIJ, 2015a). The Segregation Zone poses a great threat to the biodiversity in the West Bank, due to the negative impacts on the movement of terrestrial fauna by adding further to the fragmentation of ecosystems and habitats in the West Bank and by cutting the natural ecological corridors. It may prevent many species of mammals to travel to their sources of food and mating which may endanger the survival of specific populations or creation of new sub-populations. This also will result in reducing the size of accessible grazing area and exposing the remained rangeland to overgrazing phenomena, accelerating land degradation, reducing the green cover biomass and grazing capacity of that area. It is worth mentioning, the area where Segregation Zones take place, supports the growth of many important rangeland plants and wild relative species of herbaceous plants and trees such as *Melilotus spp., Medicago spp., Vicia spp., Hordeum spp.* and *Aegilops spp.,* in addition to the wild species of fruit trees such as pear, pistachio (ARIJ, 2007a).

The Western part of the Segregation Zone limits the contiguity of the evergreen maquis and forests in addition to Mediterranean batha and garrigue vegetation. The expected threatened dominant plant species in the western part of the segregation zone that are growing in the Central highlands region are *Quercus calliprinos, Ceratonia siliqua, Pistacia palaestina*, and in Semi-coastal region are *Inula viscose, Phragmites australis, Euphorbia perelis, Senecio vernalis, Thymelae hirsutum,* and *Lupinus palaestinus* (ARIJ, 2007a).

6.4.2 THE STATUS OF THE GAZA STRIP COASTLINE

Gaza's coastal management issues are a reflection of its development problems: large population, limited space, poor infrastructure, and intense pressure on the natural resource base. Within this narrow physical space and demanding developmental framework, it is necessary to identify the impacts of such challenges on Biodiversity.

The shallow coastal zone is the most important marine habitat for fish and other flora and fauna of the Gaza Strip. Destruction of habitat in this zone, caused either by fisheries activities, rock removal, coastal erosion, the construction of coastal structures and most prominently the dumping of sewage

[24] 61% of total West Bank area is comprised of: 1. Area "C" forms 1346 km2 (23.7% of West Bank area) - falls under Israeli Control between western West Bank segregation wall and eastern Segregation Zone. 2. Areas of western Segregation Zone and eastern Segregation Zone forms 2110 km^2 (37.3% of West Bank area).

[25] As sourced from ARIJ- GIS Land Use/Land Cover analysis 2008; The eastern segregation zone is an area of 1664 km square (only 5% of which under Palestinian control) located along the eastern terrain of the West Bank that stretch for 200 km from south to north, most of which declared as closed military area, and is of limit for Palestinians. Western Segregation wall is an area of 774 km located along western terrain of the West Bank.

water and solid waste and other disturbances. Beach construction as roads, restaurants, hotels and other buildings have been constructed, very close to and even right on the active part of the shore, thereby constraining the range of free space needed for the seawater dynamics. After the construction of the fishing port increased the need to protect the coastal zone of Gaza Strip.

The coastal erosion is another threat to the coastal zone as a habitat for plant and animal species. In the shallow coastal zone the problem of rock removal for construction is very important to fish habitat. Many of the Gaza fish species are dependent on the rocky substrate and consequently these species become under severe threat. Removal of the rocks also affects the flora habitat of shallow waters of the beach, increases the seasonal rate of erosion, which affects the fauna and flora of the beach of Gaza strip. For example all of the Gobi-species, Bon fish, and marine macro-algae of Gaza are all dependent on the rocky substrate in the shallow coastal waters (Ali, 2002). This makes them very vulnerable to habitat destruction and marine pollution that takes place.

Wadi Gaza and the coastal lines are highly threatened areas in the Gaza Strip as a result to human interference, the threats to these habitats are quite severe, Wadi Gaza faces many environmental problems that affect the public health and is used as a point to collect sewage from the middle area refugee camps and as a solid waste-dumping site. After construction of a sewage treatment plant was delayed in 2011, excrement from nearby refugee camps and towns began to be diverted through the valley en route to the Mediterranean Sea. Approximately 24 million gallons of raw or partially treated sewage exits those pipes into the Mediterranean Sea each day (Marlowe, 2015). This is in addition that only 83.5% of the Gaza population is connected to the public sewerage system (PCBS, 2015b), the remainder discharging untreated sewage into cesspits and boreholes. However, the sewage pipes are in a state of disrepair due to years of neglect under Israeli occupation. Approximately 70-80% of the domestic wastewater produced in Gaza reaches the environment untreated, via direct discharge, leakages or overloaded treatment plants. There are 18 different pipelines discharging into the Mediterranean Sea (UNEP, 2003).

There is an urgent need to protect the Wadi Gaza and its surrounding vegetation communities as these habitats contain the highest value for the flora and fauna. Wadi Gaza is considered as one of the most important coastal wetlands located on the Eastern Mediterranean Basin, very rich in biological diversity (both flora and fauna). The wadi is also a station point for the birds migratory routes from north to south and from south to north. In addition, being the biggest in Gaza and having a special outstanding landscape, and being one of the biggest in Palestine, it has the potential for being a recreational area attracting people from different areas (UNESCO, 2012).

In recognition of its importance as a natural area and as the only wetland in Palestine, Wadi Gaza was declared a nature reserve in June 2000. The Ministry of Environmental Affairs (MEnA -at that time) requested that municipalities should revise their land use plans so that they ensure that the Wadi bed be respected as a protected area.

6.5 The Way Forward

There is a need for a comprehensive review and development of Palestinian policy and legislation pertaining to Plant Genetic Resources (PGRs) utilization and conservation, incorporating standards of accreditation, intellectual property rights, indigenous knowledge, training and research. Laws

concerning controlled collection systems, controlled processing systems, controlled trade systems, and licensing systems (including patents, protection of indigenous knowledge and benefit share) are crucial. Another challenge is the strong need for cross-sector national policy coordination. Accordingly, better coordination should be ensured amongst the different stakeholders, in order to assess and set up the policies and laws concerning the biodiversity sector, as networking and coordination would support the enforcement of conservation and management laws in a comprehensive manner which ensures a responsible act from all stakeholders.

The Legal Framework for Nature Conservation should be amended to include specific laws governing nature protection and the empowerment of agencies to implement the legislative aspects. The PNA should continue issuing and updating laws, regulations, and standards. The BSAPP should be updated and harmonized with international and regional conventions, and should also be developed into action plan to orient the upcoming projects towards fulfilling the actual needs of biodiversity sector. The biodiversity law should be issued specifically to enforce conservation and management on the ground and in cooperation with other Palestinian law enforcement especially the environment and agriculture laws.

Palestinian national legislation is also needed to protect the traditional resource knowledge rights of local villagers and farmers as well as the rights of sovereignty over their cultural and genetic property. Thus, PGRs' collectors, cultivators and protectors, who work in this sector after their fathers and grand-fathers and are going to teach their skills to their children (especially those living under poverty line, without employment), and utilize the wild PGRs from generation to generation should have the priority to be protected and their knowledge since they are the closet to nature. The indigenous knowledge forms the main reference on which Palestinians mainly rural communities rely while implementing conservation and production activities. It is notable however that traditional and local knowledge remains an under-utilized and inadequately valued resource with considerable potential. There has been little in depth participatory research into plant and animal indigenous knowledge in the West Bank and Gaza strip; for instance those of the Palestinian Bedouins.

On the research front, it will be necessary to strengthen taxonomic and systematic research, ecology, habitats and wildlife population studies, indigenous genetic resources, GIS and Remote sensing, and popular knowledge assessments. Implementing field measurement and assessment surveys to get a grip on existing biodiversity and the identification of those under threat or are presumed lost or extinct is a first step that should be taken. As a result a 'Species List' and a 'Red List' of threatened species of fauna and flora can be formulated and a computerized information center can be established. The results should be freely accessible by the different sectors of the Palestinian society, especially those who are dealing intensively with those species and those who deal inappropriately with them. The results of the Palestinian research should also be used as an incentive to aware the public towards the secure measures while utilizing PGRs and emphasizing the importance of such resources and their methods of conservation. In addition, the Palestinian species lists and research findings should be documented and interlinked to the international databases, reports and/ or lists.

There is a necessity to enhance the level of cooperation and coordination among academic and research institutions whether they are governmental or non-governmental organizations that work in the field of biodiversity and to set out participatory investment in relevant projects, plans, and actions at

international and national levels to raise quality of Palestinian biological resources at its different components.

The harmonization of national action with international and regional conventions, activities and plans is very important for a better management of biodiversity at national level.

- Increasing the exchange of data and information relevant to biodiversity conservation at national, regional and international;
- Promoting technical and scientific co-operation, transfer of technology and development of research and management facilities;
- Exchanging consultation of personnel, and information sharing within regional neighboring countries among respective focal points, lead institutions and joint action projects, in addition to multilateral and bilateral cooperation and non-governmental cooperation.

It is worth noting that achievement of the CBD's objectives is necessary within national policy and law and accordingly Palestinian makers will need to adopt integrated approach towards policy making across that relate to IPRS (Intellectual Property Rights), the CBD, the TRIPs, and UNESCO agreements; to fulfill the Palestinian international obligations towards international agreements and conventions. The Stat of Palestine as a member of UNESCO, should specifically include the UNESCO standards and regulation of natural heritage sites' conservation and management into its legislations especially those related to biodiversity, landscape, agro-biodiversity, land reclamation, etc.

For the Palestinian case, the enforcement of the laws and policies could have some details such as enforce the prohibition on hunting, stop uncontrolled clearance of farmland, stop deforestation, stop pollution, stop overexploitation. Before setting out or upgrading the policies and laws in relevance to the Palestinian case several identification and monitoring components of biodiversity (species, habitats, ecological communities, genes, ecosystems and ecological processes) are necessary including:

- Identifying and monitoring components of Palestinian biodiversity that are important for its conservation and ecologically sustainable use;
- Identifying components of Palestinian biodiversity that are inadequately understood;
- Collecting and analyzing information about the conservation status of components of Palestinian biodiversity;
- Collecting and analyzing information about processes or activities that are likely to have a significant impact on the conservation and ecologically sustainable use of Palestinian biodiversity;
- Assessing strategies and techniques for the conservation and ecologically sustainable use of Palestinian biodiversity; and
- Systematically determining biodiversity conservation needs and priorities in Palestine.

Once the above items are identified, some basic elements of law and policy could be set to assist in developing more adequate systems of Palestinian biodiversity planning and conservation, including:

- Research into the abundance and scope of biological diversity and the making of inventories as a basis for eco-regional planning;
- The making of national biological diversity conservation plans and eco-regional plans, with realistic targets and time frames, with built-in review and updating processes;
- Incorporation of ethno-biological knowledge in biological diversity conservation plans;

- Enactment of national and in regional legislation to ensure implementation and enforcement of international obligations under the relevant biodiversity conventions;
- Taking a “whole of Authority” legislative approach, i.e. each relevant ministry and department taking a similar approach to the conservation of biological diversity, to ensure that decision-making relating to exploitation is consistent with decision-making about conservation of biodiversity;
- Strengthening the capacity of Authority officials to ensure that plans for biodiversity are developed in conjunction with other aspects of national and local planning, implementation and enforcement;
- Establishment and adequate support of governmental and non-governmental institutions concerned with environment protection, national parks and wildlife service’s and research into conservation matters;
- Provision of sufficient financial resources for the implementation, compliance and legal enforcement of plans and associated programs for protected areas, and strict protection of threatened species.

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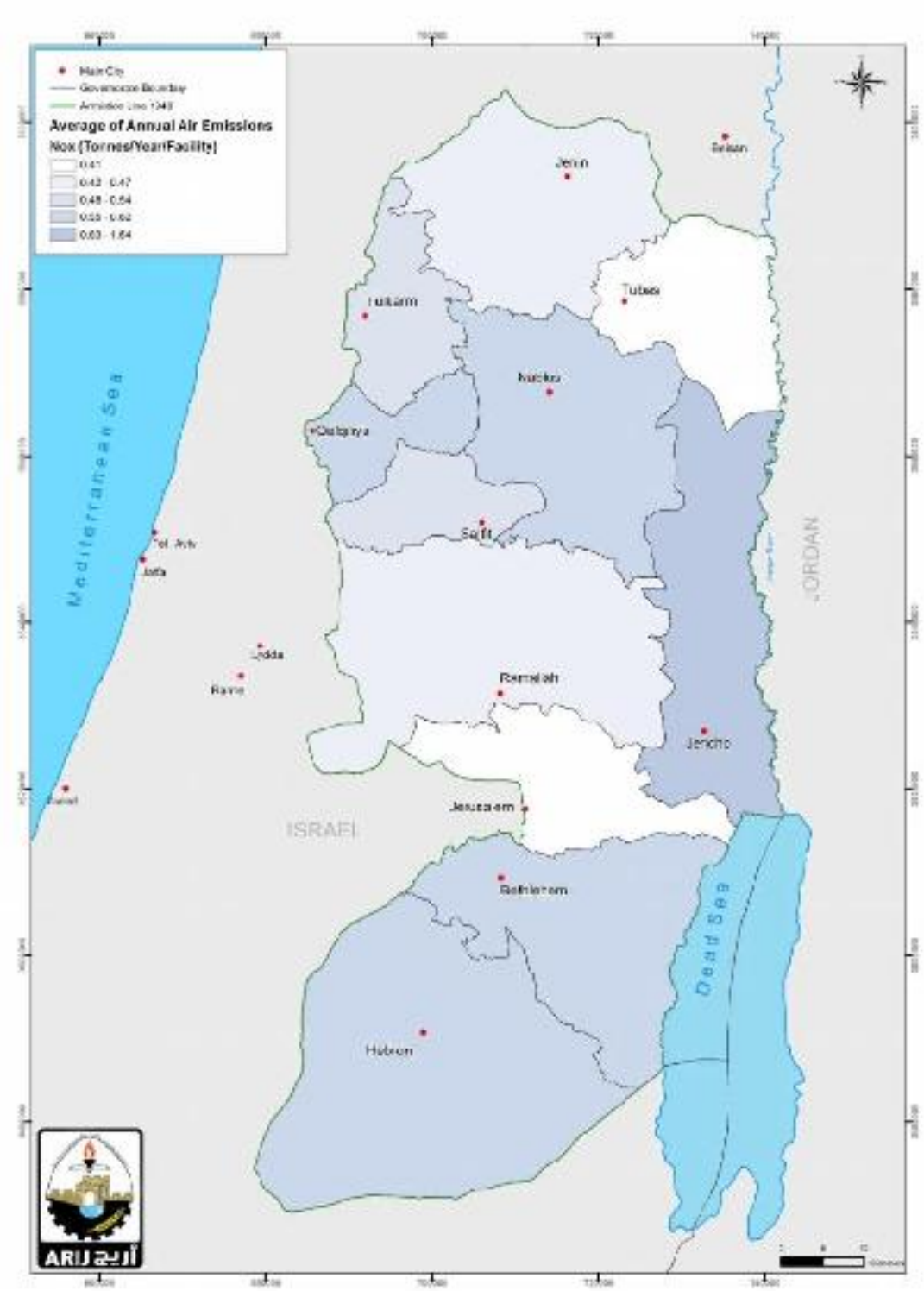
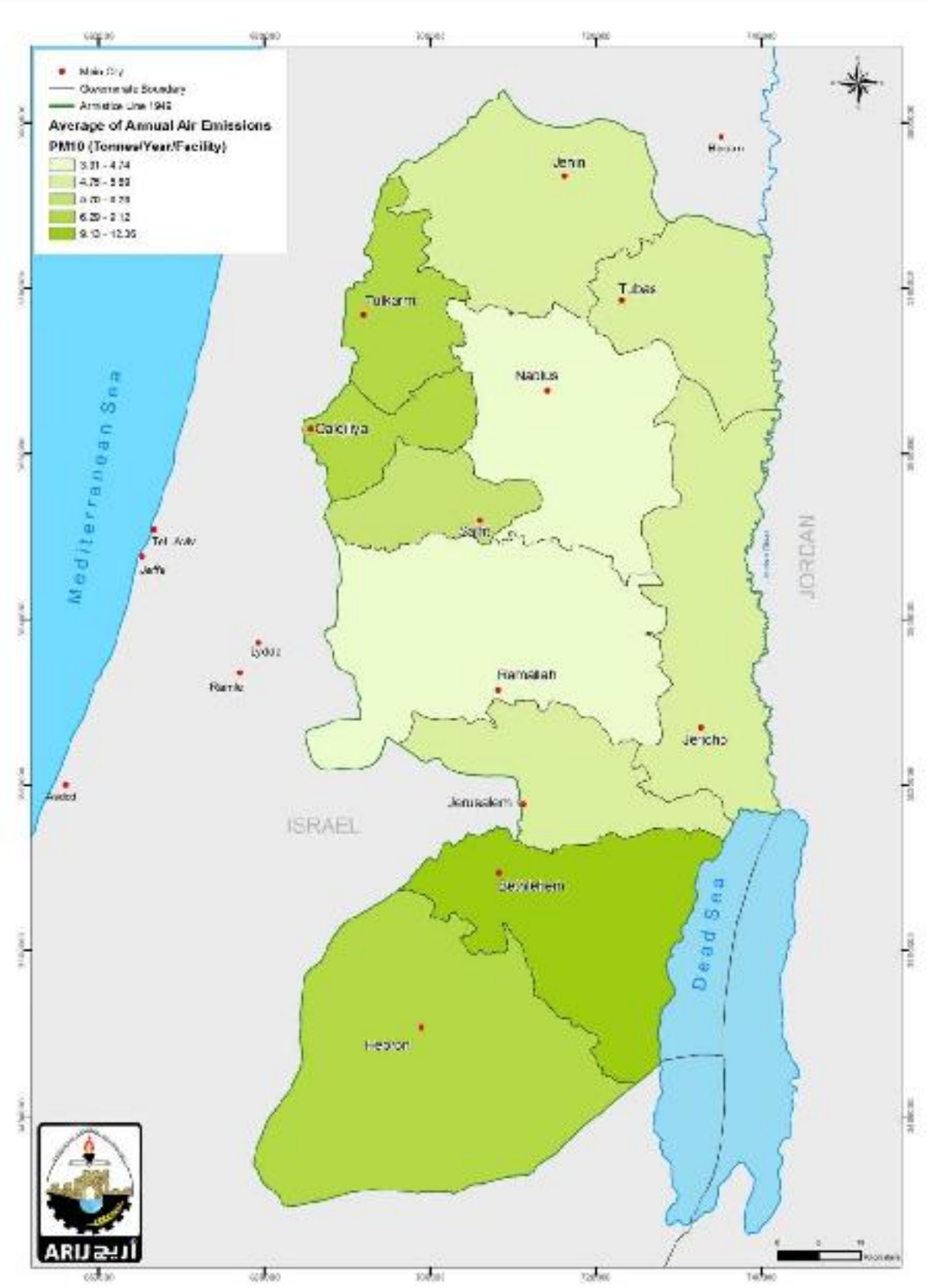
8. APPENDICES

Appendix 1

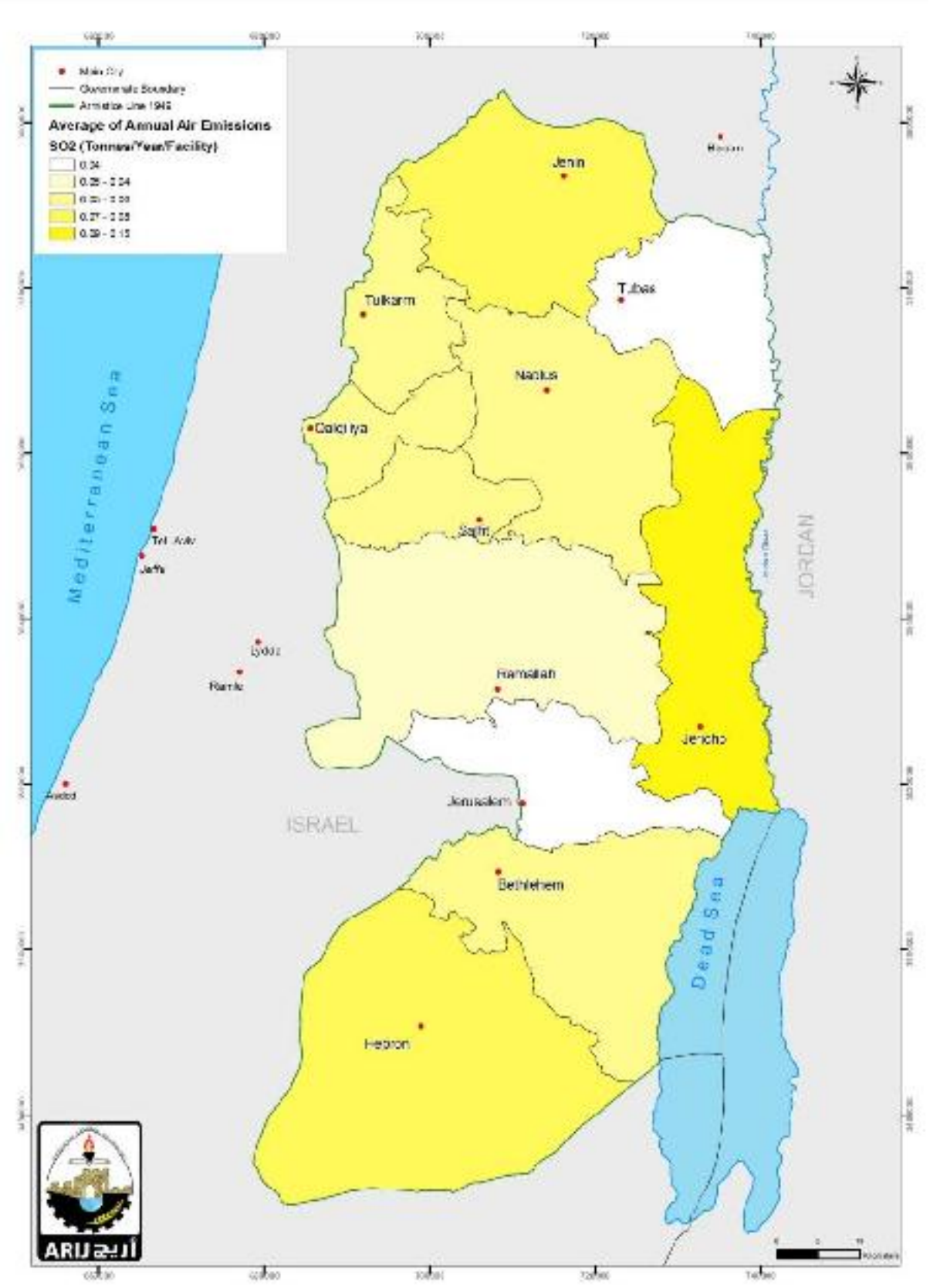
Map 1 presents a comparative assessment of facility NO_x emissions across the West Bank. It shows that Jericho Governorate has the highest NO_x emissions per facility.



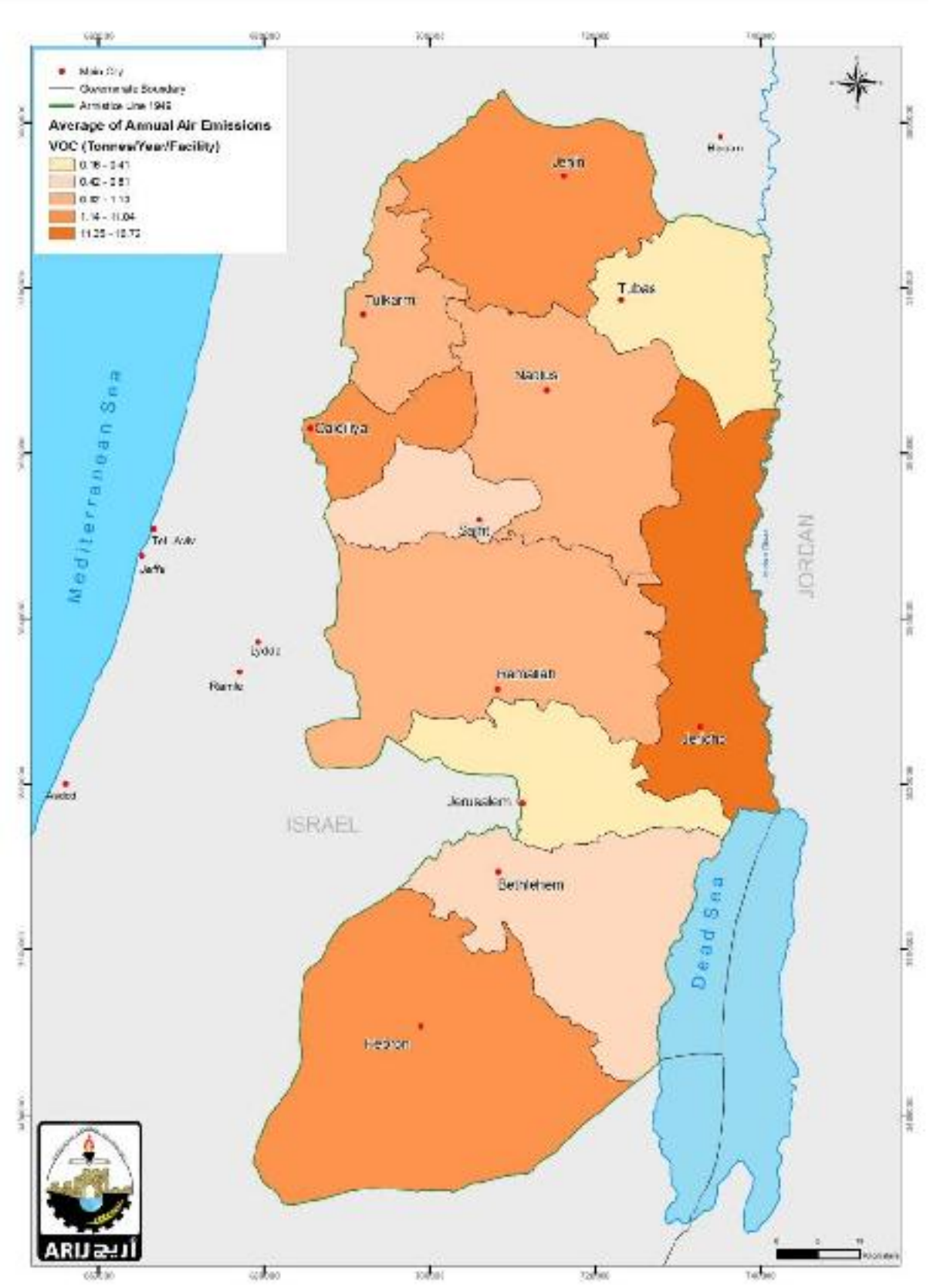
Map 2 presents a comparative assessment of facility PM_{10} emissions across the West Bank. It shows that the Bethlehem, Tulkarm and Qalqiliya Governorates have the highest PM_{10} emissions per facility.



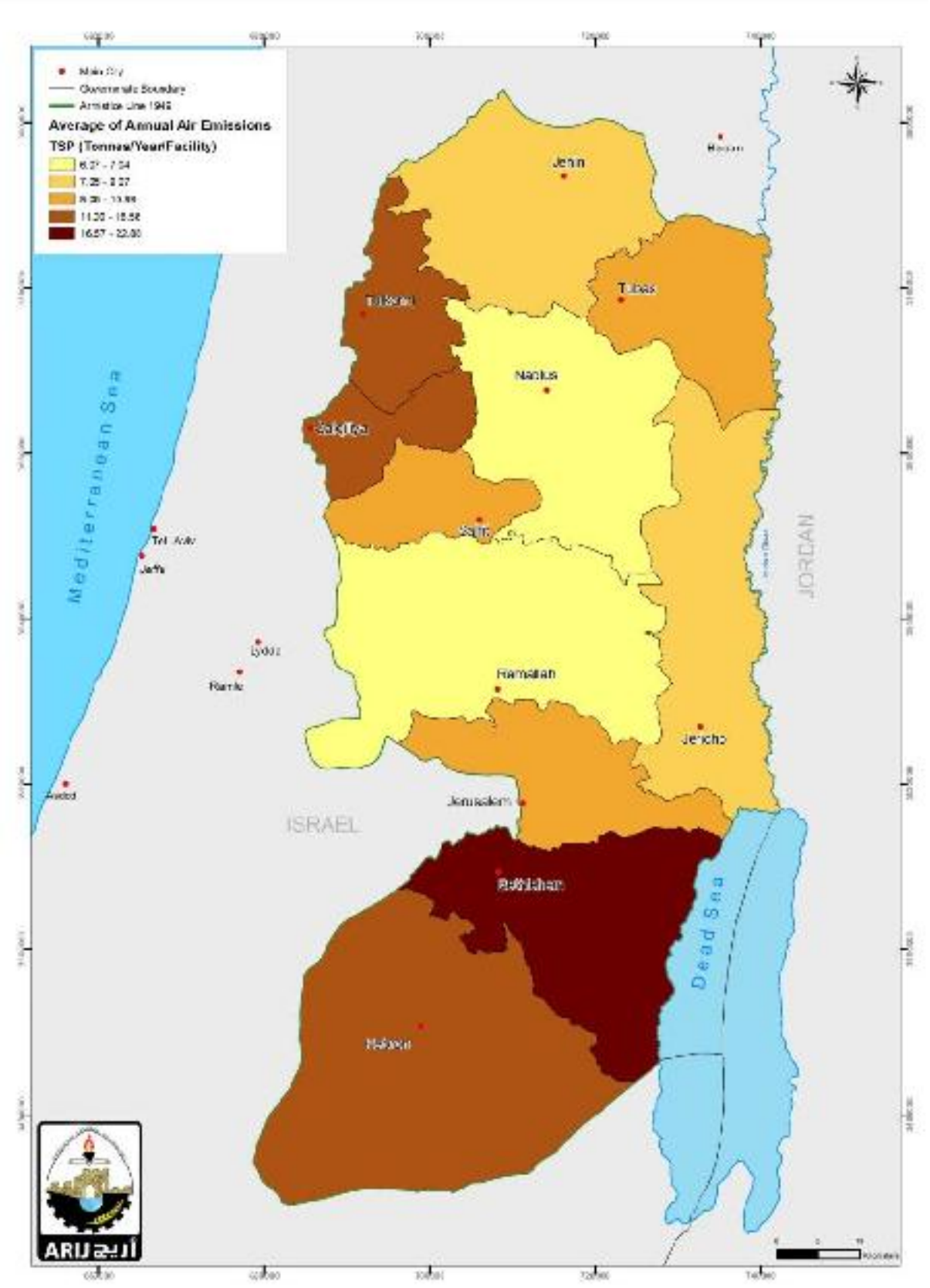
Map 3 presents a comparative assessment of facility SO_2 emissions across the West Bank. It shows that Jericho Governorate has the highest SO_2 emissions per facility.



Map 4 presents a comparative assessment of facility VOC emissions across the West Bank. It shows that Jericho Governorate has the highest VOC emissions per facility.

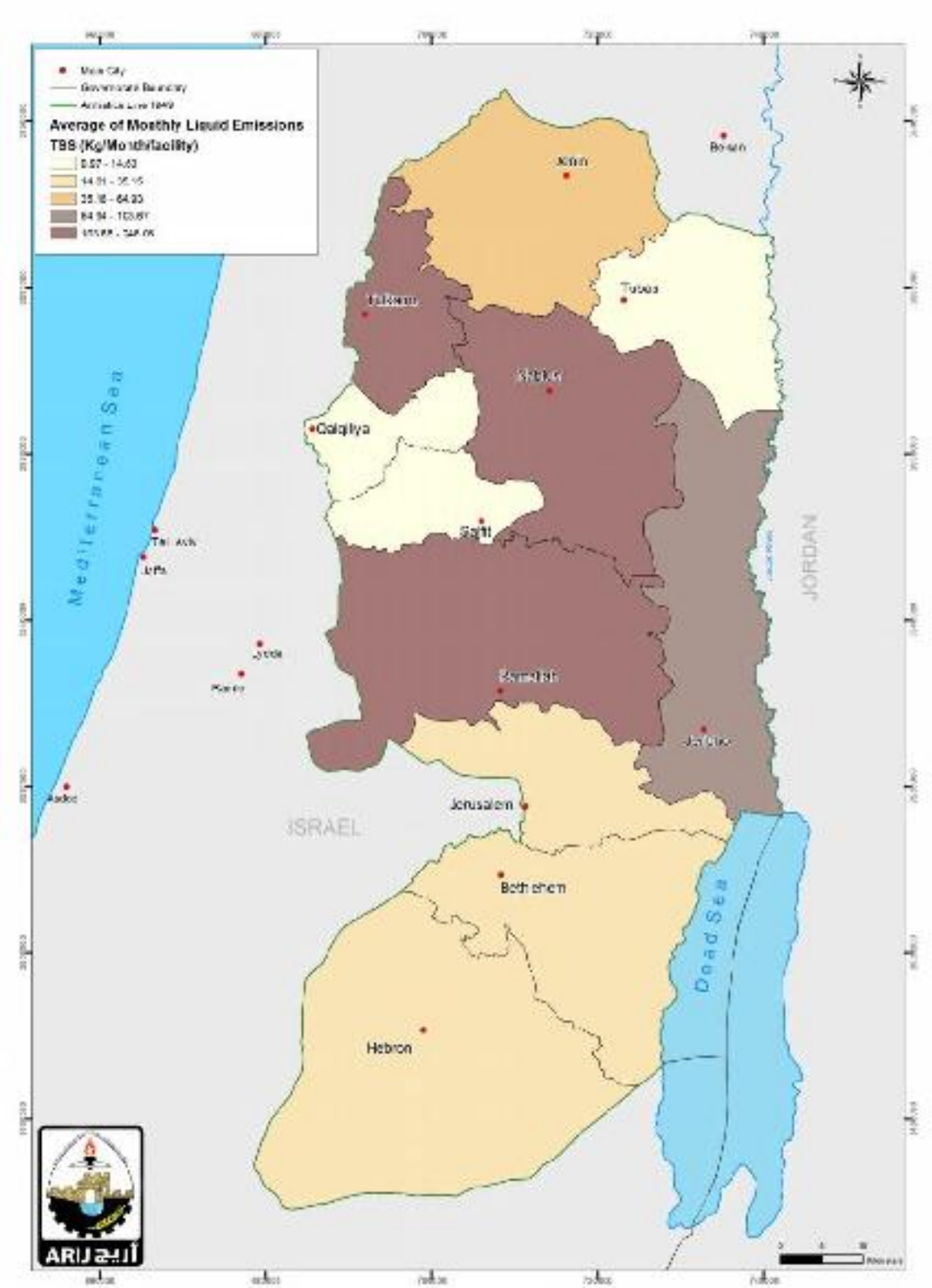


Map 5 presents a comparative assessment of facility TSP emissions across the West Bank. It shows that Bethlehem Governorate has the highest TSP emissions per facility.

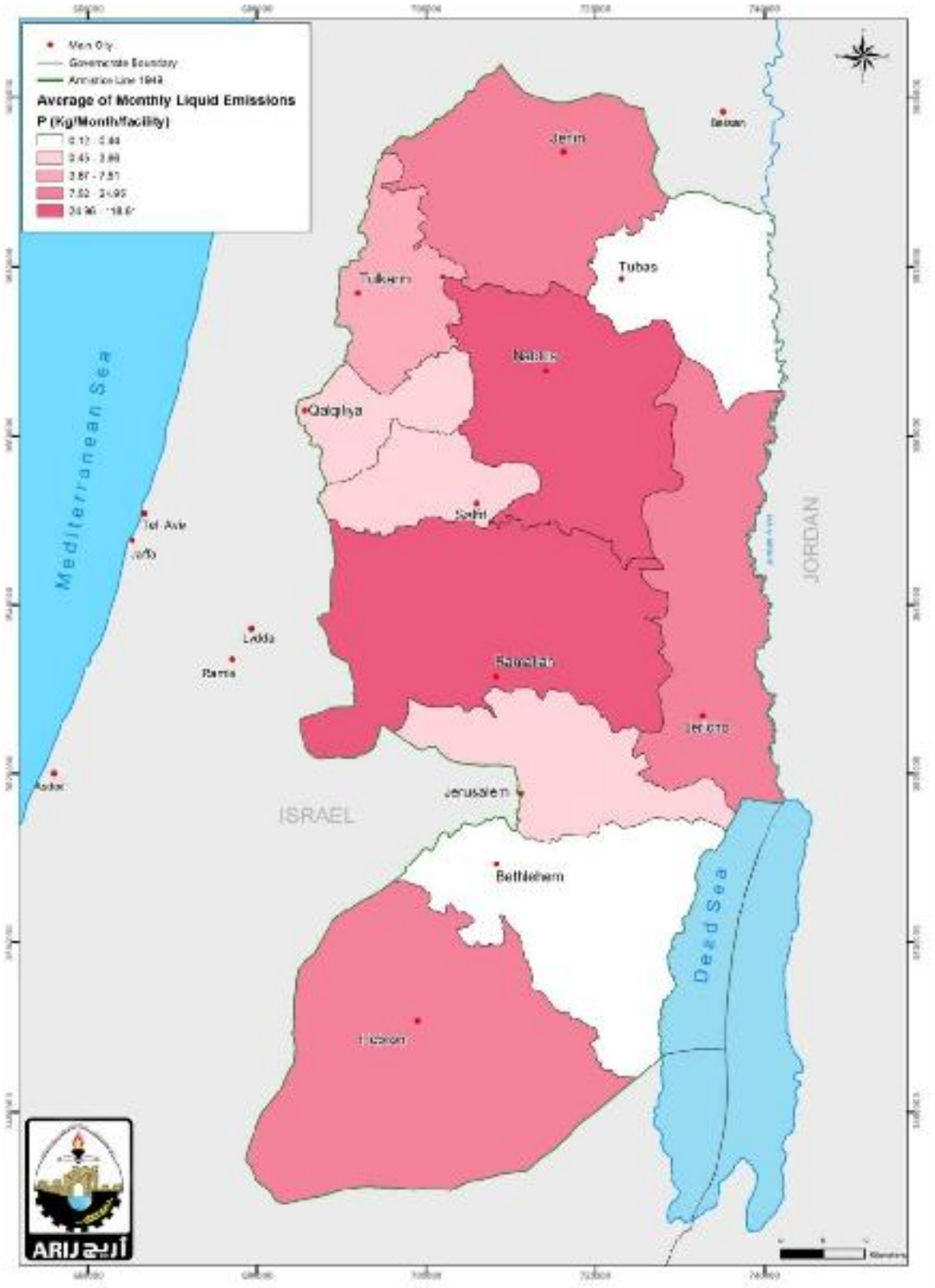


Appendix 2

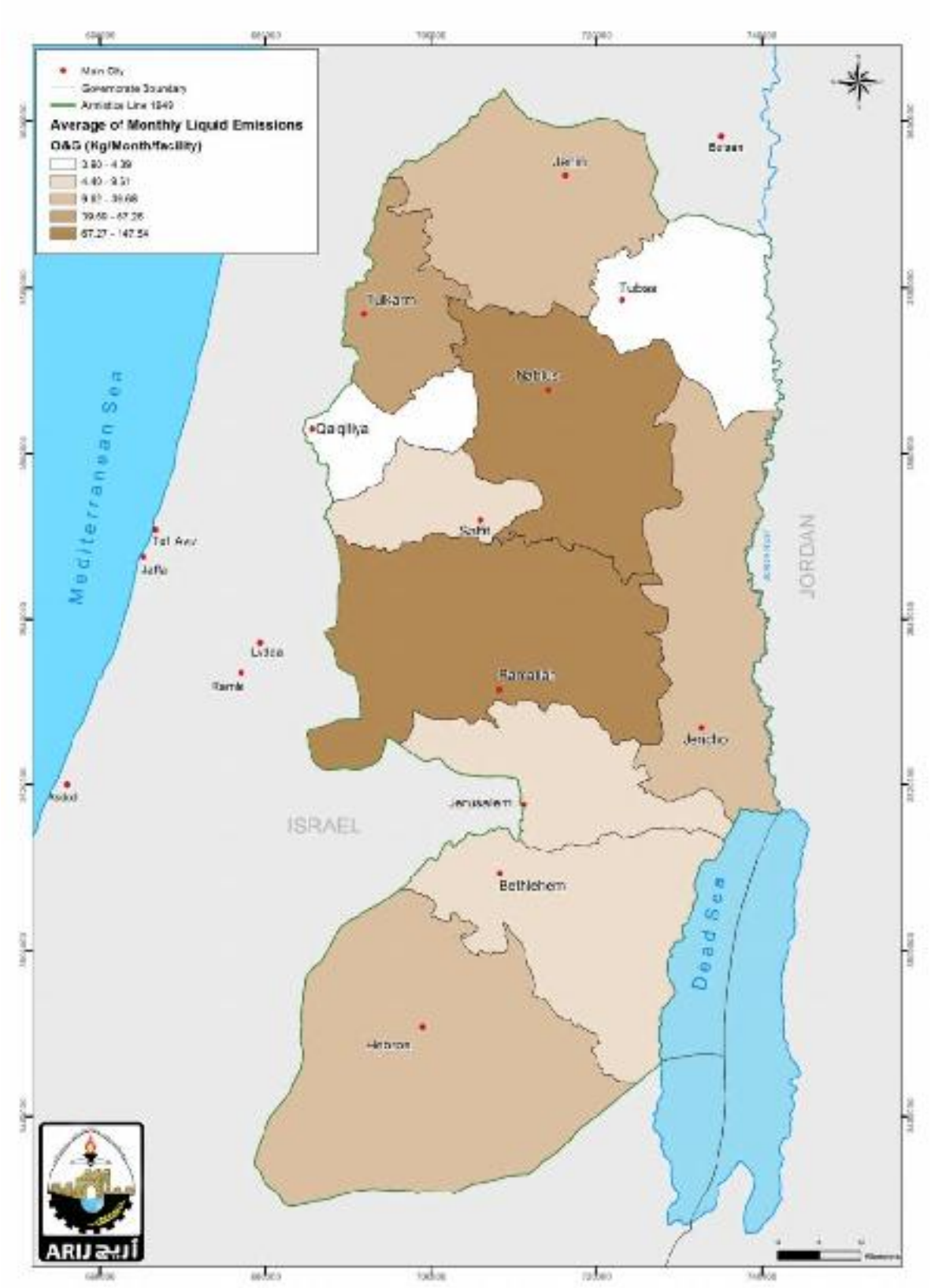
Map 1 presents the comparative average monthly TSS emissions in kilograms per facility across Palestine. It shows that the Ramallah, Nablus and Qalqiliya Governorates to have the highest average per facility emissions of TSS.



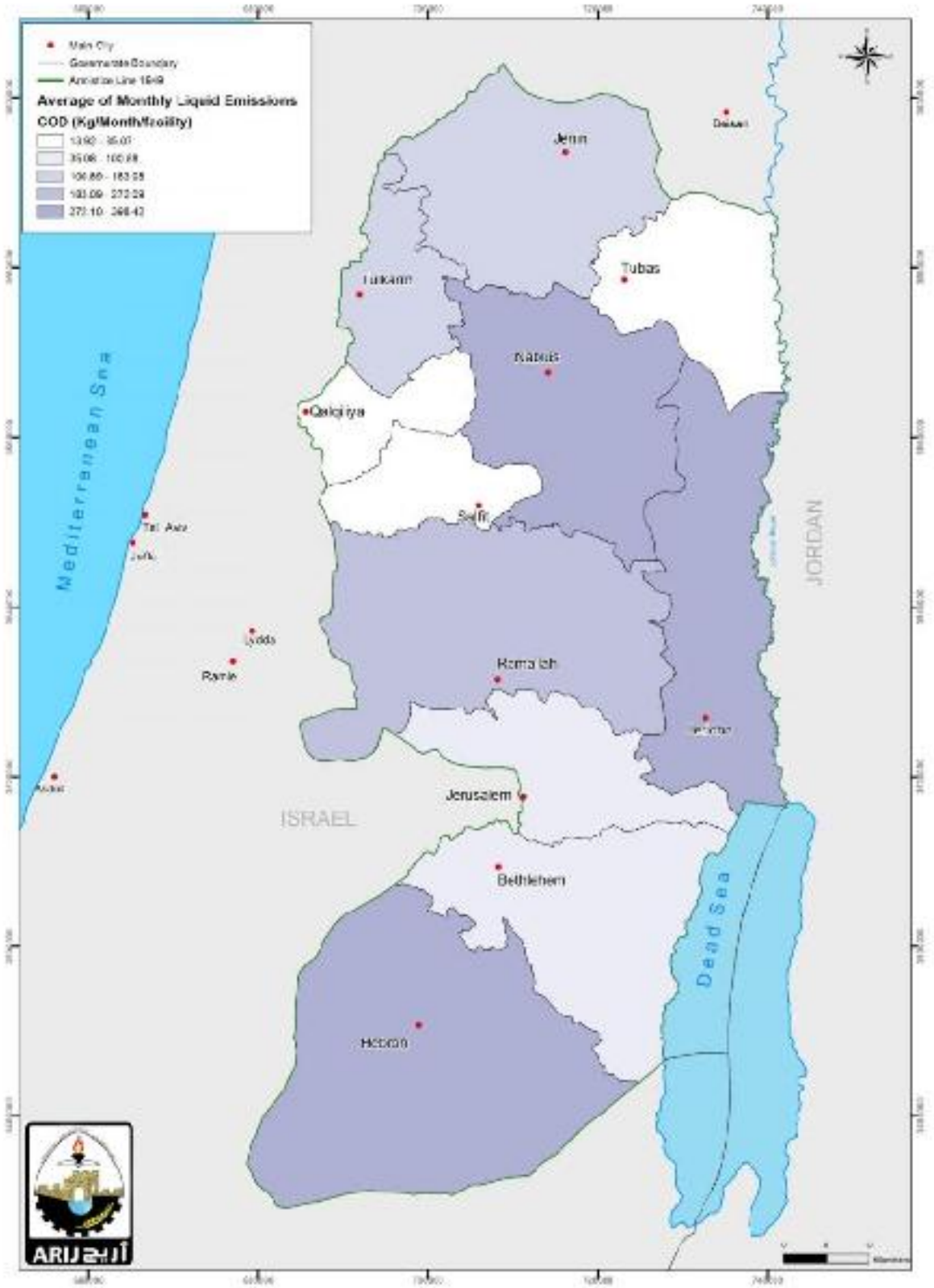
Map 2 presents the comparative average monthly P emissions in kilograms per facility across Palestine. It shows that the Ramallah and Nablus Governorates to have the highest average per facility emissions of P.



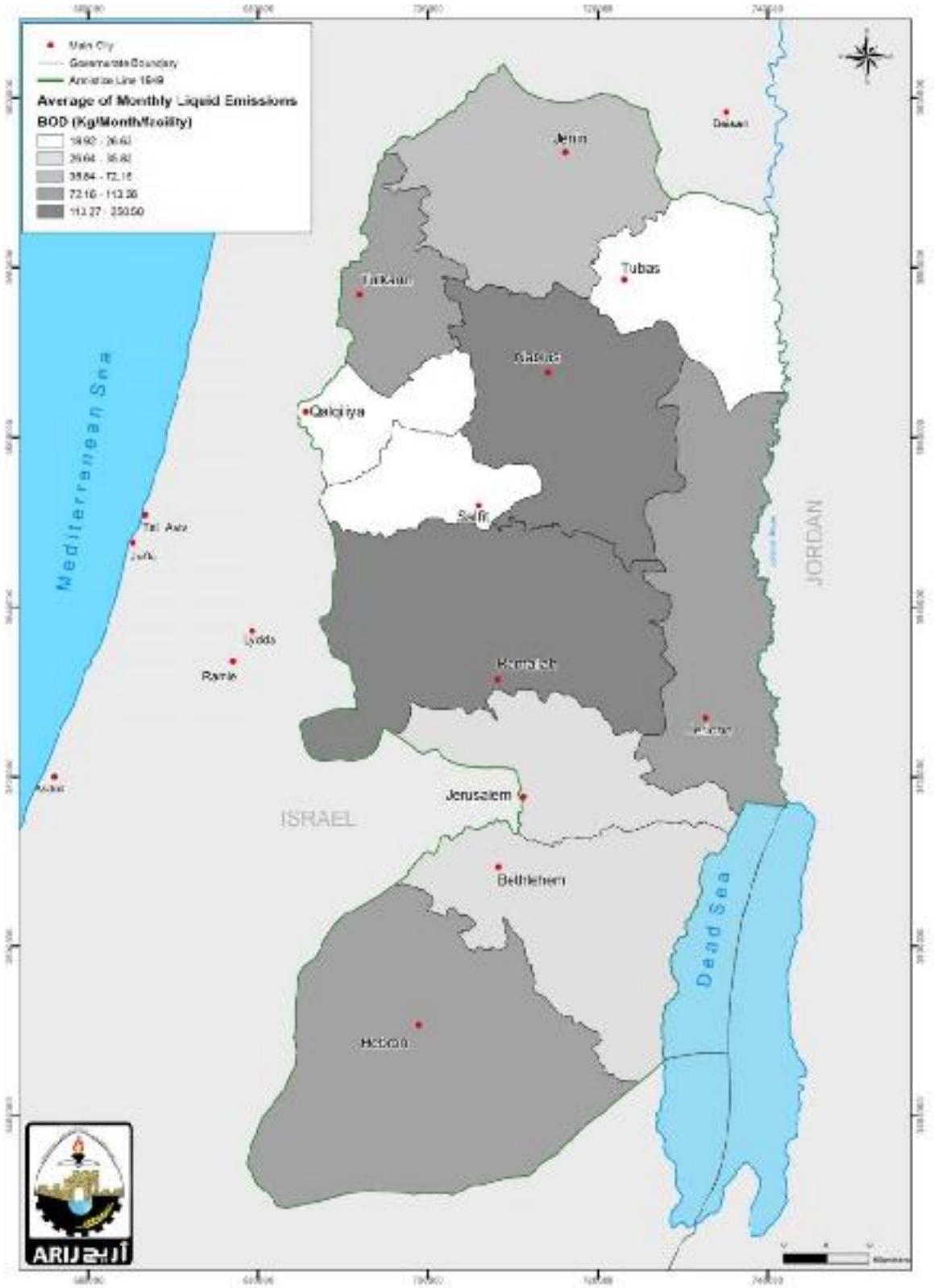
Map 3 presents the comparative average monthly O&G emissions in kilograms per facility across Palestine. It shows that the Ramallah and Nablus Governorates to have the highest average per facility emissions of O&G.



Map 4 presents the comparative average monthly COD emissions in kilograms per facility across Palestine. It shows that the Nablus, Jericho and Hebron Governorates to have the highest average per facility emissions of COD.



Map 5 presents the comparative average monthly BOD emissions in kilograms per facility across Palestine. It shows that the Ramallah and Nablus Governorates to have the highest average per facility emissions of BOD.



Appendix 3

Hotspot Analysis Methodology:

United Nations Environment Program published a technical guideline [26] which provides the following methodological steps:

1. Each stream for a facility was graded using the criteria provided based on the indicators and information gathered during the survey:

    - Human health (weighting factor = 2)
    - Drinking water quality (weighting factor = 2)
    - Environmental Health (weighting factor = 1)

The information gathered under the survey does not specify the exposure pathway for release of wastewater streams. Therefore, it is not practical to evaluate the impact of wastewater on the human health and drinking water quality. For this reason, it was assumed that all releases of waste water have detrimental effects on the environment and the severity of the effects depends on the quantities of the contaminants released.

The following weighting factors were assigned to the contaminants in the wastewater streams, considering the relative potential for the contaminant to cause health effects:

- BOD, COD, P = 1
- TSS = 0.3
- O&G = 1

For release to the atmosphere, the following weighting factors were used:

- PM_{10}, SO_x, NO_x, VOC = 1
- TSP = 0.2

TSP is ranked lower than PM_{10} because suspended particles with diameters larger than 10 microns have much less adverse effects on human health.

2. In order to weigh the risk in an equal manner, a weighting factor (w) depending on the importance of the effects on each criterion will be applied to the grades for each criterion.

$$G_s = \sum_i G_{si} w_{si}$$

where

G_s is hotspot grade for stream s
w_{si} is the weighting factor for each criterion i and stream s
G_{si} is hotspot grade for criterion i and stream s. These grades are based on the following:

- 0 for no effects

[26] United Nations Environment Programme (UNEP), 1999, Mediterranean Action Plan – Med Pol – Identification of Priority Pollution Hotspots and Sensitive Areas in the Mediterranean, Map Technical Reports Series No. 124 – UNEP and World Health Organization (WHO).

- 1 for slight effects
- 2 for moderate effects
- 3 for major effects
- 4 for severe effects
- 5 for extreme effects

The following weighting factors were considered for the criteria:

- Human health: weighting factor = 2
- Drinking water quality: weighting factor = 2
- Environmental Health: weighting factor = 1

The largest emphasis has been put on human health in this assessment.

3. The overall grades are then calculated using individual stream grades and weighting factors assigned to each of four streams as follows:

$$G = \sum G_i w_i$$

where

G is overall hotspot grade for each industrial facility
G_i is hotspot grade for stream i
w_i is the weighting factor for each stream i

The following weighting factors were considered for the streams:

- Discharge of pollutants to the atmosphere: weighting factor = 5 (maximum of 5 on the scale of 0 to 5) as it Stored quantities of materials on-site: weighting factor = 1 (relatively low potential of discharges from stored chemicals and fuels).

The surveyed information did not include the processing and disposal of solid waste on the site or release into the environment. Therefore, this stream was not considered for the analysis of the Hotspots.

- is assumed that air emissions will result in health effects.
- Discharge of pollutants to the surface water: weighting factor = 5 (maximum of 5 on the scale of 0 to 5) as it is assumed that water emissions will result in health effects.
- Solid waste generated: weighting factor = 0 (no effect from waste is expected as there are no discharges from the waste to the environment).
- Stored quantities of materials on-site: weighting factor = 1 (relatively low potential of discharges from stored chemicals and fuels).

The surveyed information did not include the processing and disposal of solid waste on the site or release into the environment. Therefore, this stream was not considered for the analysis of the Hotspots.

The following tables explain the example grades used for surface water discharges.

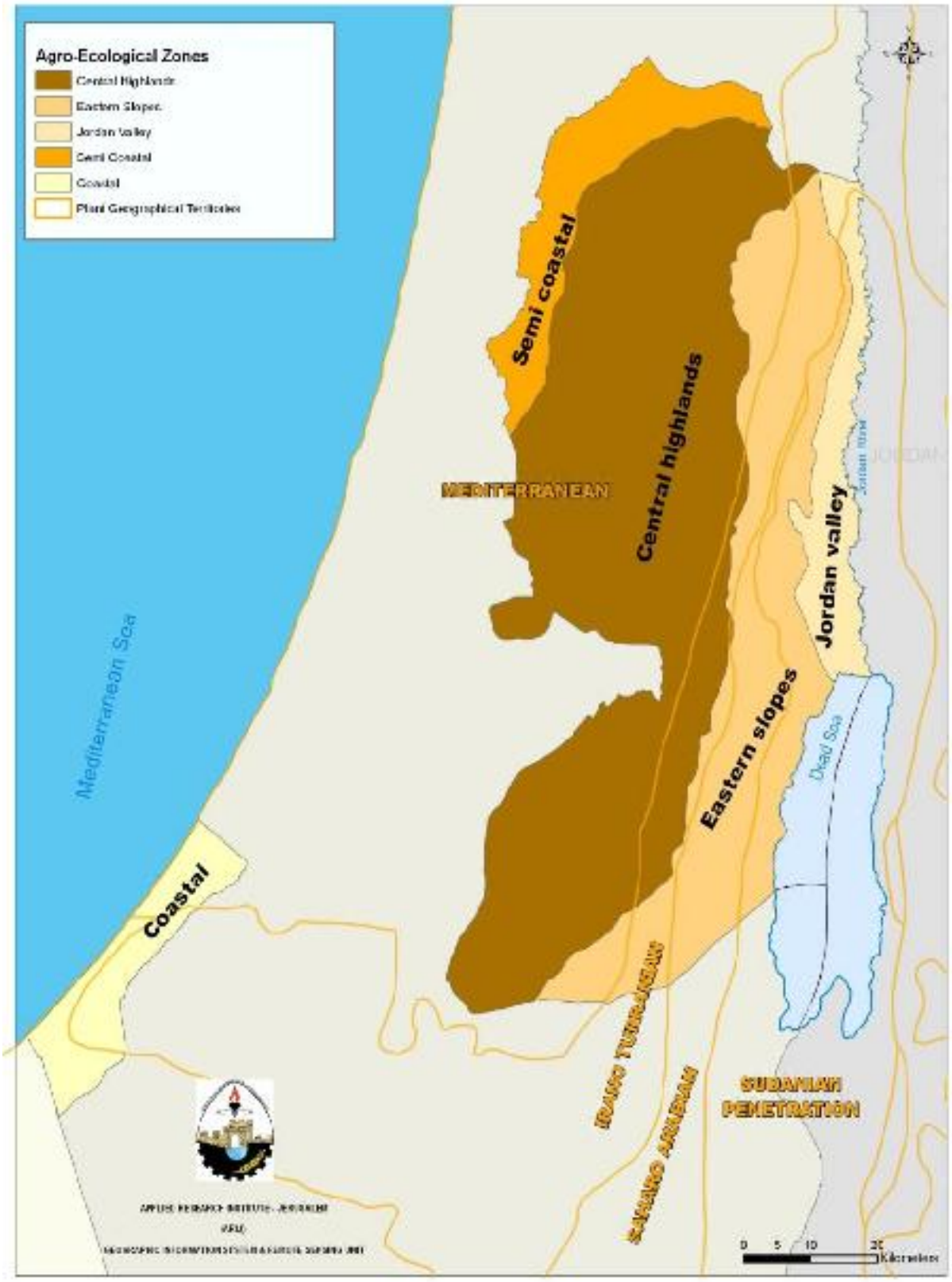
TABLE 1: EXAMPLE GRADES FOR CRITERIA FOR SURFACE WATER DISCHARGE

Public Health	
extreme effects (5)	Domestic wastewater loads of more than 30 tons BOD/day with no disinfection and having a high probability of direct contact to human beings.

	Wastewater containing more than 50 mg/L of heavy metals and having a possible contact to the public at the discharge point. Wastewater containing radioactivity or hazardous substances above WHO limitation.
severe effects (4)	Domestic wastewater loads of more than 15 tons BOD/day with no disinfection and having a high probability of direct contact to human beings. Wastewater containing more than 20 mg/L of heavy metals and having a possible contact to the public at the discharge point.
major effects (3)	Domestic wastewater loads of more than 10 tons BOD/day with no disinfection and having a high probability of direct contact to human beings. Wastewater containing more than 10 mg/L of heavy metals and having a possible contact to the public at the discharge point.
moderate effects (2)	Domestic wastewater or water containing heavy metals with no direct effect to human beings.
slight effects (1)	Any discharge which contains toxic substances or pathogens and is not mentioned in (3) - (5).
no effects (0)	Discharge with no effect.
Drinking Water Quality	
extreme effects (5)	Any wastewater directly discharged to a water body which is used as drinking water.
severe effects (4)	Any wastewater directly discharged to a water body which is not used as drinking water but is potentially a drinking water source.
major effects (3)	Indirect discharges to water sources with improper filtration.
moderate effects (2)	Indirect discharges to a water body with proper filtration.
slight effects (1)	Discharge representing a potential risk in emergency situations (flood, earthquake).
no effects (0)	Discharge with no effect.
Environmental Health	
extreme effects (5)	Any discharge which may reduce the oxygen content of the receiving body below 0.5 mg O2/L. Any discharge which contains a heavy metal concentration of more than 50 mg/L. Any discharge which contains an oil concentration of 400 mg/L.
severe effects (4)	Any discharge which may reduce the oxygen content of the receiving body below 1 mg O2/L. Any discharge which contains a heavy metal concentration of more than 30 mg/L. Any discharge which contains an oil concentration of 200 mg/L.
major effects (3)	Any discharge which may reduce the oxygen content of the receiving body below 2 mg O2/L. Any discharge which contains a heavy metal concentration of more than 20 mg/L. Any discharge which contains an oil concentration of 100 mg/L.
moderate effects (2)	Any discharge which causes oxygen depletion.
slight effects (1)	Any suspicious discharge.
no effects (0)	Discharge with no effect.

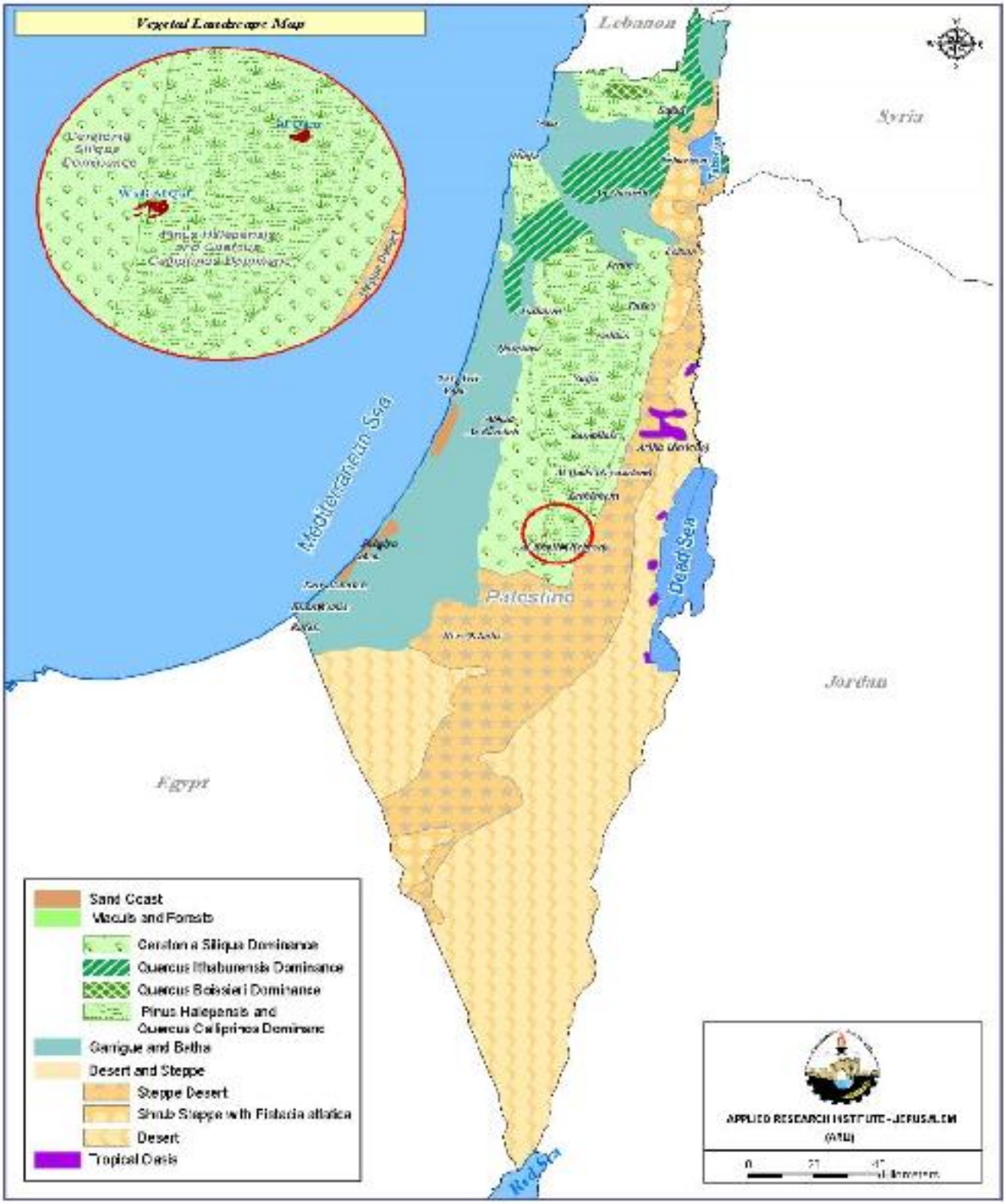
Appendix 4

Agro-Ecological Zones and Plant Geographical Territories in Palestine Map

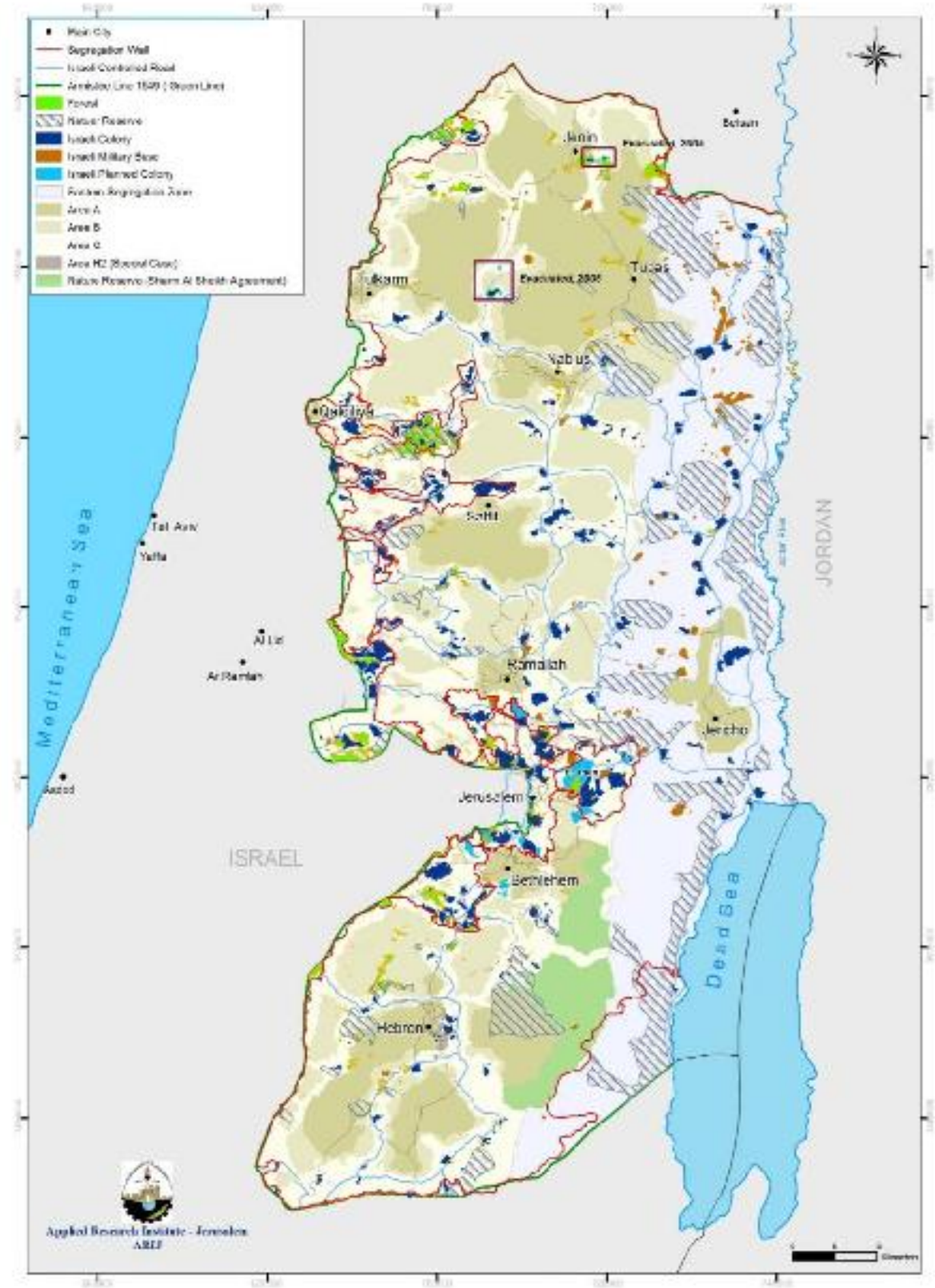


Appendix 5

Vegetal Landscape of Palestine Map



Appendix 6


Main City
Segregation Wall
Israeli Controlled Road
Armistice Line 1949 (Green Line)
Forest
Nature Reserve
Israeli Colony
Israeli Military Base
Israeli Planned Colony
Palestinian Segregation Area
Area A
Area B
Area C
Area H2 (Shared Civic)
Nature Reserve (Sharm Al Sheikh Agreement)
Jenin
Tubas
Nablus
Qalqilya
Salfit
Tel Aviv
Yafa
Al Lid
Ar Ramlah
Ramallah
Jericho
Jerusalem
Bethlehem
Hebron
Mediterranean Sea
Dead Sea
JORDAN
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