Environmental Profile for the West Bank

Volume 2

Jericho District

Applied Research Institute - Jerusalem
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Environmental Profile for The West Bank Volume 2: Jericho District

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List of Acronyms and Abbreviations

ADS	Arab Development Society
ARIJ	Applied Research Institute - Jerusalem
CMR	Child Mortality Rate
DEM	Digital Elevation Model
EC	Electrical conductivity
GDP	Gross Domestic Product
GIS	Geographic Information System
GNP	Gross National Product
IMR	Infant Mortality Rate
JAMC	Jericho Agricultural Marketing Cooperative
Mekorot	The National Water Company of Israel
NGO	Non-Governmental Organization
PARC	Palestinian Agricultural Relief Committees
PBS	Palestinian Bureau of Statistics
PCH	Palestinian Council of Health
PECDAR	Palestinian Economic Council for Development and Reconstruction
PNA	Palestinian National Authority
R.C.	Refugee Camp
R.H.	Relative Humidity
SAR	Sodium Adsorption Ratio
SAAR	Society for Austro-Arab Relations
UNRWA	United Nations Relief and Work Agency
WBWD	West Bank Water Department
W.	speed Wind speed

Measuring Units	
^{o}C	degrees centigrade
CM	cubic meter
m	meter
km	kilometer
km^2	square kilometer
MCM	Million Cubic Meters
ppm	parts per million
Dunum	0.1 hectare
Watt/m^2	Watt per Square meter

Introduction

With the high level of uncertainty about the environmental situation in Palestine following 28 years of occupation, environmental profiles are greatly important for assessing the status of the environment and as the background for a program to promote sustainable development. The Applied Research Institute launched a two year project in July 1994 to produce a series of environmental profiles for each district in the West Bank. The project is supported and financed by the Federal Government of Austria, Department for Development Cooperation, through the Society for Austro-Arab Relations in Jerusalem (SAAR). This volume is the second in the series. It describes the status of the environment in the Jericho District. The first volume was on the Status of the environment in the Bethlehem district which was published in June 1995.

The data presented in this volume have been collected by the ARIJ research team through field investigations using surveys and meetings with officials from municipalities, village councils, the United Nations for Relief and Work Agency (UNRWA), the agricultural institutions and the Jericho Weather Station. Also included is a review and analysis of previous publications .

Our aim here is to present an inventory of resources and describe the scope and extent of the environmental problems facing the district. Information concerning topography, climate, soil, land use, water resources, agriculture, wastewater and solid waste collection and disposal, pesticide usage and air and noise pollution is presented in this profile. In addition, it covers the socio-economic situation in the Jericho district and the existing historical and archeological sites existing in the district and their current status and state of repair. All maps included in this volume are produced by the GIS unit at ARIJ using ARC/Info and PAMAP software.

HISTORY AND BACKGROUND

Jericho district is located on the eastern boundary of the West Bank. For pure technical reasons, ARIJ defined the Jericho district boundaries according to the pre-1967 Jordanian and the current Israeli designation. Accordingly, the Jericho district extends from the Dead Sea in the south to the southern part of Fasayel in the north, and from the eastern slopes of the Jerusalem and Ramallah mountains in the west to the Jordan River in the east (Figure 1). The district has an area of approximately 35,330 hectares. Of this area, 591 hectares are inhabited by Palestinians and 517.4 hectares are occupied by Israeli settlements.

The only urban settlement in the district is the Jericho city which is considered by many to be both the oldest city in the world (dating from 7,000 BC) and the lowest city on earth (250 m. below sea level). It lies 10 km northwest of the Dead Sea and 7 km to the west of the Jordan River. While it has a desert climate, its abundant water sources give it the character of an oasis. It is this character which makes it an important agricultural area, especially for fruits and vegetables.

Like most of Palestine, Jericho was ruled by the Ottoman Empire until 1918 when the British took control under the United Kingdom Mandate for thirty years. It was this period, specifically on November 7, 1927, that an earthquake hit Palestine, killing around 350 people and demolishing some 800 houses, affecting areas up as far as Nablus area. Jericho city was at the epi-center of this earthquake.

Through the years, the location of the Jericho district at the eastern border of Palestine has led to widely fluctuating population due to the wars and political changes in the region. Between 1948 and 1967, the population of Jericho district was approximately 80,000, distributed mainly in Jericho city, Al-Auja village and the three refugee camps of An-Nuwe'ma, Ein Al-Sultan and Aqbat Jaber. Until 1967, approximately 86% of the population were refugees who fled from the coastal areas and the Galilee during the 1948 war. After the 1967 war, refugees were forced again to leave, fleeing to Jordan, Lebanon and Syria. As a result, An-Nuwe'ma refugee camp (R.C.) was evacuated and Aqbat Jaber lost around 80% of its population. The present population of the district is estimated at 21,500 Palestinians, living in the city of Jericho, the four villages (Al-Auja, An-Nuwe'ma, Dyouk Al-Tahta and Dyouk Al-Fouqa) and the two refugee camps (Ein Al-Sultan And Aqbat Jaber). There are also an estimated 1,325 Israeli settlers (262 families) living in eight Israeli settlements, and another unknown number of settlers in the six settlements in the district.

In general, compared to other districts in the West Bank, the district has low population density. In large part, this is due to the large Israeli designated closed military areas, military bases, nature reserves, and the 14 Israeli settlements located there.

The current Palestinian-Israeli peace negotiations which was initiated on September 13, 1993 in Washington, with the signing of the Declaration of Principles on interim self-government arrangements, was followed by an interim agreement on the autonomy of the Gaza Strip and the Jericho Area, signed in Cairo on May 4, 1994. This interim agreement provides a limited interim transfer of authority from the Israelis to the Palestinians over the Gaza Strip and Jericho area. Palestinians have a limited control over an area of 6,130 hectares of the Jericho district. This area includes Jericho city and Al-Auja village only (Figure 2).

The "Taba agreement," recently signed in Washington on September 28, 1995, marks the next phase in the Oslo process. This interim agreement will give the Palestinian Authority autonomy over cities, towns, villages, refugee camps and hamlets, in the West Bank, with Gaza maintaining its status from the Cairo Accords. Israeli military forces will redeploy from the populated areas in the West Bank, but will maintain control over security areas, and areas to be decided in the final status negotiations. The agreement specifies the area of Jericho as stretching from the area of Quruntul just to the west the city of the Jericho, to the north-east of the city. Roadblocks, which had significantly impaired movement in and out of the city from the implementation of the Cairo agreement, are to be removed.

Chapter One
Topography And Climate

Topography

A digital elevation model (DEM) for the Jericho district, containing Z-value with pixel size of 200 m was created by the GIS unit at ARIJ. This model is constructed using the finite difference technique of the Topographer Model of the Pamap GIS software version 4.1. The finite difference technique is considered to be suitable for using trend data as the input data. The trend data represents the overall shape of the terrain. It is usually contour lines but can also be three dimensional lines with varying elevation.

Figure 1.1 represents the producing DEM, which is themed using the threshold table with an interval of 100 m. Themes are colored values that give a quick and effective method for identifying features and areas that meet specified criteria. The threshold table is simply a theming table which converts the surface cover's values into different classes for display purposes. The surface cover's pixel values do not change when a threshold table is imposed onto a surface. The threshold table simply tells GIS software which color to use when displaying certain pixels.

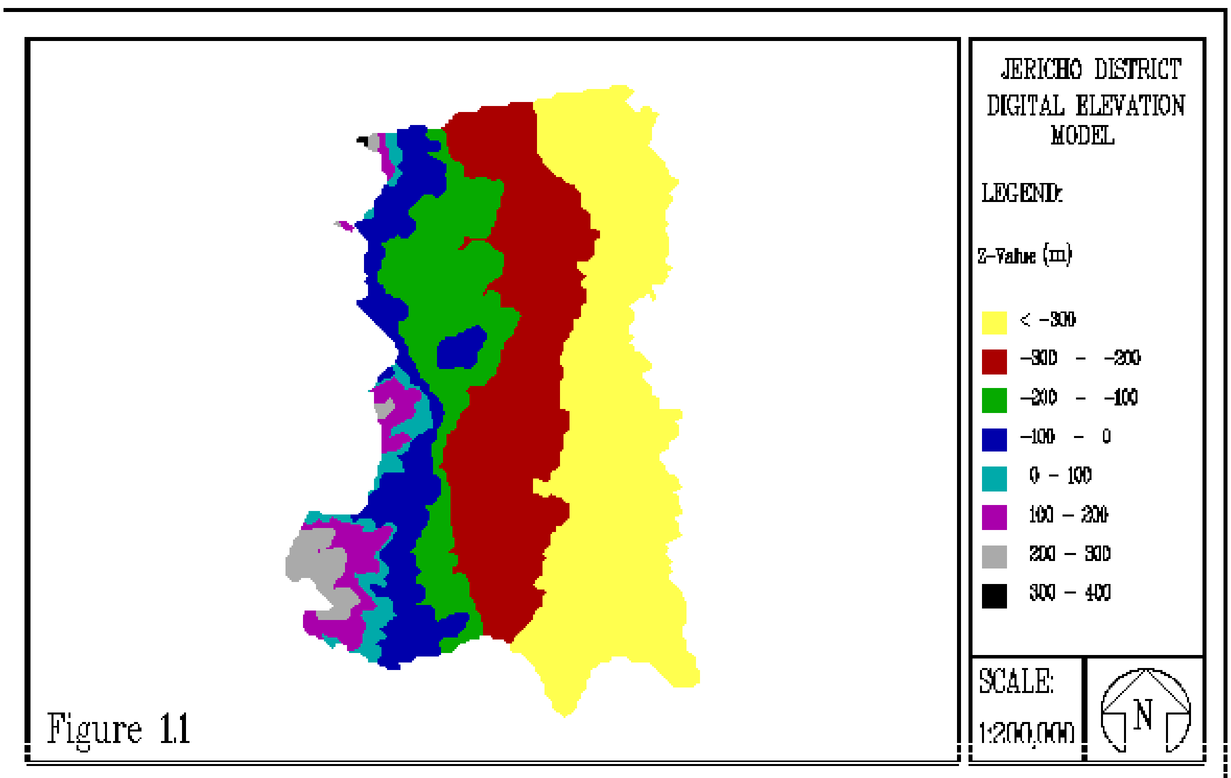


Figure 1.1

ARIJ has produced two types of contour maps. A contour map, based on the created digital elevation model (Figure 1.2) with a contour interval of 100 m. Smaller contour intervals can be created by using the DEM. The other produced contour map based on the maps produced for Palestine by the British survey in 1942 (Figure 1.3). The topography of the study area shows a continuous decrease in elevation in the Jericho district from about 350 m above sea level at the northeast border of the district to about 370 m below sea level at the area adjacent to the Dead Sea. Most of the Palestinian built up areas in the district are located at an elevation of 100 to 300 m below sea level.

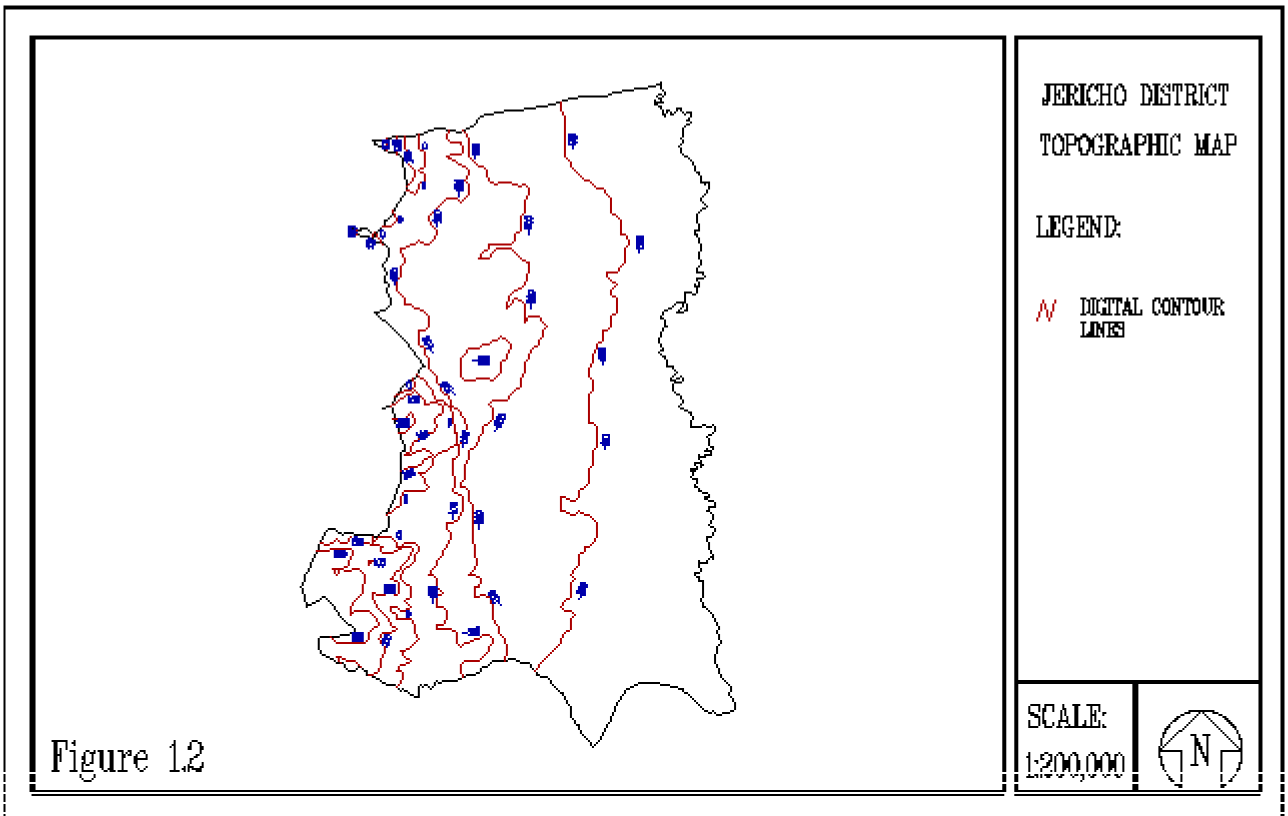


Figure 1.2

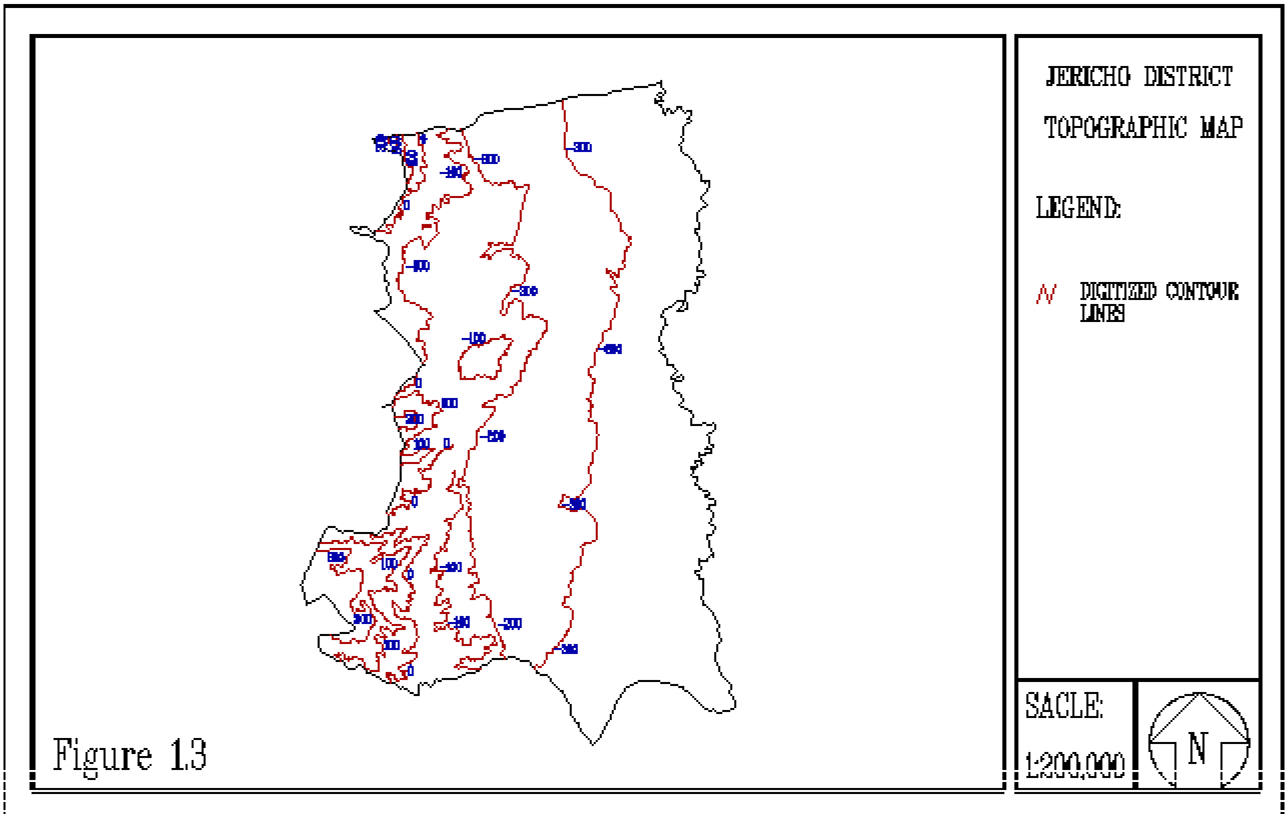


Figure 1.3

Six main wadis cross the Jericho district, namely Wadi Al-Mallaha, Wadi Al-Auja, Wadi Abu Ubeida, Wadi An-Nuw'ema, Wadi Al-Qilt and Wadi Al-Ghazal (Figure 1.4). Wadi Al-Mallaha runs northsouth, while the remaining five wadis run eastwest. Wadi Al-Auja and Al-Qilt have permanent water flow while the rest are intermittent.

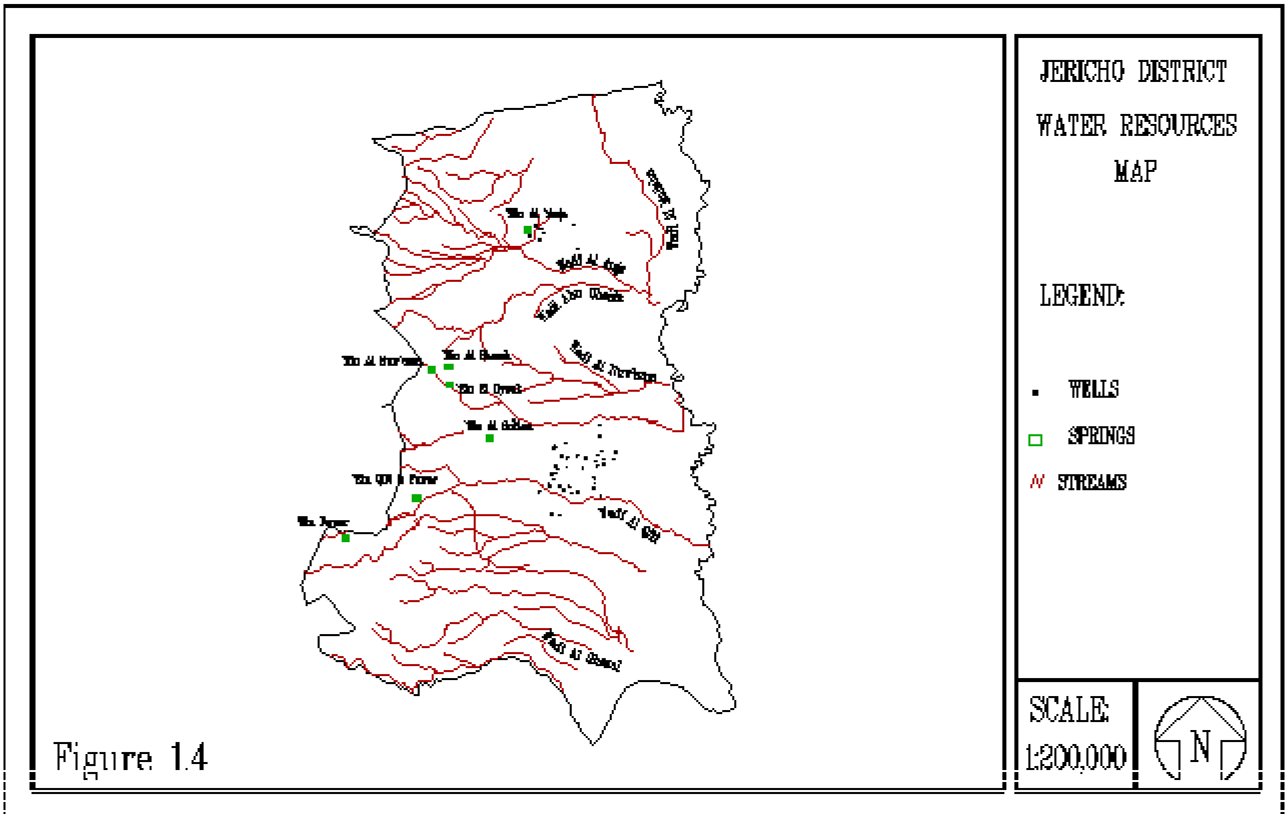


Figure 1.4

Climate

The climate of Jericho district is classified as arid, which has hot summers and warm winters with very rare frosts incidents.

Temperature:

The location of the Jericho district to the east of the highlands prevents the benefits of the northwestern wind that cools the rest of the West Bank especially in the Summer time. The temperature increases from north to south contrary to the altitude. January is the coldest month, and August the warmest. The average maximum temperatures during January (coldest month) and August (hottest month) are around 19oC and 38oC respectively. The average minimum temperatures for the same months are around 7oC and 22oC respectively (Orni, 1980). The highest maximum temperature recorded between 1970 and 1981 reached to 49oC in June and the minimum was -1oC in December/January (Israeli meteorological services, 1994).

Wind:

The average daily wind speed in the district is around 3.27 m/sec. Throughout the year, the daily wind direction in the Jericho city changes from a northwestern at night to southern in the early morning, with a speed of 3 m/sec (Kessler).

The southern wind starts from the Dead sea at approximately 8:00 a.m. until 12:00-2:00 p.m., turning gradually to the north by northwest and reaching its peak at 6:00 p.m., with a general average speed of 5 m/sec (Kessler).

During spring, the maximum wind speed is measured at 15 m/sec, often reaching to 20 m/sec from west to northwest. The maximum wind speed through the rest of the year reaches to 12 m/sec. The effect of the *Khamaseen* wind (hot, dry and sandy wind blowing from the Saudi Arabia) on agriculture is limited because it comes after the end of the growing season. (Kessler)

Radiation:

Data collected from the Jericho weather station indicate that the solar radiation reaches its peak during July. The total annual solar radiation measured for the period between June 1994 and May 1995 amounts to 62,520 watt/m^2 (Jericho weather station, 1995). The total incoming radiation at the district is thus high, which bring great benefit to agriculture and greenhouse cultivation. Figure 1.5 shows the monthly variation in radiation for the year 1994/95.

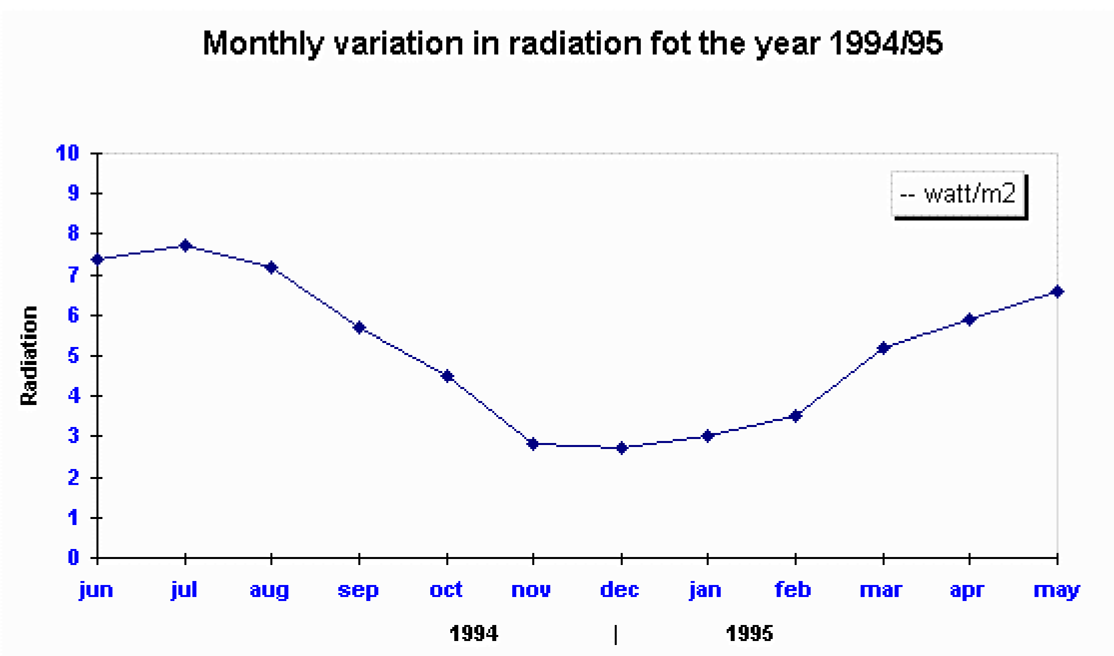


Figure 1.5 - Monthly variation in radiation for the year 1994/95.

Rainfall:

The rainy season in the Jericho district starts in the middle of October and continues to the end of April. Rainfall showers are particularly violent and short in duration Both rainfall and dewfall decrease from the northern to southern part of the district, contrary to temperature and evaporation. According to the Jericho weather station, the mean annual rainfall at the Jericho city for the period 1968-1992 was 166 mm (Figure 1.6). In general, the Jericho district has little rain and short rainy season ranging between 20-25 rainy days per year (Israeli meteorological service, 1994).

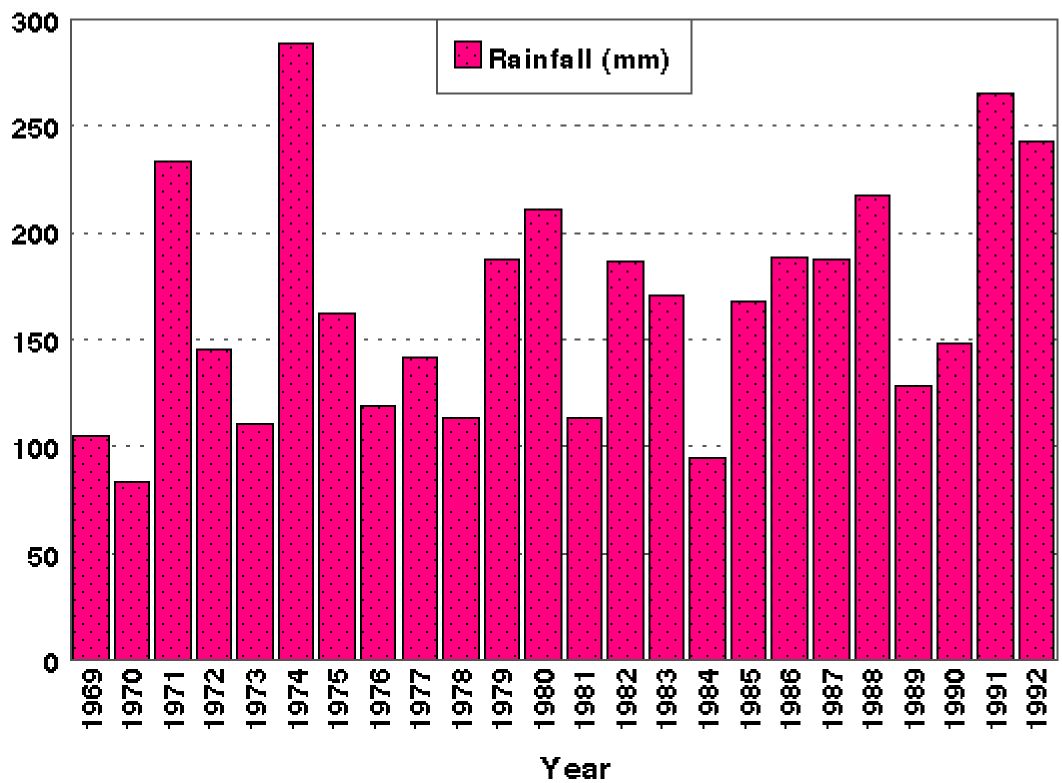


Figure 1.6 - Annual rainfall in mm for 1969-1992

Snow and hail are uncommon in the district. In 1950 snow fell heavily on the Jericho district covering the hills and valleys. Since that year, Jericho district has not seen snow again.

Humidity:

The mean annual relative humidity in Jericho district is about 50%. It reaches its highest rates in winter, amounting 70% during the day time and approximately 85% during the night. During summer, the relative humidity ranges between 45-60%, dropping to as low as 5% when the temperature is very high. In the spring, the relative humidity reaches around 60% with a mid-day average of 30%, despite the presence of the southern wind which is common during this season (Kessler).

Evaporation:

The evaporation rate in the Jericho district is very high varying between 59 mm when solar radiation is lowest and 298.5 mm in July when solar radiation is at its highest (Meteorological service, 1994). During the spring and autumn, the total amount of evaporation reaches 200-250 mm/month (Kessler). The variation in evaporation is affected by the changes in sun radiation. Figure 1.7 shows that in the Jericho district, evaporation exceeds precipitation during the year, giving an indication that irrigated agriculture is necessary.

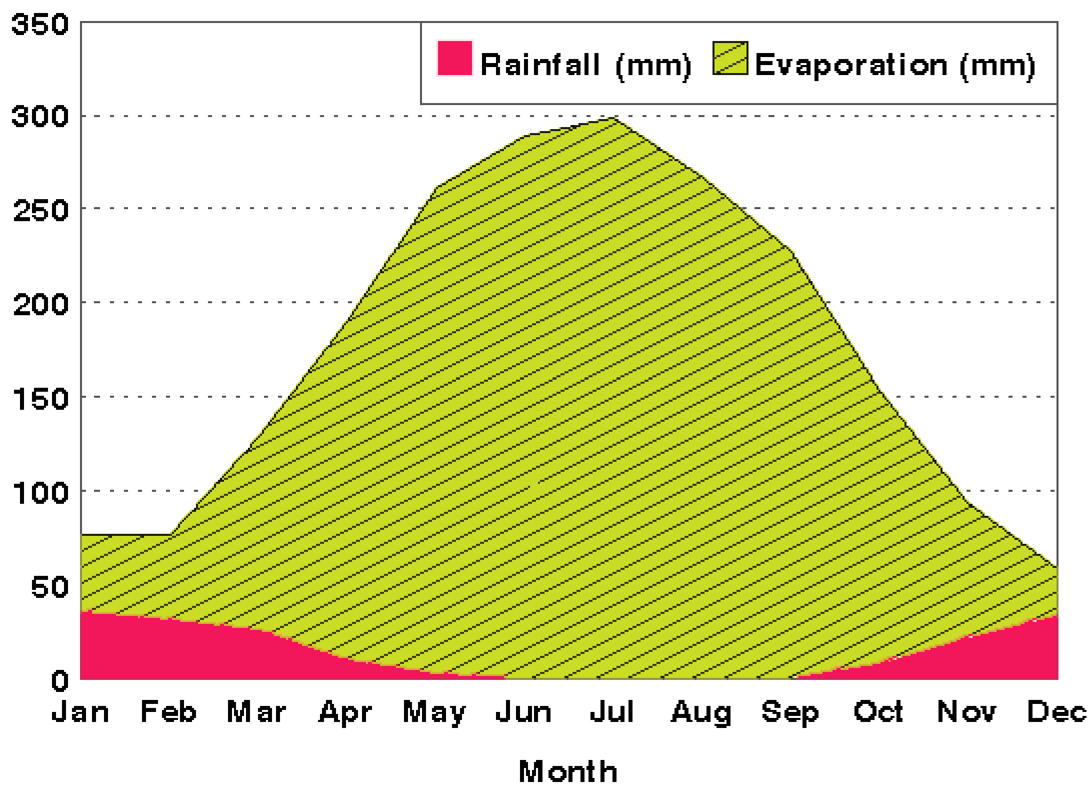


Figure 1.7 - Monthly rainfall and evaporation in the Jericho district for 1969-1992

Table 1.1 Average climatic parameters in the Jericho district from 1969-1992

	Rainfall (mm)	Max.Temp (oC)	Min.Temp (oC)	Pressure (Mb)	Evap. (mm/month)	W.speed (m/sec)	R.H. %
Jan	35.73	19.15	7.43	1048.03	76.88	2.48	69.8
Feb	30.7	20.88	8.32	1045.80	76.72	2.88	65.4
Mar	25.4	24.34	10.54	1043.86	128.65	3.64	57.2
Apr	9.83	29.31	14.15	1041.06	189.3	4.5	44.6
May	2.04	33.7	17.58	1039.56	261.64	4.4	38.1
Jun	0.28	36.69	20.36	1036.94	289.2	4.26	38.2
Jul	0.00	37.8	22.12	1034.19	298.53	4.45	40.5
Aug	0.00	37.59	22.41	1034.82	267.0	4.08	44.0
Sept	0.38	36.07	21.14	1038.50	226.61	3.48	47.2
þOct	7.19	32.32	17.94	1042.15	153.59	2.6	51.2
Nov	21.84	26.38	12.93	1045.73	93.6	2.16	59.5
Dec	32.96	20.54	8.95	1047.72	59.21	2.04	70.2

Source: Data collected from the Israeli Meteorological services.
Table Notes: Max: Maximum
Min.: Minimum
Evap. : Evaporation
W.: Wind
R.H. : Relative Humidity

Chapter Two
Socio-Economic Characteristics

Demography and Population

The population of the Jericho district is estimated at around 21,500, representing approximately 1% of the total population of Palestine. This number includes the two refugee camps of Ein Al-Sultan and Aqbat Jaber. Jericho city is the only urban area in the Jericho district and its population represents around 64.2% of the population. The inhabitants of the refugee camps represent 22.5% while the inhabitants of the villages represent 13.3% of the total population in the district (PBS, 1994). Population figures for the year 1994, indicate that around 58% of Jericho city residents were between the ages of 0-19, 24% are between 20-34 and 10% are between 35-54 (Israel Information Service Gopher, 1994). These figures indicate that over than half of the population are dependent and lack self reliance.

Infant and child mortality rates (IMR and CMR) are indicators of the well-being of children in any country, reflecting the health and socio-economic status of the population. For Palestine, all the available figures for infant mortality are general and not specific for one region or district (Heinberg & Ovensen, 1993). Infant mortality rates have been increasing since 1990, reaching in the West Bank 21 deaths per 1000 live births. Moreover, the life expectancy is approximately 72 years, and the birth rate was estimated at 44 births per 1000 in 1992 (Abu-Libdeh, 1993).

Approximately 68% of the working age population (16-59) in the district has jobs. Out of this number, 46% is permanently employed, 49% has seasonal employment and 5% has part time employment (PARC & Arab Thought Forum, no. 5, 1994).

In 1991, the per capita Gross National Product (GNP) in Palestine was estimated at US$1,715, and the Gross Domestic product (GDP) at US$1,275. Unfortunately there are no figures for each district within the West Bank (World Bank, 1993).

Institutions, Societies and Organizations

Provision of services for the Jericho district is not limited to the governmental and civil administration institutions. The district contains other charitable societies and non-governmental organizations (NGO's) that fill the gaps in governmental services. The Palestinian National Authority was taking control over these institutions since September 1994. The following is a list of the main institutions:

- Jericho Culture and Art Center.
- Jericho Chamber of Commerce.
- Red Crescent Society.
- Women of Jericho Society.
- Young Women Christian Association (YMCA).
- Arab Development Society Project.
- Jericho Agricultural Marketing Cooperation.
- YMCA Vocational Training Center.
- Care of Martyrs' Children Society.
- Palestinian Agricultural Relief Committees.

Housing & Infrastructure Services

The majority of the land in the Jericho district is owned by Jerusalemites, while managed by feudal tenure and share cropping systems. Moreover, the *Awqaf* (the body responsible for the maintenance of Muslim holy sites) owns large areas of lands in the district, roughly estimated at 7000 hectares mainly located in the Al-Auja area. These areas make up approximately 90% of the total land owned by the *Awqaf* in the West Bank, though the Israeli authorities have confiscated around 3.4 thousand hectares of this area.

While traditionally the main material used in house construction in most of the West Bank is either stone or cement, the Jericho district differs with their use of mud brick. Until 1945, houses in the district were built using almost entirely mud bricks. Today, more than 52% of the houses in the Jericho district are still made up of mud brick (Encyclopedia Palestina, 1984). This might be explained by the cooler effect which mud brick provides in high temperature weather conditions (Arab Thought Forum, 1987).

The average household size in the West Bank is 7 persons. The standard international measurement of housing density is the number of persons per habitable room within a housing unit. Since there are no specific figures for Jericho district, it is assumed that this district has similar figures to the rest of the West Bank. The following list shows the number of persons per room by locality in the West Bank and in Israel (Barghouthi & Daibes, 1993):

- West Bank Towns 1.7 persons/room
- West Bank Villages 2.0 persons/room
- West Bank Camps 2.2 persons/room
- Israel 0.8 persons/room

Domestic Water Supply:

A groundwater well adjacent to the Al-Sultan spring, in the center of Jericho city, is the major source of water in the city. Leakage is very high through out the network, thus increasing the measured per capita water consumption. Al-Auja and Nuwe'ma villages are supplied with domestic water from the West Bank Water Department (Mekorot). The remaining of the communities obtain their domestic water from Palestinian owned groundwater wells.

Wastewater Disposal Facilities:

The Jericho district lacks any wastewater disposal network. All inhabitants depend on cesspits for sewage disposal. The Palestinian Economic Council for Development and Reconstruction (PECDAR) is currently studying a plan to construct a wastewater collection network for Jericho city (ARIJ survey, 1995).

Solid waste Collection Services:

Nearly all of the population in the Jericho city and Al-Auja village have access to solid waste collection services. Refugee camps receive their services from the UNRWA, however, are insufficient to cover all of the camps population Villages such as Nuwe'ma and Al-Dyouk lack any kind of solid waste collection services. In these areas, the solid waste is dumped and burned near the houses or on vacant land (ARIJ survey, 1995).

Electricity Services:

The entire population in the Jericho city and the surrounding area receive electricity from the Jerusalem District Electricity Company (Israel Information Service Gopher,1994). The electric supply in the rural areas of the Jericho district, as is the case in the rural West Bank as a whole, is erratic. Less than 50% of rural households have 24-hour electric supply (Heinberg & Ovensen, 1993).

Transportation Services:

Three types of transportation services are available in the Jericho district, similar to other districts in the West Bank. These are buses, public taxis and private taxis (Barghouthi & Daibes, 1993).

The Jericho city is also the passenger terminal for Palestinians to exit the country to Jordan through the King Hussein (Allenby) Bridge.

Telecommunications:

There is one SE 50-telephone exchange with a capacity of 1500 lines in Jericho, connected to the district network. Two electronic connectors provide another 240 lines from the Ramallah exchange (Israel Information Service Gopher, 1994).

Health Care Sector

Over the past 28 years, the health services in the Jericho district have been provided by four distinct and almost completely uncoordinating bodies: the government, controlled by the Israeli authorities, the private Palestinian sector, the charitable and non-governmental organizations (NGOs) and the UNRWA services which is directed toward the refugees.

The health sector is one of five sectors which has been transferred to the Palestinian National Authority (PNA) since September 1994. Since then, the PNA established the Ministry of Health, taking full responsibility for health issues and services in the West Bank and Gaza Strip. The following are the health services available to residents in the Jericho district.

Primary health care clinics:

There are 13 primary health care clinics in Jericho, of which six are sponsored by NGOs, four by the public sector and the remaining three are provided by UNRWA (PCH, 1994).

Hospitals:

A single governmental hospital provides health services in the Jericho district. This general hospital has 52 beds, five of which are designated for maternity cases. The hospital has no distinct departments and its staff is comprised of four specialist physicians, two resident physicians, 16 nurses, two laboratory technicians, one radiology technician and one anesthesiologist (PCH, 1994). In general, the health services provided by this hospital are not sufficient and do not meet the needs of the population, therefore people are often obliged to travel to other districts or Israeli hospitals for treatment.

There are three ambulances in the Jericho district, owned by the Red Crescent, UNRWA and the government hospital (Greek Catholic Convent Clinic).

A local committee administers a rehabilitation center in the Jericho city, which houses fourteen children aged 5-15 years with moderate mental disabilities. The center offers rehabilitation and special education services. The staff comprises two psychologists and education specialists and two other employees with in-formal training (Bargouthi & Daibes, 1993).

Medical and Health-Care Personnel:

The total number of human health resources at the primary health care centers in the Jericho area are 15 physicians, one dentist, 12 nurses, one midwife, three paramedics, 16 health educators, two assistant pharmacists and one lab technician (PCH, 1994).

Educational Sector

Since 1967, the educational establishments in the Jericho district as well as in the West Bank was operated either by the Israeli Civil Administration, UNRWA or the private sector. Education in general, during the occupation period, faced many serious problems such as poor teaching conditions and inadequate facilities. The school system is based on three cycles Kindergartens, primary schools (elementary + preparatory) and secondary schools. The Bethlehem Directorate of Education was responsible for the education sector of the Bethlehem and Jericho districts. Recently, in late 1994, the control of the educational sector was transferred from the Israeli authority to the Palestinian National Authority (PNA). Since then, the responsibility of the education in the Jericho district has been separated from Bethlehem district and transferred to the Jericho Directorate of Education.

According to the statistics of the Bethlehem Directorate of Education for the year 1993/94, the total number of schools in the Jericho area is approximately 20, of which 7 are governmental, 3 are UNRWA and 10 are private schools. The Jericho district also has two vocational schools (YMCA and Care of Martyrs' Children society) and one private vocational training center (ADS). Close to 4670 pupils are studying in the Jericho area (Israel Information Service Gopher, 1994).

Chapter Three
Geology, Land Use And Soils

Geology

The geology of Jericho district is characterized by the Jordan rift valley deposits which are mainly composed of Marl & Pleistocene Alluvial formations. The geologic formations in the Jericho district, as shown in the geological map (Figure 3.1), are:

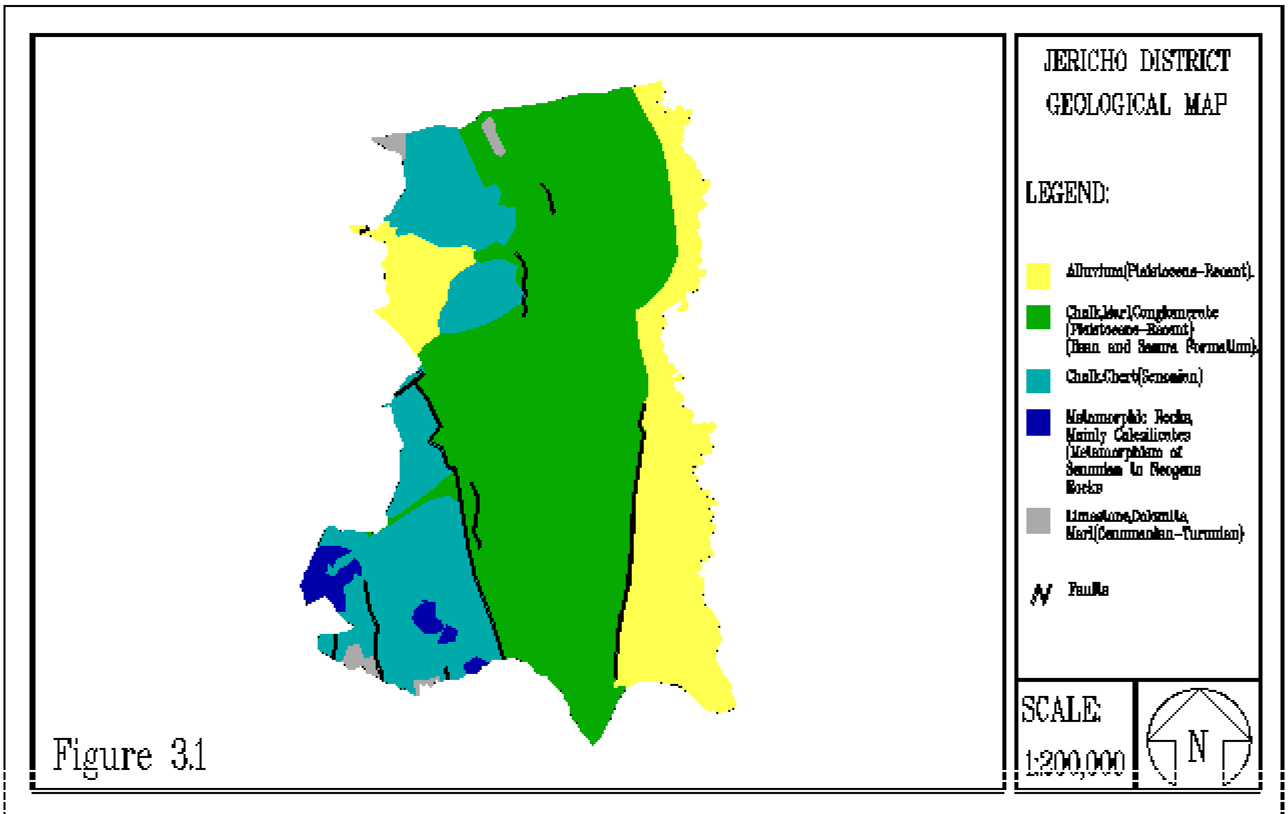


Figure 3.1

I. Alluvium Formation:

This formation covers the area adjacent to the Jordan Valley starting by a width of 1 km in the north and 5 kms in the south. It is of the Pleistocene to Recent in age. It is bounded structurally by the Jordan rift regional fault in the east and another fault of 12 km long in the west.

II. Lisan & Samra Formation:

This formation covers the greatest part of the Jericho district. It is of the Pleistocene to Recent age, and includes three local faults of up to 3 kms long. This area is bounded by the alluvium formation in the east and by a greater fault of about 13 kms long in the west. It is mainly composed of marl, chalk and conglomerates.

III. Chalk and Chert Formations:

These formations occupy the western part of the Jericho district. They are composed of the Senonian Chert and Chalk deposits and are covered structurally by minor faults.

IV. Metamorphic rock formations of Senonian to Neogene ages:

These formations are composed mainly of calcium silicates. They occupy small areas within the Chalk and Chart formations.

V. Dolomitic Limestone Formation:

This formation is composed mainly of limestone, dolomite and marl. It is of Cenomanian-Turonian in age, and occupies very small portions of the southwestern and northwestern parts of the Jericho district.

The system of faults distributed all over the district are responsible for the main emerged springs.

Land use

Jericho district has a total area of 35,330 hectares (353,300 dunums). Five major land use classes can be distinguished in the district. These are Palestinian built-up areas, Israeli settlements, closed military areas and bases, nature reserves and cultivated areas (Figure 3.2). Of the total area, the Palestinian and Israeli built up areas occupy approximately 1.7% and 1.5% respectively.

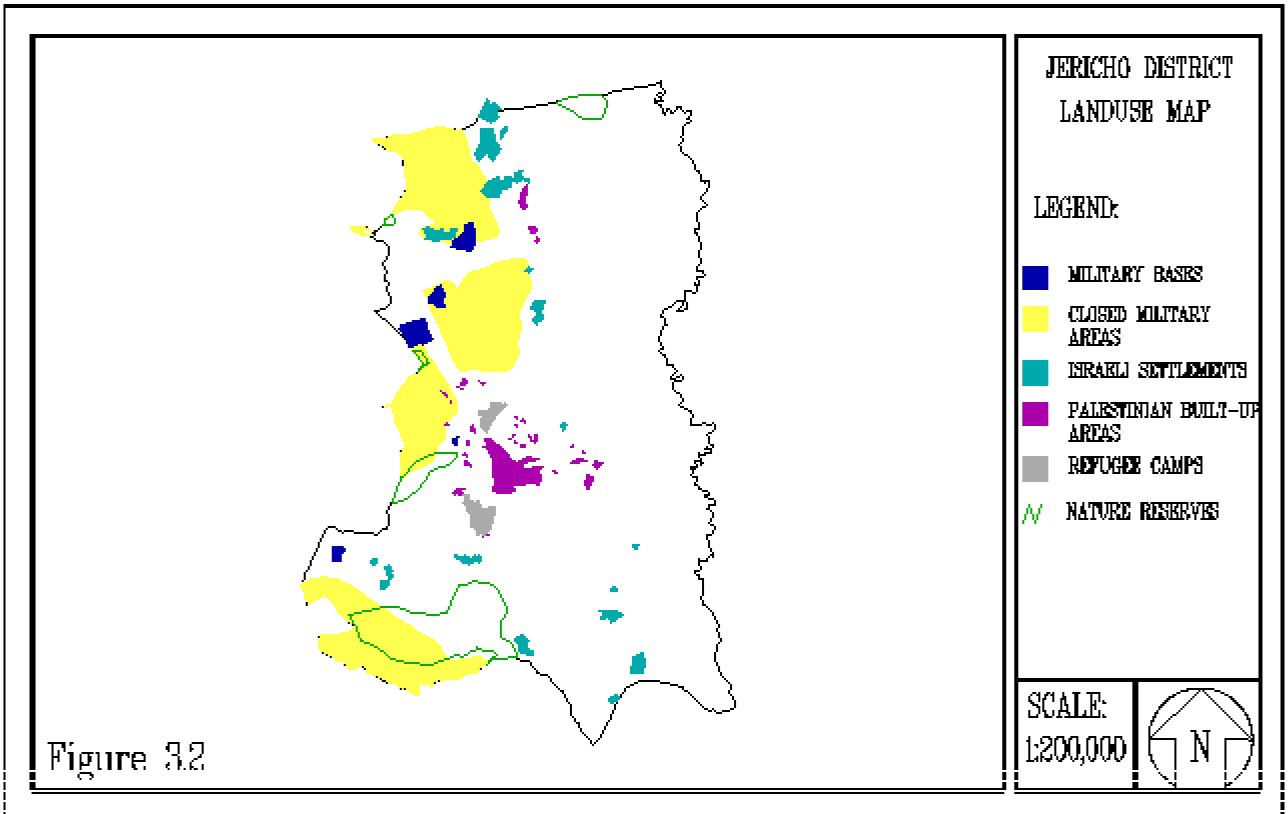


Figure 3.2

I. Palestinian built-up areas

There are seven Palestinian built-up areas in the district. The Jericho city is the only municipality in the district, while Dyouk El-Tahta, Dyouk El-Fuka, Nuwe'ma, Al-Auja are classified as villages. In addition there are Aqbat Jaber and Ein Al-Sultan refugee camps (Figure 2). These areas collectively account for approximately 591 hectares. The Palestinian built-up areas are located on either alluvial and brown soils, which are considered to be the most suitable soil for agricultural purposes in the district, or loessial serozems soils which are covered with pasture plants.

II. Israeli settlements

There are 14 Israeli settlements in the district. These are Gilgal, Netiv Hagedud, Niran, Yitav, Zori, Na'ma, Elisha', En Hogla, Bet Ha'erava, Lido Yehude, Atraqzia, Mizpe Yeriho, Vered Yeriho and Almog (Figure 2). These settlements occupy approximately 517.4 hectares of land, and are located on different soil associations. Elisha', for example, is found on alluvial arid brown soils, which are considered to be the most suitable soil for agriculture in the district, while Atraqzia is found on Solonchalks, which is used for agricultural purposes if intensively managed.

III. Closed military areas and bases

Closed military areas take up approximately 5,844 hectares in the district. The Israeli army claims these areas are of security importance and are used for military training purposes. In addition, there are six military bases with a total area of approximately 265 hectares. These closed military areas and bases extend along the western border of the district and are located on the following soil associations:

- Brown lithosols and loessial serozems, while not suitable for agricultural purposes, are important in terms of natural biodiversity and as a potential source for managed grazing.
- Brown lithosols and loessial arid brown soils, in which annual field crops, mainly wheat and barely, could be grown in these soils.

IV. Nature Reserves

Currently, there are four declared nature reserves in the Jericho district with a total area of about 1,965 hectares, mostly located within the declared closed military area in the district. Because of the Israeli government's history of confiscating land through declaring an area

a nature reserve, there is suspicion about the true Israeli intentions and the environmental importance of the areas currently declared.

V. Cultivated Areas

The cultivated areas in the Jericho district cover approximately 2419.4 hectares. Due to the limited rainfall combined with the hot weather, irrigated agriculture is dominant in the district. The cultivated areas are concentrated in Jericho city, Dyouk, Nuwe'ma and Al-Auja including the following major types of cultivation (Jericho Agricultural Station, 1994):

1. Fruit trees: The cultivated fruit trees occupy an area of 771.1 hectares. Most dominant are bananas and citrus covering an area of 560 and 136.9 hectares respectively.
2. Field crops and Forages: The total area of the cultivated field crops and forages occupy approximately 144.5 hectares and include barley, wheat and sudan grass.
3. Vegetables: The total cultivated area amounts approximately to 1,504 hectares, with 1,026 of the total area located at Jericho city and the rest distributed in Dyouk, Nuwe'ma and Al-Auja villages. For more information about cultivated areas see chapter five.

Table 3.1: Land use classification in the Jericho district.		
Land use	**Area (hectares)**	**% of Land**
Palestinian Built-up Areas	591.0	1.7
Israeli Settlements	517.4	1.5
Closed Military Areas	5,844.0	16.5
Military Bases	265.0	0.8
Nature Reserves	1,965.0	5.6
Cultivated Areas	2,419.4	6.8
Others*	23,698.6	67.1
Total	35,330.0	100

*** Others represent either unused land or land used for grazing.**

Soils

The Jordan Valley is the only ecosystem in Jericho district. Nine soil associations can be distinguished in this ecosystem (Figure 3.3).

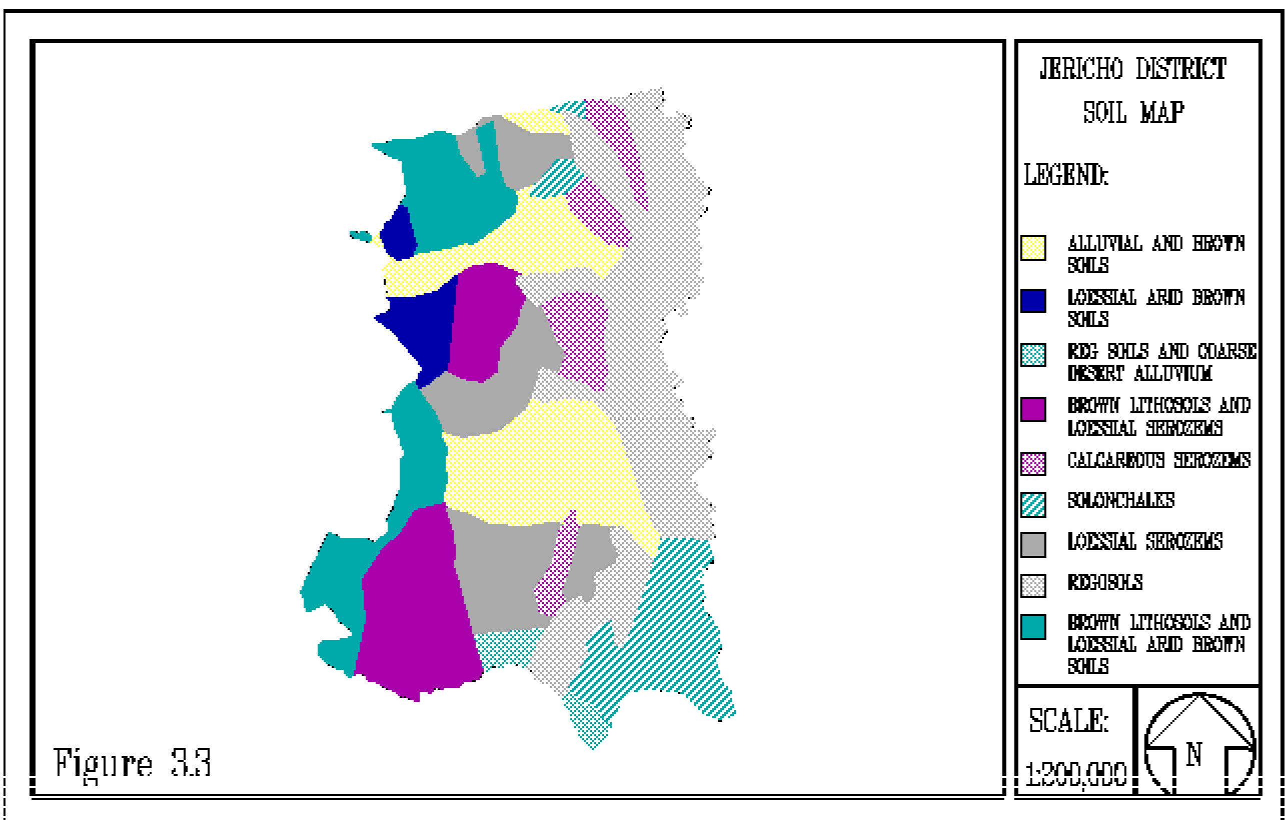


Figure 3.3

1. Alluvial Arid Brown Soils

This type of soil association is located mainly in the Jericho city and Al-Auja areas. It covers an area of about 6,470 hectares. It is exists of alluvial fans and plains, formed as a result of erosion of calcareous silty and clayey materials. This soil type supports Herbaceous vegetation of desert annual halophytes and glycophytes and responds well to irrigation, producing various crops, mainly subtropical and tropical fruits, such as citrus, bananas, and dates, as well as winter vegetables. The American great group classifications that represent this soil association are *Haplargids* and *Camborthids*.

2. Loessial Arid Brown Soils

This type of soil association is found on moderate slopes to the west and northwest of the Jericho district, covering an area of about 1,290 hectares. The soil is formed originally from conglomerate and/or chalk and mainly found on gently sloping plateaux as well as dissected plateaux with locally hilly topography. The major vegetation type found in this region is *Achillea santolina,* and the main current land use consists of various field crops and some horticultural crops planted as irrigated crops. Wheat, barely, and sorghum are also grown under rainfed conditions. The American great group classifications that represent this soil association are *Palexeralfs, Haploxeralfs* and *Xerochrepts*.

3. Reg Soils and Coarse Desert Alluvium

This type of soil association is located in the southern part of the Jericho district. It is found in plains and dissected low plateaux and characterize large valleys and alluvial fans. The soil covers an area of approximately 800 hectares and it's parent materials are mainly of unconsolidated mixed stone and deposits. The vegetation on this soil is restricted in a few areas to rivulets. In most areas dwarf shrubs such as *Anabasis articulata and Reaumuria* are dominant. This soil is almost of no agricultural value and its native vegetation poor pastures for camels, goats and sheep. The American great group classifications that represent this soil association are *Gypsiorthids* and *Camborthids*.

4. Brown Lithosols and Loessial Serozems

This type of soil association is found on steep to moderate mountain slopes, in the areas southwest of Aqbat Jaber Camp and northwest of Nuwe'ma, covering an area of about 4,670 hectares. The soil is originally formed from limestone, chalk, dolomite and flint.

The major vegetation types found on this soil are *Anabasis articulata* and *Zygophyllum.* The current land use is restricted to winter crops grown by Bedouins in some wadis. The American great group classification that represents this soil association is *Haplargids*.

5. Calcareous Serozems

This type of soil association is found southeast of Jericho city, northeast of Nuwe'ma and east of Al-Auja villages. It is formed mainly as a result of the flooding of the Jordan River. This soil covers an area of about 2,400 hectares and is originally formed from limestone, chalk and marl. The vegetation it hosts is restricted to *Salsola vermiculata var vilosa* and its current land use is limited to winter grazing. The American great group classifications that represent this soil are *Xerochrepts, Calciothids* and *Gypsiorltids*.

6. Solonchalks

This type of soil association is found in the south eastern part of the district. It covers an area of approximately 3,460 hectares. The soil occupies the drainage valleys and closed basins in the district, where the groundwater table is near the soil surface. The soil parent rocks are recent alluvial deposits ranging in texture form sand to clay. Its major vegetation cover is halophytic with species of *Tamarix, Suaeda,* and *Nitraria being dominant.* Without proper drainage this soil is of almost no agricultural value. In the Jericho district some dates are grown on the periphery of the depressions, where the ground water is still relatively fresh.

7. Loessial Serozems

This type of soil association dominates the areas of Nuwe'ma, north of Al-Auja and south of Aqbat Jaber camp covering an area of approximately 4,920 hectares. This soil is typical of plateaux and moderate slopes. The soil parent materials are loessial sediments, gravel and highly calcareous loamy sediments. Its major vegetation cover is an association of the *Hammada scoparia*. Most of the area covered by this soil is used for grazing and only part of it is dry-farmed. There are also some irrigated orchards. The American great group classification that represents this soil is *Haplargids.*

8. Regosols

This type of soil association characterize the eastern border of the Jericho district. It is found as badlands along terrace escarpments in the Jordan Valley, covering an area of approximately 8,880 hectares. The soil parent materials are sand, clay and loess. The soil dominant vegetation cover are *Anabasis articulata, Salsola vermiculata* and *Salsola tetrandra,* and are used primarily for grazing. The American great group classifications that represent this soil are *Xerochrepts, Calciothids* and *Gypsiothids.*

9. Brown Lithosols and Loessial Arid Brown Soils

This type of soil association characterizes the western part and covers an area of approximately 2,410 hectares of the Jericho district. These type of soils are mainly found on steep rocky and eroded slopes. Brown lithosols are found in the pockets among the rocks, while Loessial arid brown soils are found on flat hilltops, plateaux and foot-slopes. The parent rocks of this soil association are chalk, marl, limestone and conglomerates. Its major vegetation cover is A*rtemisia herba-alba.* The American great classifications that represent this soil are *Haploxeralfs and Xerochrepts.*

Table 3.2: Soil classification in the Jericho district

Soil Association	Area Hectares	Amer-ican Classif-ication	Location	General Charac-teristic	Natural Vegetation	Rainfall (mm)	Mean temp-erature
1. Alluvial arid brown soils	6,470	*Haplargids and Camborthids*	Alluvial fans and plains	The soils have brown color and loamy texture. Parent Rocks are Calcareous sitly and clay materials.	Herbaceous vegetation of desert, annual halophytes and and glycophytes.	150-200	23
2. Lossial arid brown soils	1,290	Palexeralfs, Haploxeralfs and Xerochrepts	Gently sloping plateaux and dissected plateaux	The soils have yellowish-brown color, loamy texture and subangular stucture . Parent rocks are conglom-erated chalk	Achillea santolina	250-350	19-21
3. Reg soils and coarse desert alluvial	800	Gypsiorthid and Camborthids	Plains, dissected low plateaux, large valleys and alluvial fans	The soils have very pale brown color. Texture is loamy. Parent materials are of mixed stone	Rivulets and dwarf shrubs such as Anabasis articulata and Reaumuria	80	21-23

				deposits			
4. Brown lithosols and and loessial serozems	4,670	Haplargids	Steep to moderate mountain slopes	The soils have Yellowish-brown or very pale brown color, coarse texture, and subangular stucture. Parent rocks are limestone, chalk, dolomite and fint.	Anabasis articulata and Zygophllum	80-200	17-23
5. Calcareous serozems	2,400	Xerochrepts Calciorthids and Gypsiorthids	Flood plains	The soil is highly calcareous with greyish-brown color. The texture is meduim to fine. Parent rocks are limestone, chalk and marl .	Salsola vermiculata var vilosa	100-400	21-24
6. Solonchalks	3,460	————	Occupy the drain age valleys and closed basins where the ground water table is near the soil surface	The texture ranges from sand to clay, suffering from high water table and in some cases is extremely saline, with up to 50% salts. The parent materials are recent alluvial deposites.	Halophytic with dominance species of Tamarix, Suaeda and Nitraria.	50	23-25
7. Loessial serozems	4,920	Haplargids	Plateaux and moderate slopes	The soils have yellowish-brown to brown in color, and coarse texture. Parent materials are loessial sediments, gravels and highly	Hammada scoparia.	150-250	20-21

				calcareous loamy sediments			
8. Regosols	8,880	Xerochrepts, Calciorthids, and Gypsiorthids	Badlands along terrace escapments in the Jordan valley	The soils have pale brown color, loamy texture. Parent materials are sands, clays and loess	Anabasis articulata, Salsola vermiculata and Salsola tetrandra	150-200	22-24
9. Brown lithosols and loessial arid brown soils	2,410	Haploxeralfs and Xerochrepts	Steep rocky and eroded slopes. Brown lithosols are found in pockets among the rocks, while loessial arid brown soils are found on flat hilltops , plateaux and foot-slopes.	The soils have yellowish-brown, coarse texture, and subangular blocky to massive structure . Parent rocks are chalk, marl, limestone and conglo-merates	Artemisia herba-alba	200-250	19-21

Chapter Four
Water Resources

Hydrogeology

1- Groundwater Aquifer Systems

According to the Jordanian nomenclature (Rofe & Raffety, 1963), there are several aquifer systems in the district, mainly:

1.1 - Lower Cenomanian Aquifer System:

This aquifer system is composed of the Lower Ajlun series and overlaid by the Upper Ajlun series (Upper Middle Cenomanian-Turonian). The latter has much more pure Dolomitic limestone in its sequence. The lower part of the Upper Ajlun series constitutes the major aquifer in the region. The chalky limestone and dolomite are overlaid by fine well developed calcareous limestone, forming an excellent aquifer and building stone. This aquifer system is composed of the following geologic formations:

1. Lower Beit Kahil Formation (Early Lower Cenomanian)
2. Upper Beit Kahil Formation (Late Lower Cenomanian)
3. Yatta Formation (Lower Middle Cenomanian)

The Beit Kahil and Yatta formations are believed to jointly form a major Aquiclude. The presence of limestone layers within these formations made it possible for springs to form. While the wells of many Israeli settlements are tapping this aquifer for domestic and agricultural reasons, Palestinians are denied access to it.

1.2 - Upper Cenomanian-Turonian Aquifer System:

This aquifer system is composed of the Upper Ajlun Series and consists of the following geologic formations:

1. Hebron Formation (Upper Middle Cenomanian Aquifer)
2. Bethlehem Formation (Upper Cenomanian Aquifer
3. Jerusalem Formation (Upper Cenomanian-Turonian Aquifer)

These three formations are usually considered by hydrogeologists as a single system of aquifers called the Cenomanian-Turonian Aquifer System.

1.3 - Tertiary Aquifer System:

This system is composed of the Beida Formation (Neogene Aquifer) which is composed of conglomerate lenses, limestone, marl and clay with Lower Tertiary age. Geomorphologically, the Beida Formation can be easily recognized by its soft rounded features, light colors and encrusted surface. The lenses of conglomerates and the margins of the formation have good aquiferous characteristics. Intercalated marls act as confining Aquiclude.

1.4 - Quaternary Aquifer System:

This aquifer system is composed of the three formations, Lisan, Alluvial and Gravel fans:

1. Lisan Formation (Pleistocene Aquifer) extends along the Jordan Rift Valley and near Jericho. It is lithologically composed of valved marl consisting of thin layers of gypsum and limestone and forming light and dark alternating bands.
2. Alluvial and gravel fans (Holocene) distributed in the Jordan Valley. They cover the flood plains of the Jordan River and are strongly related to the faulted areas which are subjected to erosion. The alluvium is, generally, unconsolidated in the Rift Valley where it is formed of laminated marls with occasional sands. Gravel fans are widely distributed in the Jordan valley and have the capability of transferring groundwater from the limestone aquifers. The coarse marginal faces of Beida, Lisan, and alluvium formations form good aquifers.

The Palestinian wells in the Jericho district tap the Upper Cenomanian-Turonian aquifer system and the Neogene and Pleistocene shallow aquifer systems. However, the water of these wells is limited in quantity and deteriorated in quality.

2- Groundwater Basins:

The general groundwater flow direction in this system is to the east and southeast towards the Jordan Valley and the Dead Sea. Figure 4.1 shows the groundwater basins and the exposed aquifers in the Jericho district with respect to other basins and aquifers in the West Bank. The Jericho district overlies two sub-basins of the Eastern Aquifer System. These two sub-basins are:

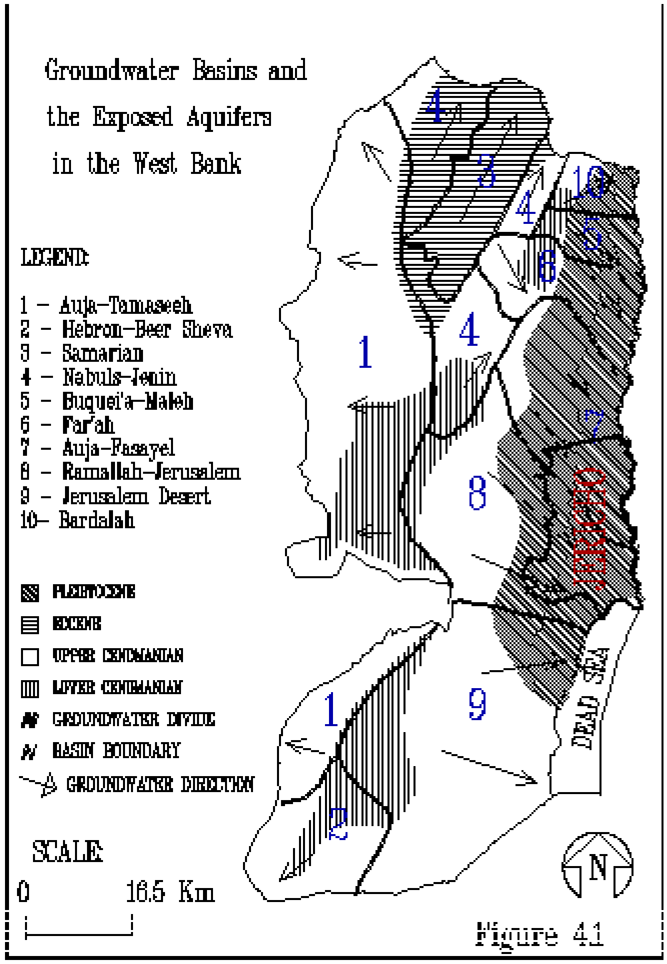


Figure 4.1

1. Auja-Fasayel Sub-basin which drains the Neogene/Pleistocene and Upper Cenomanian aquifers and flows towards the southeast direction.
2. Ramallah-Jerusalem Sub-basin which drains the Neogene and Pleistocene, Lower Cenomanian and Upper Cenomanian aquifers and flows towards the east and southeast direction.

The Eastern Aquifer Basin is not fully exploited because of water quality problems. An extensive hydrogeological study is needed to identify its actual potential resources, safe yield, the hydrogeological characteristics, groundwater quality, and flow pattern of each aquifer.

Groundwater Sources and Consumption

1- Groundwater Wells

There are 63 irrigation wells in the Jericho district divided according to control and management into: 48 private Wells owned by Palestinians, and 15 cooperative association wells owned by the Arab Development Society (ADS), where seven of them are currently in operation. The annual discharge and pumpage from springs and wells in the Jericho district are shown in table 4.1 below.

Table 4.1: Distribution of wells and springs and their annual discharge (1992) from different groundwater basins and aquifers (ARIJ, 1995).

Loca-tion	Irrig-ation wells	Pumpage forirrig. MCM/yr	Drin-king wells	Pumpage for dom.MCM/yr	Spr-ings	Annual flow MCM	GW Basin	GW Sub-basin	Forma-tion Aquifer
Jericho	38	4.44	-----	-----	6	46.2	East	Ramallah Jerusalem	Neogene Pleis-tocene
ADS-Jericho	15	3.00	-----	-----	-----	-----	East	Ramallah Jerusalem	Neogene Pleis-tocene
Al-Auja	10	0.05	-----	-----	1	16.11	East	Auja-Fasayel	U.Cenom . L.Cenom.
Total	63	7.49	-----	-----	7	62.31	East		

GW : Groundwater U.Cenom. : Upper Cenomanian L.Cenom. : Lower Cenomanian

2- Springs

There are four main spring systems in the Jericho district emerging from the eastern groundwater basin underlying the Jericho area. The total annual discharge of these springs reached 62.31 MCM in 1992, as is shown in table 4.1.

2.1 Wadi Al-Qilt Spring System:

The total average annual discharge of this system is about 5 MCM (IPCRI, 1993). Figure 4.2 shows the discharge variation of the spring system with rainfall during the period of 1982/83 until 1993/94 (WBWD, 1994). Wadi Al-Qilt is fed from three main springs Ein Fara, Ein Fawwar and Ein Al-Qilt (Rofe & Raffety, 1963 ; Scarpa, 1994).

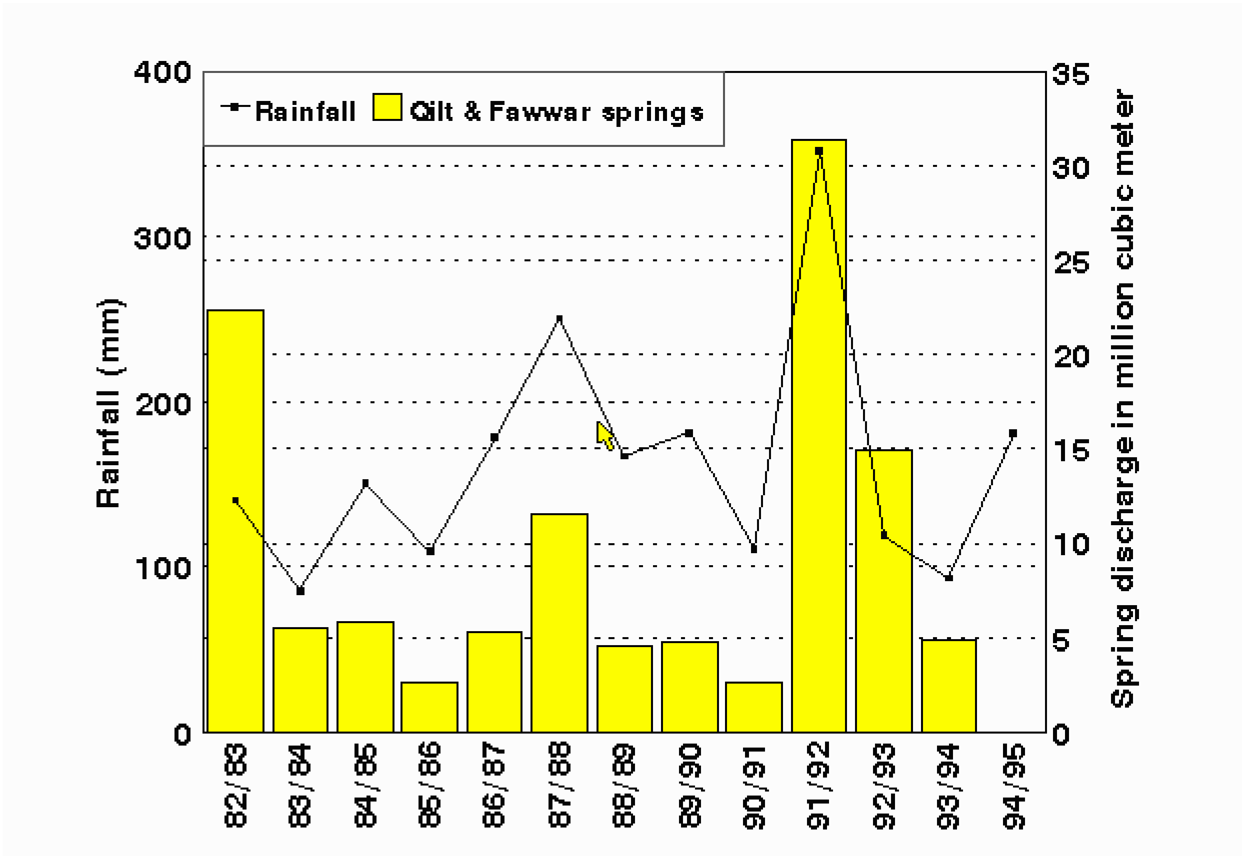


Figure 4.2: Discharge variation of Wadi Al-Qilt Spring System with rainfall during the period of 1982/83 until 1993/94

(WBWD,1994).

- Ein Fara is a seasonal spring which emerges upstream at an elevation of 325 m above sea level through the floor of the wadi.
- Ein Fawwar is a seasonal spring which emerges 4 km downstream at an elevation of 80 m above sea level with an average discharge of about 30,000-100,000 CM/day. Both Fara and Fawwar springs drain from the Quaternary Alluvium Aquifers.
- Ein Al-Qilt emerges 2.5 km downstream of Ein Fawwar at an elevation of 10 m above sea level. Its flow rate is almost constant with a little variation from winter to summer. It has a catchment area of about 115 km2 and an average annual rainfall of 550 mm, of which about 20% recharges the groundwater Upper Cenomanian-Turonian Aquifer, appearing as a normal fissure flow at about the Bethlehem-Jerusalem Formation interface.

2.2 Ein Al-Sultan Spring System:

It is located to the east of Wadi Al-Qilt in Jericho city and related to the Upper Cenomanian-Turonian Aquifer. Its annual flow discharge of about 4 MCM (ARIJ, 1995). used to fulfill the municipal and agricultural needs of the Jericho population. Figure 4.3 shows the discharge variation of Ein Al-Sultan with rainfall during the period of 1982/83- until 1993/94 (WBWD, 1994).

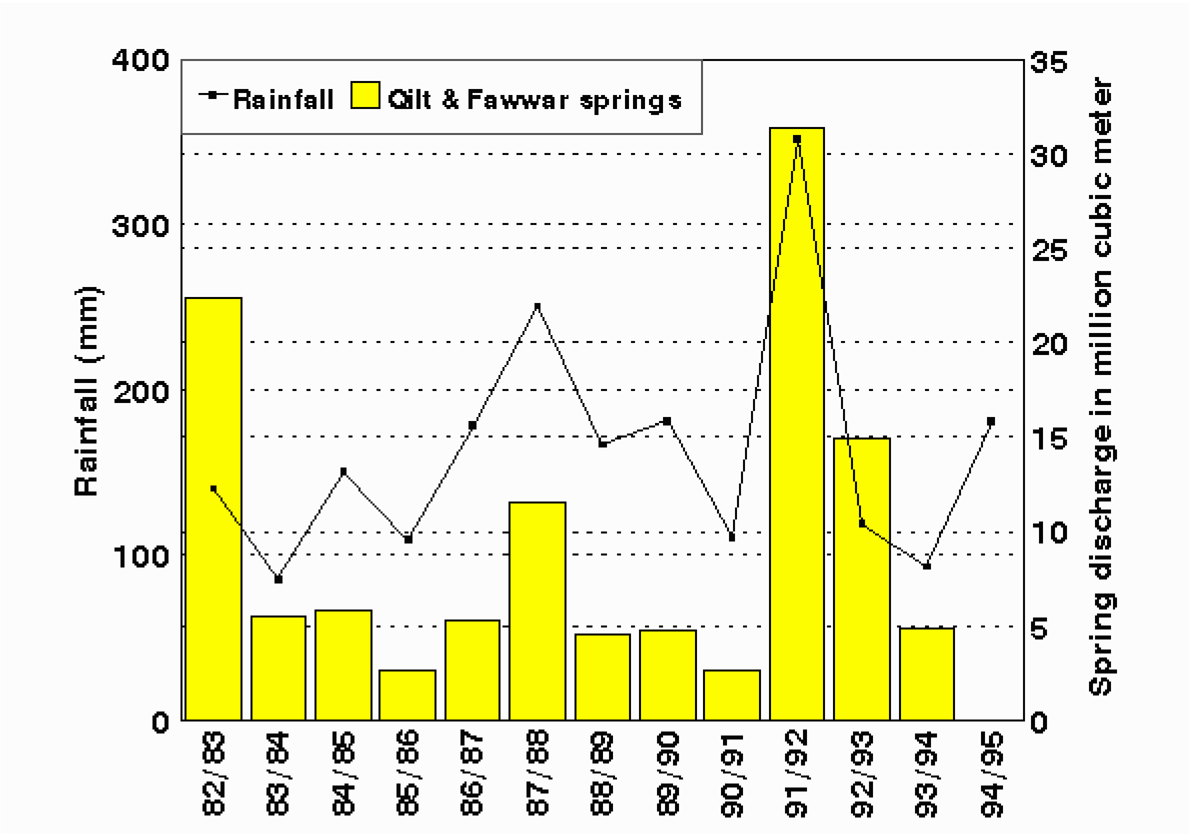


Figure 4.3 Discharge variation of Ein Al-Sultan period of 1982/83 until 1993/94

(WBWD, 1994).

2.3 Dyouk Spring System:

This system is composed of three springs; Dyouk, Nuwe'ma, and Shosah emerging on a fault parallel to the Rift fault. They drain the Pleistocene Lisan Formation and are fed from the Cenomanian Ajlun aquifers (Davidson & Hirzallah, 1966). Figure 4.4 shows the discharge variation of the spring system with rainfall during the period of 1982/83 until 1993/94 (WBWD, 1994).

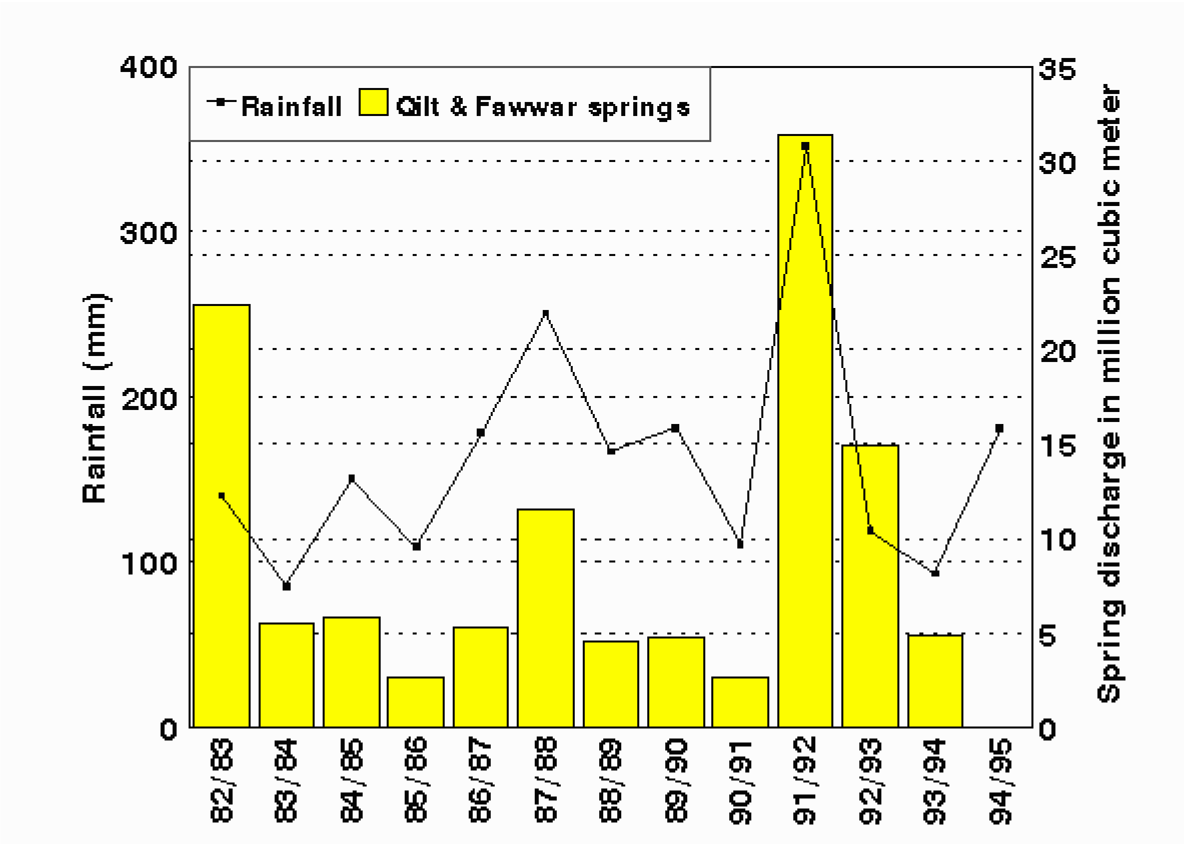


Figure 4.4 Discharge variation of Dyouk Spring the period of 1982/83 until 1993/94

(WBWD, 1994).

2.4 Al-Auja Spring System:

Ein Al-Auja has a catchment area of 170 km2 and receives an average rainfall of about 500 mm annually. The average annual discharge of this system is about 10 MCM (IPCRI, 1993) which drains the Upper Cenomanian-Turonian aquifer (Rosenthal & Kronfeld, 1982). Its water is used for irrigation purposes and its discharge is affected by rainfall variation. Figure 4.5 shows the discharge variation of the spring with rainfall during the period of 1982/1983 until 1993/1994 (WBWD,1994).

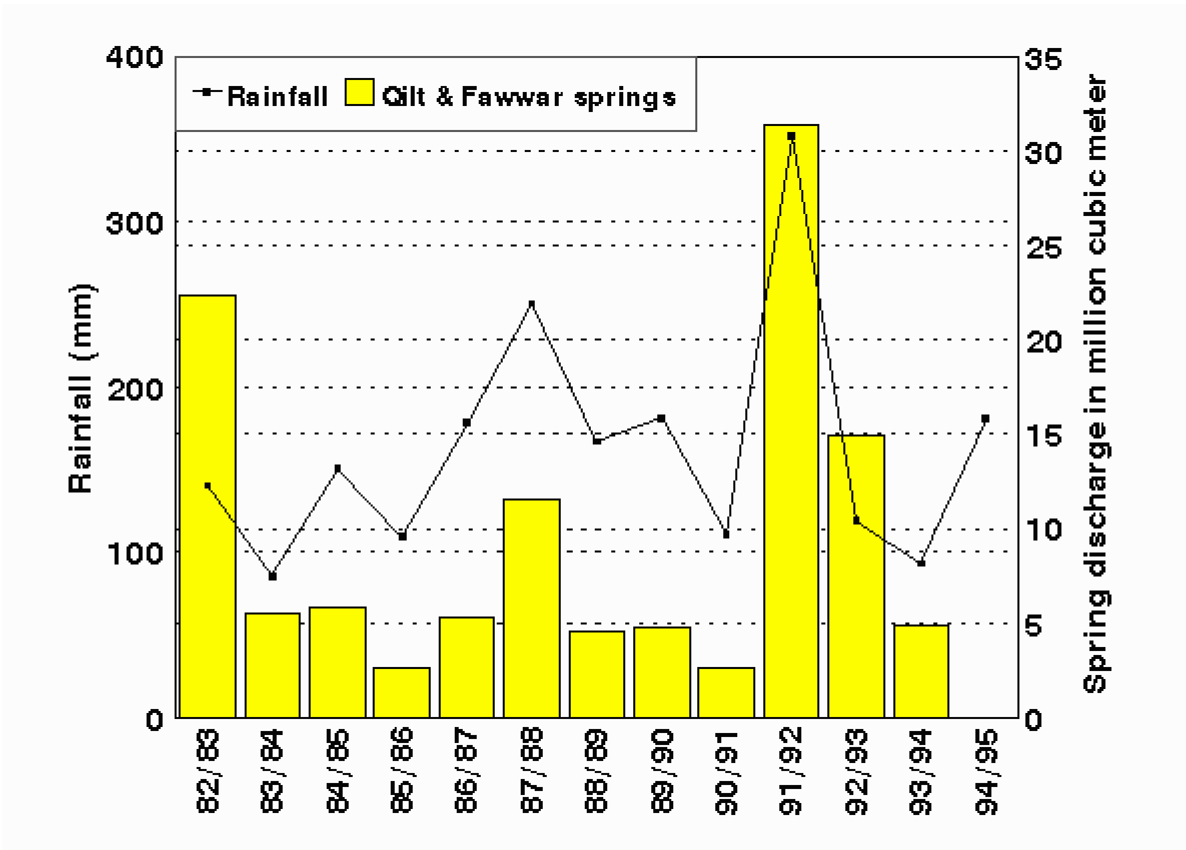


Figure 4.5 Discharge variation of Al-Auja Spring System with rainfall during the period of 1982/83 until 1993/94

(WBWD, 1994).

Photo 2: Al-Auja Spring

Groundwater Quality

ARIJ conducted water samplings in March, 1995 for forty two groundwater wells and seven major springs in the Jericho district to define the groundwater quality. The chemical analysis of the water samples was conducted at the laboratories of Abu Dies University to determine the major cations and anions in the water samples. On site physical water quality measurements were also conducted. ýTable 4.2 shows the descriptive statistical analysis of the hydrochemical data obtained from the chemical analysis of the seven major springs in the Jericho district.

Table 4.2: Statistics analysis of the hydrochemical data at the major springs in the Jericho district.				
Parameter	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**
pH	7.0	8.3	7.46	0.44
Conductivity(µS/cm)	364.0	446.0	408.70	34.80
Ca^{+2} (PPM)	30.0	37.0	34.57	2.37
Mg^{+2} (PPM)	14.0	22.0	19.42	3.20
Na^{+1} (PPM)	4.0	50.0	34.54	18.83
K^{+1} (PPM)	2.0	3.0	2.16	0.41
$HCO3^{-1}$ (PPM)	168.0	281.0	219.70	38.06
$NO3^{-1}$(PPM)	2.75	5.5	4.13	0.81
SAR	0.1	1.8	1.16	0.64

All springs in the Jericho district are used for irrigation except Ein Al-Sultan which is used for both domestic and irrigation purposes. In order to identify water quality for irrigation, electrical conductivity (EC), the water salinity indicator, and sodium adsorption ratio (SAR) were used. Wilcox (1955) classified water quality for irrigation using EC and SAR in the form of a diagram called Wilcox diagram. Figure 4.6a shows Wilcox diagram which classifies spring water quality for irrigation in Jericho district. According to Wilcox (1955), the EC for spring water which ranges from 369 and 446 µS/cm with a mean of 408.7 µS/cm, indicates good quality water for irrigation purposes.

SAR values for the analyzed water samples ranges from 0.1 into 1.8. They are calculated according to the following formula:

$$\mathbf{SAR = Na^{+1}/((Ca^{+2} + Mg^{+2})/2)^{1/2}}$$

In the diagram 4.6a spring water is located in the region of medium salinity hazard and low sodium hazard i.e. it is suitable for irrigation purposes.

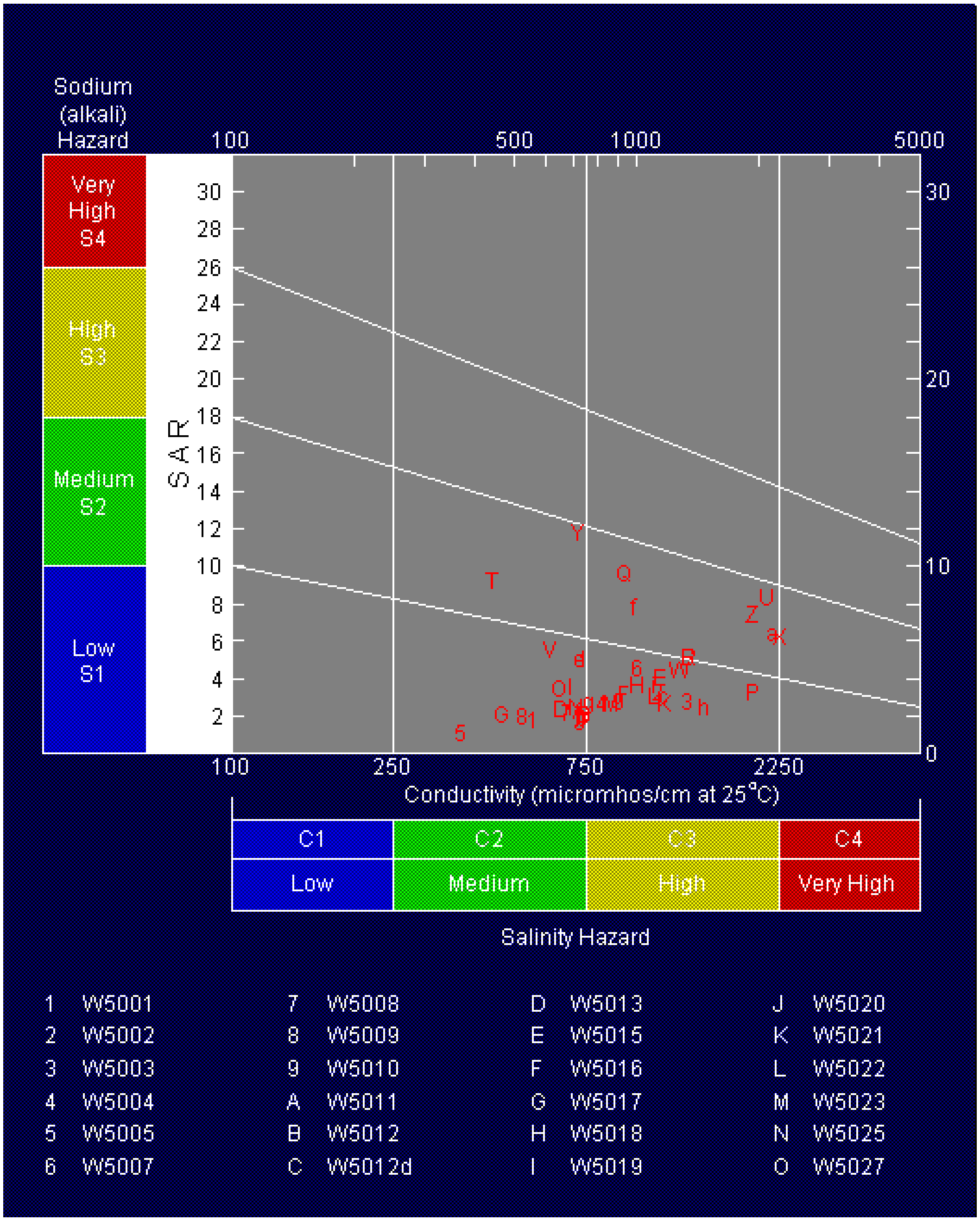


Figure 4.6a* Wilcox diagram of springs in the Jericho district.

** This diagram are constructed by Groundwater for Windows (GWW) software. The wells and springs are identified by numbers and characters*

Groundwater wells in the Jericho district are used primarily for irrigation purposes. The salinity indicator (EC) ranges from 369 into 2280 µS/cm with an average of 994 µS/cm which is permissible, according to Wilcox classification (1955). Table 4.3 shows the ranges of results of hydrochemical analysis of the groundwater wells in the Jericho district.

Table 4.3:Statistical analysis of hydrochemical data for Jericho district.				
Parameter	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**
pH	5.8	7.8	7.04	0.31
Conductivity(µS/cm)	369.0	2280.0	994.0	474.0
Ca^{+2} (PPM)	32.0	3.0	133.2	78.7
Mg^{+2} (PPM)	14.0	364.0	143.0	89.94
Na^{+1} (PPM)	12.0	1090.0	302.0	247.4
K^{+1} (PPM)	2.0	108.0	32.85	26.9
HCO_3^{-1} (PPM)	93.0	492.0	231.54	94.14
NO_3^{-1} (PPM)	1.29	52.0	10.10	8.48
SAR	0.4	11.8	4.14	2.43

The sodium hazard indicated by sodium adsorption ratio (SAR) ranges from 0.4 into 11.8 with an average of 4.14. Figure 4.6b shows Wilcox diagram which classifies water quality of groundwater wells for irrigation in Jericho district. In the diagram water is located in the region of medium to high salinity hazard and low to medium sodium hazard i.e. groundwater quality of wells is unsuitable for irrigating almost all kinds of crops because of its high salinity.

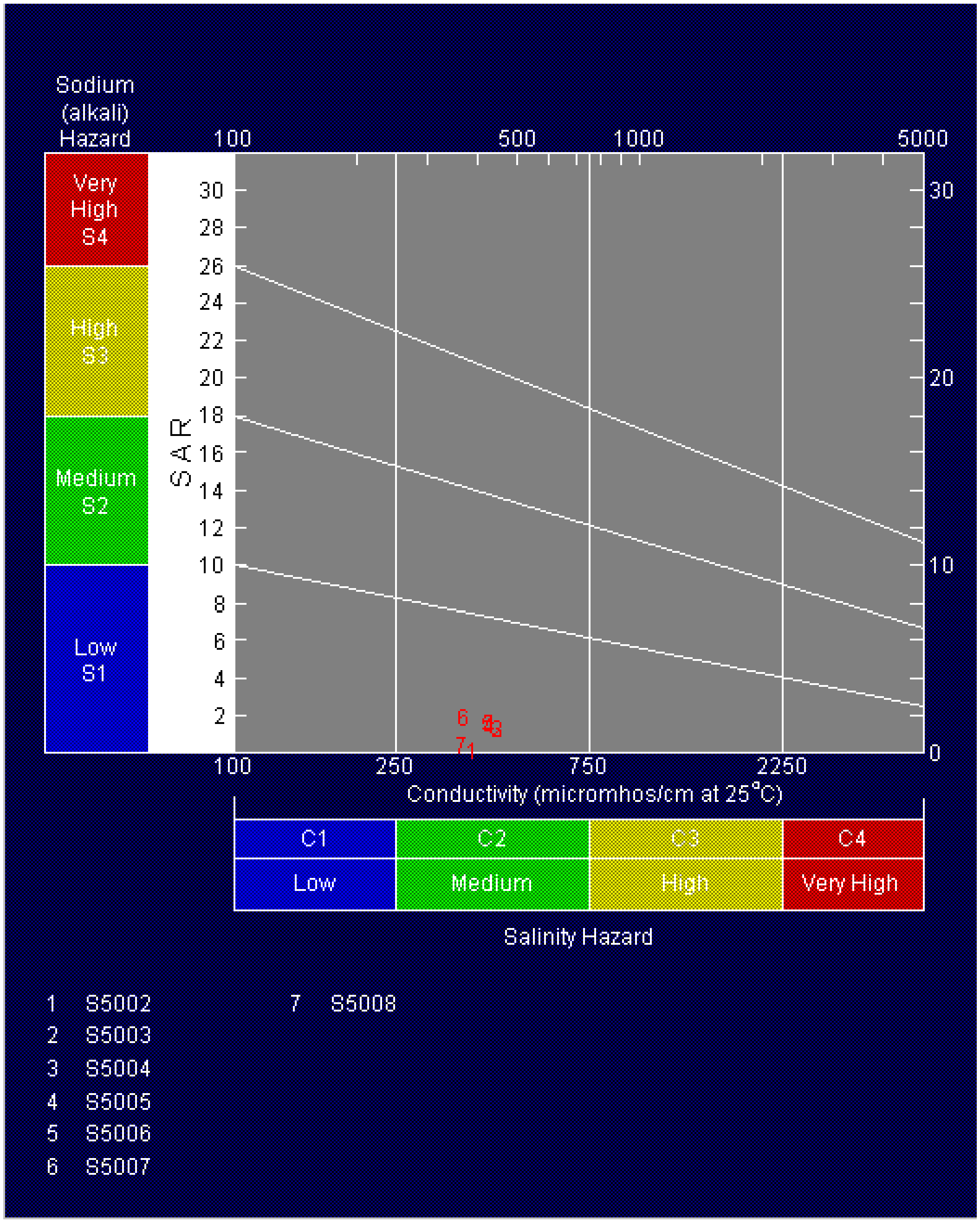


Figure 4.6b: Wilcox diagrams of wells in the Jericho district.*

** This diagram are constructed by Groundwater for Windows (GWW) software. The wells and springs are identified by numbers and characters*

Contour maps are used in this profile to represent the hydrochemical data for groundwater, including both wells and springs, in the Jericho district. Figure 4.7 shows a contour map representing the distribution of electrical conductivity (EC) in groundwater in different areas of the Jericho district. It is clearly shown that the electrical conductivity increases towards the Dead Sea and Jordan valley, which may be attributed to sea water intrusion and scarcity of rainfall.

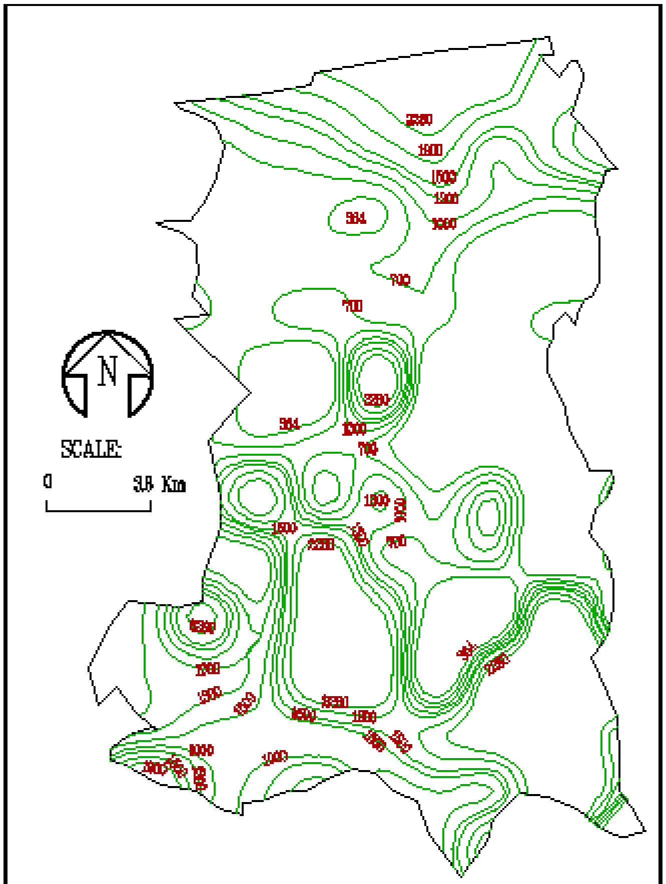


Figure 4.7 Electrical Conductivity (microsiemens/cm) Distribution in the Jericho District's Groundwater

Figure 4.7: Electrical Conductivity (EC) distribution in the Jericho district's groundwater

Figure 4.8 shows a contour map representing the distribution of sodium adsorption ratio (SAR) in the groundwater of the Jericho district. SAR increases towards the Dead Sea and the Jordan valley, which may be attributed, in addition to sea water intrusion, to Halite and Evaporites deposits adjacent to the Jordan valley. Mixing with deep fossil groundwater may be the cause for higher values of SAR and other constituents in the water.

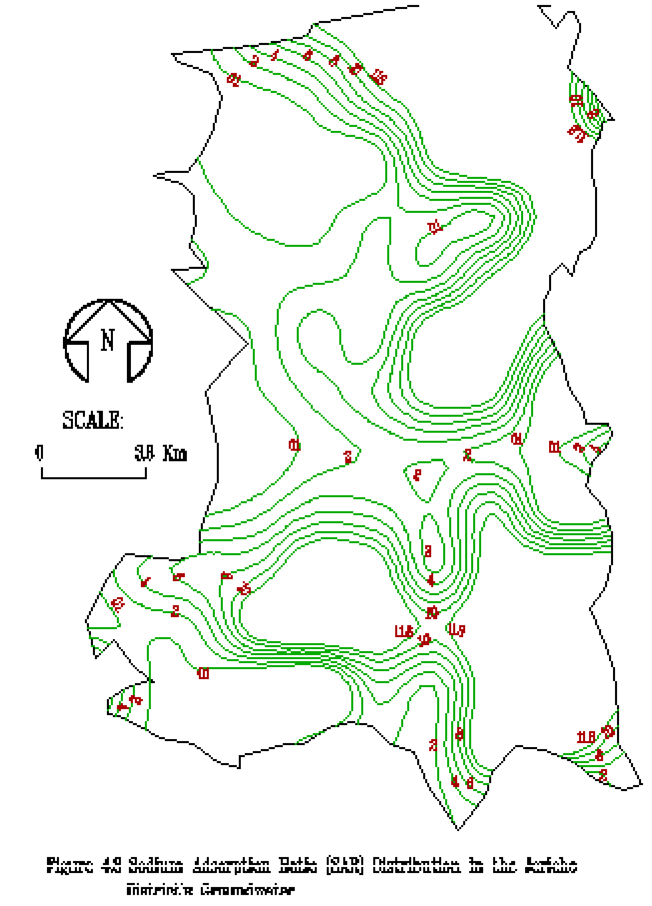


Figure 4.8: Sodium Adsorption Ratio (SAR) distribution in the Jericho district's groundwater

Figure 4.9 shows a contour map representing the distribution of Nitrates (NO3-) in the Jericho district groundwater. The high values of Nitrates may have resulted from irrigation activities and intensive usage of fertilizers in the district. Each crop planted in the area has a specific sensitivity for the different water quality indicators, so, water quality is the limiting factor of the cropping pattern in the Jericho district.

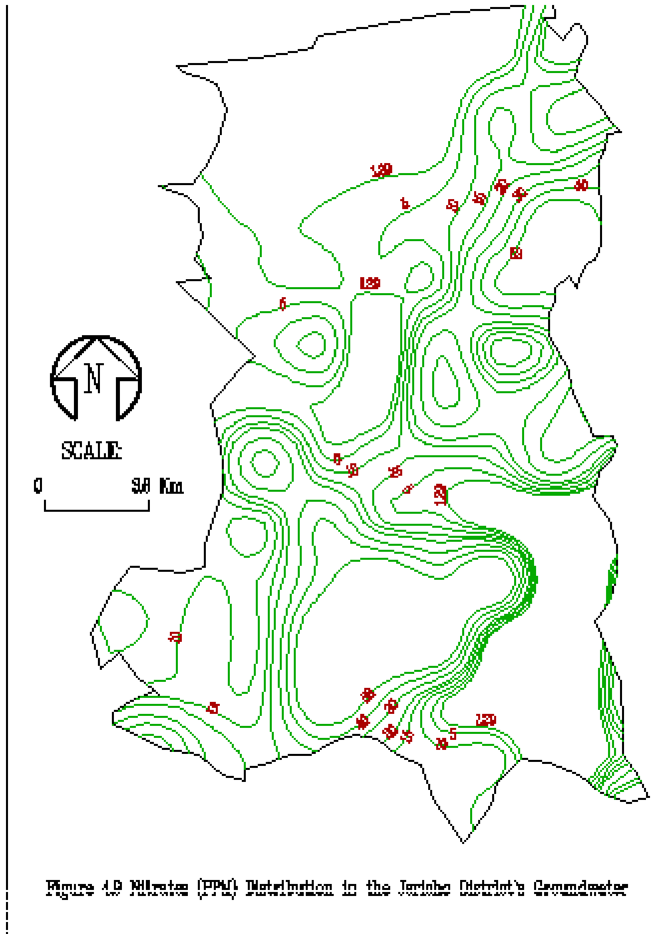


Figure 4.9: Nitrates distribution groundwater.

Surface Water Resources

Surface water in the Jericho district can be classified into flood water and the Jordan River water.

1- Flood Water

Flood water is very limited due to limited rainfall in the area. Flood water in the Jericho district originates outside the district from the eastern catchment of Jerusalem and Ramallah areas. Exact measurement of flood water quantities is difficult because of the mixing of their water with spring water in the downstream areas of these wadis. Literature has reported discharge of floods in the study area to be about 10.01 MCM/yr (P.L.O., 1990).

2- Jordan River Basin

Background:

The Jordan River is 252 kms long from its source near Banias to the Dead Sea, with a surface catchment area of about 17,665 km2. The headwaters of the Jordan River originate in the southern and western slopes of Mount Hermon (Figure 4.10). The river system is composed of the Hasbani, the Dan and the Banias rivers. They flow south in a deep depression from the northern mountains to Lake Tiberias at approximately 200 meters above mean sea level, finally spilling into the Dead Sea at approximately 400 meters below mean sea level. Syria, Israel, Lebanon, Jordan and Palestine are all riparians of the Jordan River basin and 80% of the basin is located in Jordan, Israel and Palestine. The natural flow of the river (in the absence of extraction) is estimated to be roughly 1,476 MCM at the entrance to the Dead Sea. This water represents an important component in the water budget to the riparians. The Jordan River's water satisfies around 50% of Israel's and Jordan's demand. For Palestinians, Jordan River is the only permanent source of surface water. It flows along the eastern border of the West Bank from the north to the Dead Sea in the south. During the occupation, the Israeli authorities and the military closure of the areas along the Jordan Valley, have forbidden the Palestinians from their share of the Jordan River's water.

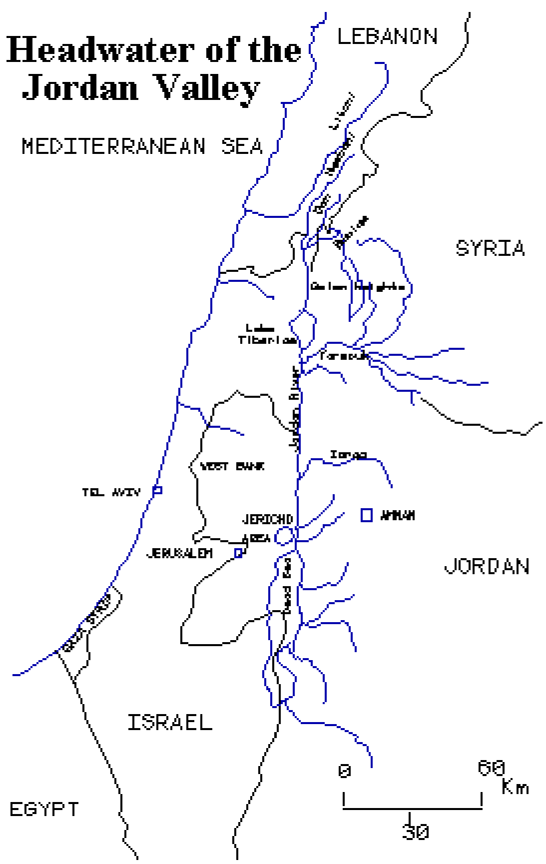


Figure 4.10: Headwater Of The Jordan River

Dispute and previous plans:

The dispute between the riparians on the Jordan's water started since the Zionist Movement launched a political campaign to establish the Jewish State at Palestine. Since that time, many plans had been proposed to divide the water of the Jordan River, but none of the solutions were accepted to all parties. The following section outlines the results of a study presented by ARIJ in 1992 summarizing the plans and events which have taken place since 1922 (Hosh, 1992). "Two important water-related events highlight the British Mandate of Palestine, 1922-1948, the Rutenberg Concession and the Ionides Plan. In 1926, the British High Commissioner granted the Jewish owned Palestine Electricity Corporation, founded by Pinhas Rutenberg, a 70 year concession to utilize the Jordan and Yarmouk Rivers' water for generating electricity. The concession denied Arab farmers the right to use the Yarmouk and Jordan Rivers' water upstream of their junction for any

reason, unless permission was granted from the Palestine Electricity Corporation. Permission was never granted.

In 1937, the government of Great Britain assigned M. Ionides, a hydrologist, to serve as the Director of Development for the East Jordan Government. His actual task was solely to conduct a study on the water resources and irrigation potentials of the Jordan Valley basin. This study served as a main reference in the preparation of the proposed United Nations Partition Plan of Palestine.

Published in 1939, the Ionides Plan suggested three recommendations. Firstly, Yarmouk flood waters were to be stored in Lake Tiberias. Secondly, the stored waters in Lake Tiberias plus a small quantity (1.76 CM/sec) of the Yarmouk River water, diverted through the East Ghor canal, were to be used to irrigate 75,000 acres (30,000 hectares) of land east of the Jordan River. And finally, the secured irrigation water of the Jordan River system, estimated at a potential of 742 MCM, were to be used primarily within the Jordan Valley basin.

Since the Jordan and the Yarmouk Rivers were at that time still under the authority of the Palestine Electricity Corporation, the plan was difficult to implement.

Zionist supporters worldwide were not satisfied with the findings and recommendations of Ionides. Their aspiration to utilize the Jordan River Basin for the irrigation of the Negev and the southern parts of Palestine was fulfilled by Walterclay Lowdermilk. Lowdermilk was commissioned by the United States Department of Agriculture to conduct such a study.

Lowdermilk devised a plan calling for the irrigation of the Jordan Valley; the diversion of the Jordan and Yarmouk rivers to create hydroelectric power; the diversion of water from northern Palestine to the Negev desert in the south; and the usage of the Litani River in Lebanon.

In striking contrast to the Ionides plan, Lowdermilk concluded that 1800 MCM of water is available in the Jordan Basin for the purpose of irrigation. A canal was recommended to connect the Mediterranean Sea with the Dead Sea. Also, an authority similar to the Tennessee Valley Authority should be formed to assume full control over all activities concerning water resources. Such water management would ideally ensure adequate water resources and job opportunities for 4 million new Jewish immigrants in addition to the 1.8 million Arabs already living in Palestine and East Jordan at that time.

Control over the proposed project should be solely in the hands of Jews, with a limited amount of input allotted to the United Nations. Arabs unable or unwilling to live under such conditions were to be transferred to areas near the Euphrates and the Tigris Valleys.

Lowdermilk's plan and suggestions were enthusiastically embraced by influential Zionists. Technical experts were subsequently contracted to implement and interpret this plan into feasible schemes. James B. Hays was selected for this assignment.

The Hays Plan of 1948 called for half of the Yarmouk River water to be diverted into Lake Tiberias, replacing water diverted from the upper Jordan River, as outlined in the Lowdermilk plan from which Hays worked. Two additional stages were suggested to be implemented in the future, although not stated, they most likely included the diversion of the Litani River water into geographical Palestine in order to be used for Israeli projects.

As a continuation of the Lowdermilk-Hays Plan, the new government of Israel, soon after the War of 1948, began to prepare practical plans for the utilization and control of the area's water resources. A Seven Year Plan, approved publicly in 1953, centered around the diversion of the Jordan River water south toward the Negev desert and establishing a unified and comprehensive water network that would cover all parts of Israel.

In September 1953, the construction of the National Water Carrier began, and thus plans to divert the Jordan River water, south to the Negev, were activated. Diversion originated at the Banat Yacoub Bridge in the demilitarized zone between Israel and Syria. After Syrian objection to the excavation process, and United States' economic sanctions against Israel, a temporary freeze on the work at Banat Yacoub Bridge was announced in October 1953.

During the 1948 war, the Rutenberg electricity generating plant was destroyed by the Jewish army in an attempt to avoid exclusive Arab control over the use of the Jordan and Yarmouk Rivers. The war forced a great number of Palestinian refugees to flee and settle in the eastern part of the Jordan Valley. The Jordanian Government and UNRWA (The United Nations Relief and Works Agency) agreed to develop irrigation schemes in the area to assist Palestinian refugees to cultivate the land and resettle. For this purpose, the Jordanian Government commissioned a British consultant, Sir Murdoch MacDonald, to conduct a study on their behalf.

The MacDonald Plan was finalized in 1951. It is considered a compliment to the Ionides Plan. The plan called for Jordan Basin water to be exclusively used for irrigation of both banks of the Jordan River by storing surplus water from the Yarmouk River in Lake Tiberias and constructing canals down both sides of the Valley. Arabs were uneasy with the suggestion of the storage of water in Lake Tiberias, as they were in previous plans.

Therefore, Arabs favored the plan put forth by the American engineer M. E. Bunger. He identified a suitable location for the construction of a water storage dam along the Yarmouk River at the Maqarin area, where three valleys join together. The impounded water would be diverted to another dam at Addassiyah into gravity flow canals along the East Ghor Canal in the Jordan Valley. The plan included two hydroelectric generating plants at the site of the two dams to supply water and electricity to both Jordan and Syria. The Bunger Plan addressed several of Jordan and Syria's needs and intended to resolve, to some extent, the Palestinian refugee problem by increasing the productivity of available agricultural lands in the East Jordan Valley and parts of Syria.

As soon as work began in July 1953, Israel vocalized its concern about increasing Arab control over the area's water resources. Israel objected on the grounds that the original Rutenberg Concession gave it exclusive rights to the Yarmouk River. As a result, pressure was exerted on the United States Government and UNRWA to cease support for the project. To the surprise of the Jordanian Government, work halted soon thereafter and the project was terminated.

In October 1953, the United States prepared the Johnston Plan as an attempt to solve the area's water crisis. The rising tension caused by the Israeli initiation of the National Water Carrier project, encouraged the United States to mediate between the two parties. The plan sought to satisfy the minimum requirements of riparian Arab states, as well as Israel. Eric Johnston implemented a water plan prepared by Charles Main, under the supervision of the Tennessee Valley Authority. Essentially, the Johnston Plan was a combination of the Lowdermilk-Hays and the MacDonald-Bunger Plans. The new plan included water distribution quotas of the Jordan Valley Basin, estimated at 1,213 MCM annually, among the riparian states.

The plan was not well received by either Israel or the Arab States. Consequently, Arabs and Israelis submitted counter proposals for dividing water shares, the Arab Technical Committee and the Cotton Plan, respectively. Table 4 describes the development of Johnston Plan in the years 1953-1955.

Table 4.4: Development of Johnston Plan 1953-1955

	Johnston 1953		**Arab Technical 1954**		**Cotton 1954**		**Revised 1955**	
Country	water	Area	Water	Area	Water	Area	Water	Area
Jordan/Palestine	774	49	861	49.0	575	43	720*	
Syria	45	3	132	11.9	30	3	132	11.9

Lebanon	---	---	35	3.5	450.7	35	35	3.5
Israel	394	42	200	23.4	1,290	179	450*	
Total	1,213	94	1,228	87.8	2,345.7	260	1,337	
Water = million cubic meters **Area = thousands of hectares** *** = an estimate**								

Because the available irrigation water in the Jordan River Basin does not exceed a maximum of 1,213 MCM, the Cotton Plan included, within its scope, the Litani River to cover the water shortfall. The Cotton Plan allocated 400 MCM of the Litani's water to Israel and 300 MCM to Lebanon.

The period between October 1953 and July 1955 was a negotiating and bargaining stage over the Jordan River system. By the end of 1955, the Johnston Plan became more favorable to Israel, whose share rose to 450 MCM while Jordan's shares dropped to 720 MCM.

The final form of the Plan, even though it was rejected by Arab States, was employed by the United States as a basis for its future plans in the region. The failure to reach bilateral agreement reinforced each country's inclination to proceed independently.

In 1958, Israel re-initiated the National Water Carrier project but with some technical changes and also the Seven Year Plan was replaced by the Ten Year Plan. The new plan shifted the diversion point to Eshed Kinort, at the north- west corner of Lake Tiberias. The new diversion project was carefully designed in accordance to Israel's water allocation in the Revised Johnston Plan. It also refrained from invalidating its general principles.

Arab reaction to Israel's National Water Carrier was to build dams on tributaries of the Jordan and Yarmouk Rivers, thus reducing the water flow to Israel. In 1965, Syria began building dams to divert water from the Banias and Dan Rivers in the Golan Heights. These headwater diversions threatened to deprive Israel of 35% of its water potential from the Upper Jordan. Israel, as a riparian state of the Jordan Basin, considered this action an aggression on its water resources and sent fighter planes to destroy working sites.

Israeli occupation of the Syrian Golan Heights in 1967 and subsequent control over the Jordan's headwaters in the area ended Arab dreams and plans for utilizing the water of the Jordan Basin.

In 1969 Israel bombed the East Ghor Canal in Jordan, keeping it out of order for four years. After secret negotiations between Jordan and Israel in 1969-1970, Israel permitted the repair of the East Ghor Canal while Jordan, in return, reaffirmed its adherence to the Revised Johnston Plan quotas".

Current Situation:

All of the proposed plans neglected the Arab historic rights and were thus rejected. During the past 50 years, the course of this important river has been altered and its headwaters siphoned off, leaving it currently as nothing more than a trickle of sewage. Several projects had altered the character of the river such as:

1. The greatest part of the Yarmouk River is directed to the Eastern Valley canal and the rest is pumped to Lake Tiberias. The Jordanians use 100-120 MCM per year from the Yarmouk River (Moore).
2. The Israeli authorities have Launched the Gilgal project where water of the Jordan River is pumped to the settlements in the Jordan Valley.
3. Mekorot, the Israeli water company, is diverting the Jordan's water before it leaves Lake Tiberias.

Israel is using around 670-715 MCM per year from the water of the river. This includes, local consumption from Tiberias, utilization in the upper Jordan and Huleh Valley and Israeli withdrawals from the Yarmouk River, in addition to the water pumped through the National Carrier Water. On average, 380 MCM per year is pumped from the Tiberias through the National Water Carrier for domestic and agricultural use in the central and southern parts of Israel (Moore).

As the Jordan's water flows south, its quality suffers from constant degradation. By the time it reaches to the Dead Sea, the water is highly saline and loaded with heavy metals. The deterioration of water quality may be due to the upstream utilization by other riparians and the diversion of the salty springs of the Lake Tiberias by the Israeli authorities into the Jordan River. In addition to the agricultural return flows and the disposal of untreated wastewater by Israeli settlements in the Jordan Valley.

Palestinians through the current negotiations must fight to recover their rights to control and utilize their water from the Jordan and Yarmouk rivers. In addition, they should reach an agreement with the Israelis as an upstream country to prevent pollution and conserve the quality of the Jordan's water.

Chapter Five
Agriculture

Despite high temperature, evaporation, and low rainfall (Figure 5.1), the Jericho district is distinguished for its agricultural activities. The success of agriculture in the area is related to the combination of its location below sea level, year-round warm weather and the availability of water (from springs and wells).

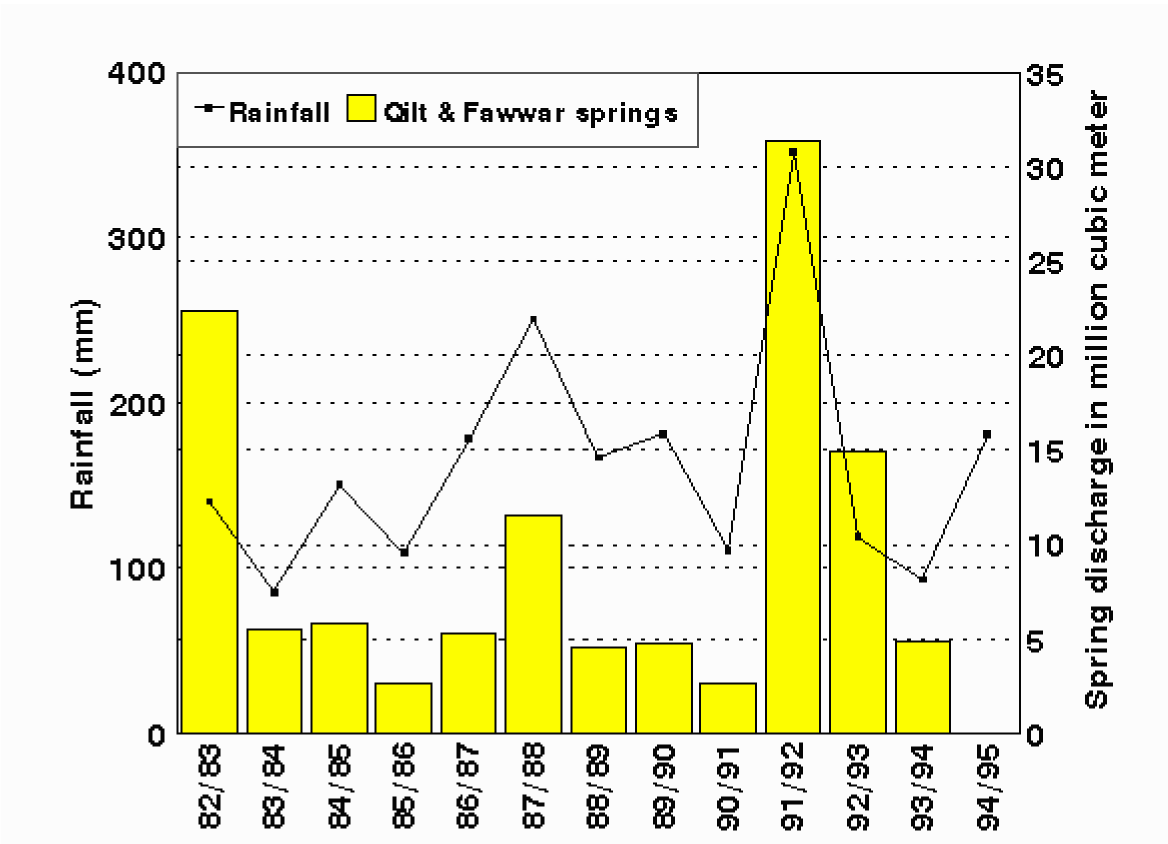


Figure 5.1 Average distribution of rainfall and temperatures in the Jericho district for (1983-1992)

The warm winter temperature helps in cultivating vegetable crops which would not be possible during this season in other parts of Palestine, the Middle East and Europe. Thus, agriculture in the Jericho district has a high economic potential both in the local and export markets. Tropical crops are also possible, increasing the diversity of agriculture in Palestine.

The Jericho district has three main agrarian regions: Jericho city, Dyouk and Nuwe'ma, and Al-Auja (Jericho Agricultural Station, 1994). All plantations are irrigated from agricultural wells and springs located at the district.

Plant Production

The area cultivated by Palestinians has not been expanded during the last 20 years due to the restrictions imposed by the Israeli occupation authorities on the land and amount of water permitted to be pumped from each agricultural well.

Table 5.1 Distribution of agricultural areas in the Jericho district

Region	Area (Hectares)
Jericho city	1,447.9
Al-Auja	625.3
Dyouk & Nuwe'ma	346.2
Total	2,419.4

In the 1993/94 growing season, the agricultural area in the district was approximately 2419.4 hectares (Jericho Agricultural station, 1994), forming nearly 43% of the total irrigated agricultural area in the Palestinian part of the Jordan Valley and 23% of this area in the West Bank (SAAR, 1992). Of the three agrarian regions, Jericho city has the largest agricultural area while Dyouk and Nuwe'ma have the lowest. Table 5.1 shows the distribution of agricultural areas in the district.

The main cultivated crops in the Jericho district are vegetables including melons, fruit trees and field crops and forages. The area and the total production of each crop are shown in Figure 5.2.

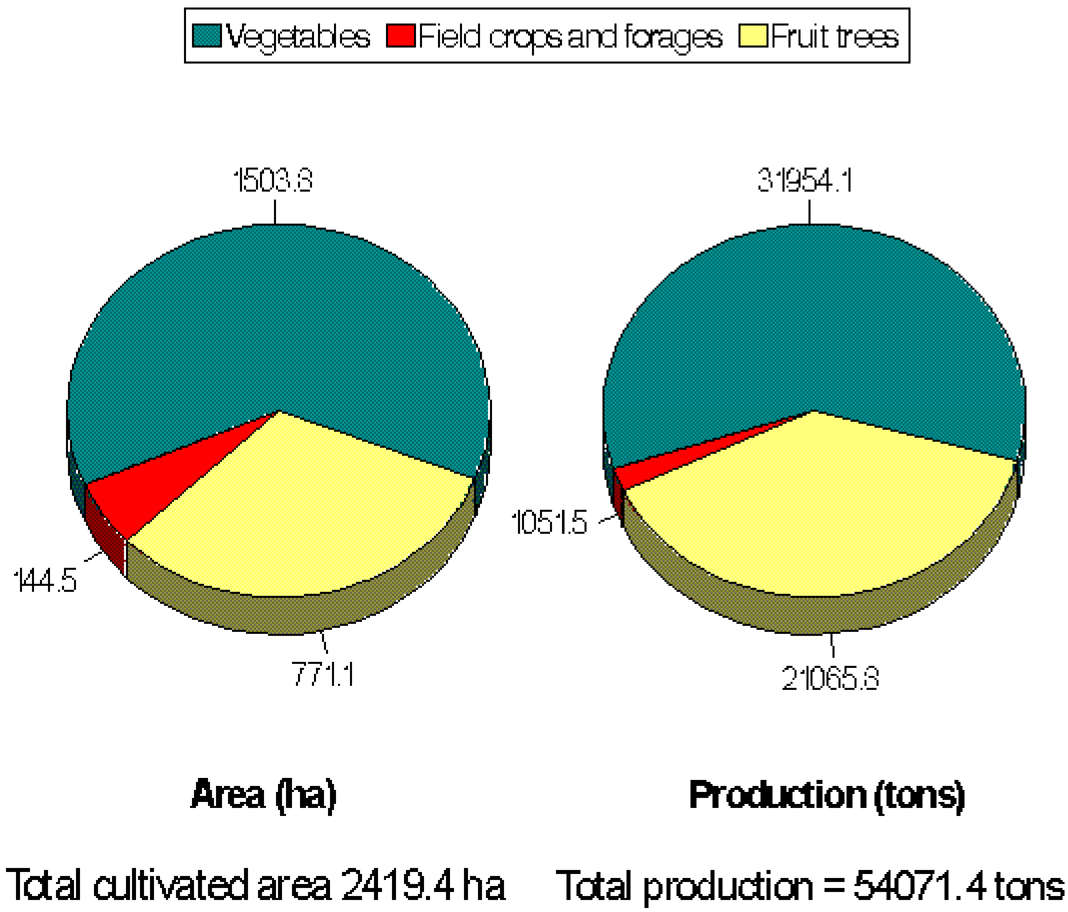


Figure 5.2: Total cultivated area and production of different cropping patterns in the Jericho district for the 1993/94 growing season.

Vegetables

About 28 vegetable crops are grown throughout the Jericho district over an area of 1503.8 hectares and under different types of cropping systems. This area is calculated on the basis of effective plantation per hectare. Cropping systems are divided as: irrigated open field; low tunnels (crops grown under low plastic tunnels of 80 cm in height, usually used for early plantations to protect the crops from low temperatures during winter); medium and high tunnels (2-3.5 m in height); and plastic houses (more than 3.5 m in height) (Jericho Agricultural Station, 1994).

Due to water resource limitations in the district, most vegetable crops are irrigated using drip systems. Sprinklers and traditional flooding are also used in limited areas, especially in the basins cultivated with crops such as spinach, parsley and citrus.

The cropping season usually extends from September through June. During the rest of the year, land is being prepared for the coming season. Obviously, this pattern varies depending on the cropping system, the crop, the needs of the land and the weather in a given year.

The planting dates in the Jericho district fall in two long periods, from September until January for early and winter cropping, and from February to April for summer cropping. Farmers often plant some of the plots with short life cycle crops, so that they can cultivate a second summer crop, resulting in an increase in the effective cultivated area. Recognizing the possibilities for increasing production through the intensification of agricultural techniques, farmers and business people have introduced modern technologies such as: plastic houses, high tunnels, low tunnels, plastic mulches, drip irrigation, improved varieties of plants and chemicals such as pesticides and hormones. The combination of these have resulted in an increase in crop production, especially for prostrate varieties (i.e. cucumbers and tomatoes). On the other hand, enlarging the vegetative cover per area has increased the water requirements where other alternatives of water resources should be found.

Of the total cultivated vegetables, tomato, squash, Jews mallow, cucumber, eggplant and sweet corn have the largest areas and production, comprising about 71.6% of the areas and 73.6% of production (see Figure 5.3).

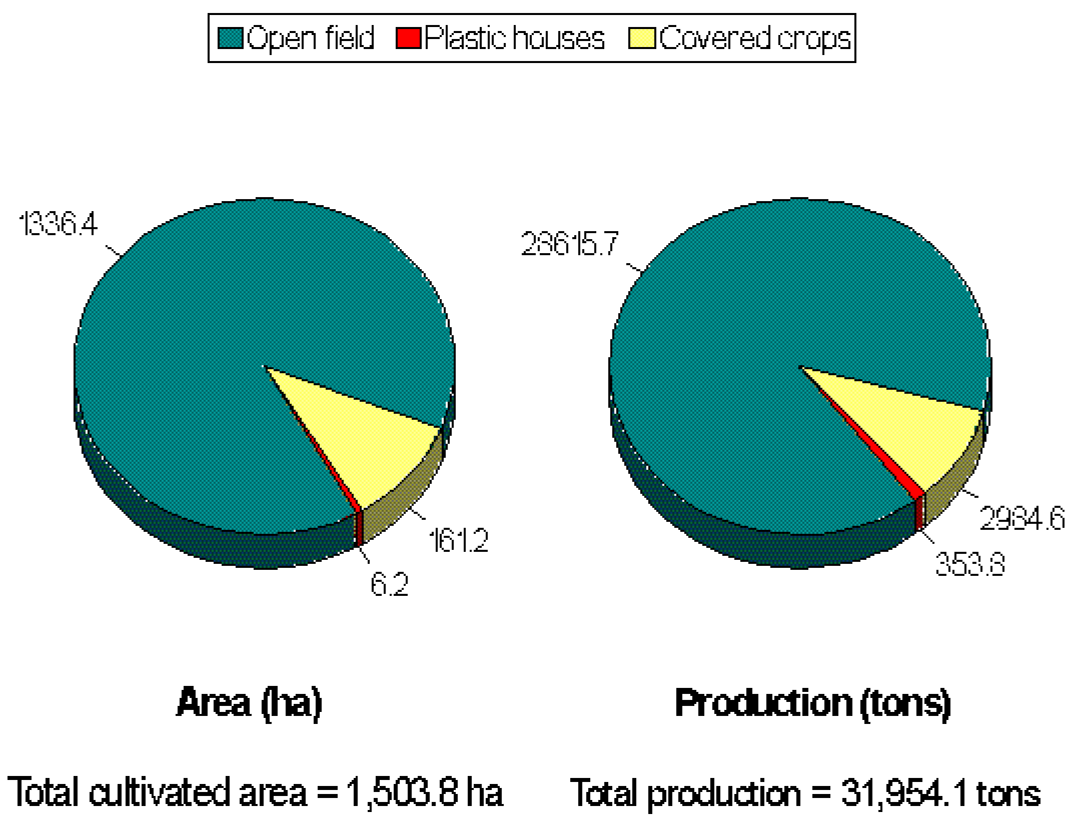


Figure 5.3: Total area and production of vegetable crops under different cropping systems in the Jericho district for the 1993/94 growing season

Plastic houses and high tunnels cover up to 6.2 hectares, and are used to produce sweet and hot peppers, tomato, beans, cucumber, eggplant and Jews mallow. Low plastic tunnels, occupying around 161.2 hectares, and are used to plant the same types of vegetables planted in the open field irrigated areas, including all the 28 vegetable crops.

The intensive irrigated vegetable production requires a continuous work during all stages of the growing season, providing more employment opportunities for the people. Usually, farmers in the Jericho district tend not to own the land they cultivate but they always work through share-cropping or renting arrangements. This is due both to the unpredictability of the produce market, making the farmers wary of investment in land, and also to the traditional land ownership arrangements.


Photo 3: Cultivation using low plastic tunnels in the Jericho district

Field crops and forages

All kinds of field crops and forages in the Jericho district are cultivated under irrigated conditions where sprinkler irrigation is commonly used. High productivity is obtained from this cultivation, especially when compared with the same crops grown under rainfed conditions in other areas of the West Bank, especially the southern parts where there is limited annual rainfall.

Wheat and barley are the main cultivated field crops covering an area of 106.5 hectares in the Jericho district. Green forages, such as alfalfa and Egyptian clover cover an area of 36 hectares, with an average production of 20 tons per hectare (Figure 5.4). This area should be increased especially with forage varieties that can withstand salinity. Increasing forage production will supply fodder to the livestock sector and reduce the dependency on Israeli green forages. Most of these forages are also good for improving soil quality.

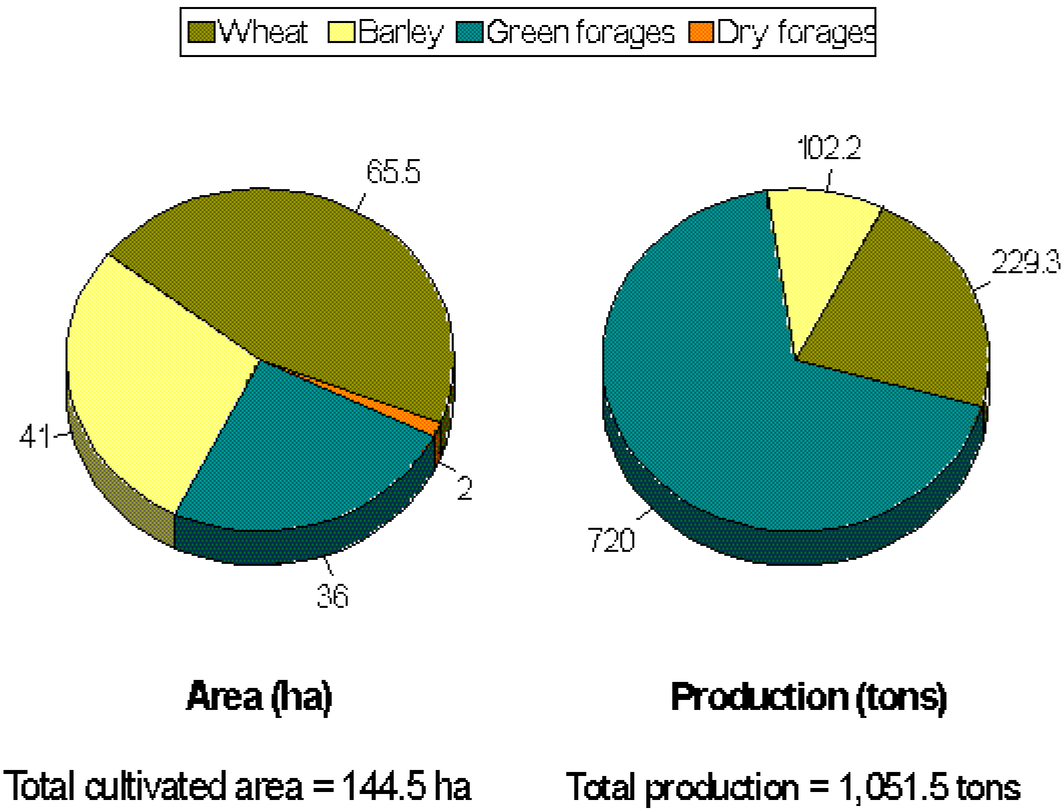


Figure 5.4: Total area and production of field crops and forages in the Jericho district for the 1993/94 growing season

Fruit trees

Seven different types of fruit trees are cultivated on an area of 771.1 hectares in the Jericho district with an average total production of 21,065.8 tons in the 1993/1994 growing season (see Figure 5.5) (Jericho Agricultural Station, 1994).

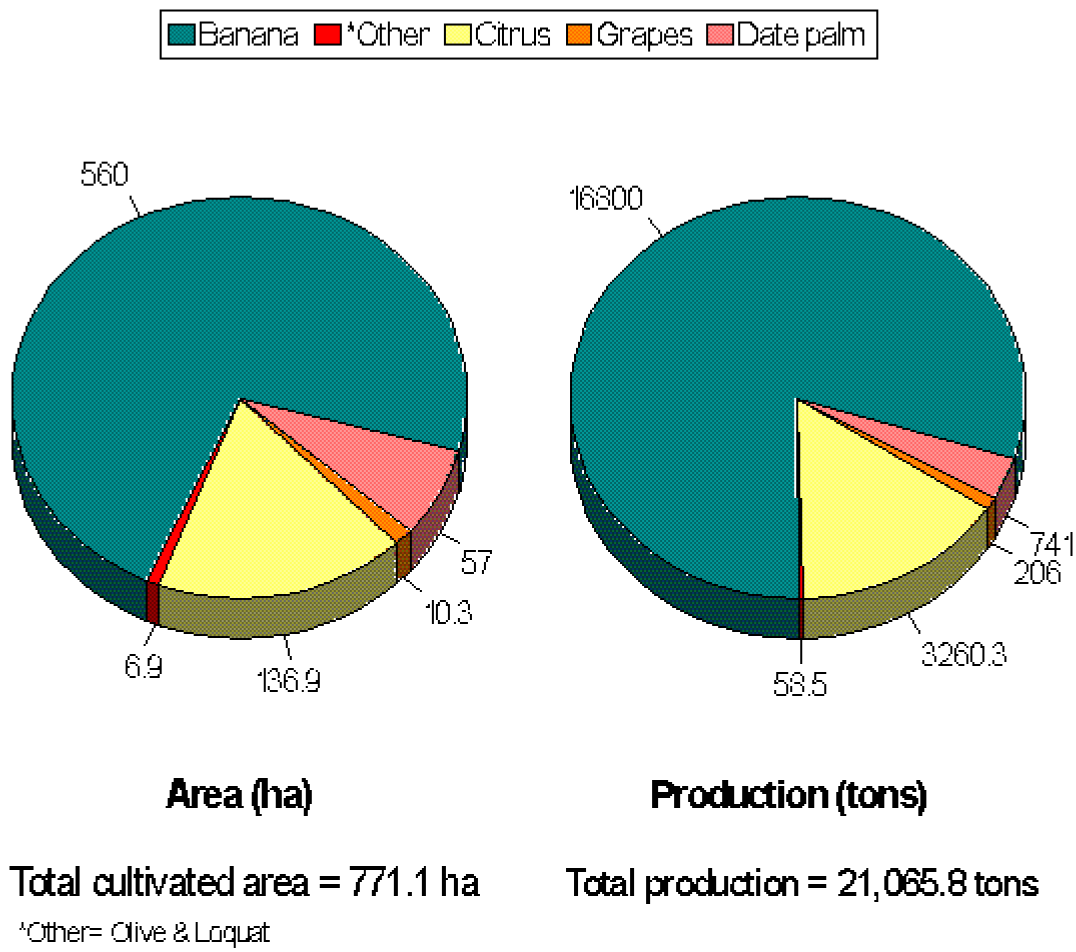


Figure 5.5: Total area and production of different fruit trees in the Jericho district for the 1993/94 growing season.

Bananas have the largest cultivated area of all fruit trees comprising 72.6%, and making up 79.8% of the total fruit production in weight. The banana is a profitable crop, both in terms of production and net revenue, but it requires large amounts of water, up to 17,000 CM/yr/hectare.

There are 6 cultivated types of citrus trees, totaling 17.8% of the fruit trees area and nearly 15.5% of fruit production (see Figure 5.6). Oranges have five different varieties (Joint, Valencia, local or Baladi, French, Shamoti), making up about 50% of the citrus area and 40% of its production. Shamoti oranges and lemons cover the largest area of citrus and produce about 20 and 30 tons per hectare respectively. However, the decrease in the economic value of citrus, especially for oranges, have led some farmers to cut down the citrus trees, replacing them with vegetables, and bananas. The remaining 74.2 hectares of fruit trees are devoted to date palms (57 hectares), grapes, olives, and loquats (Figure 5.5).

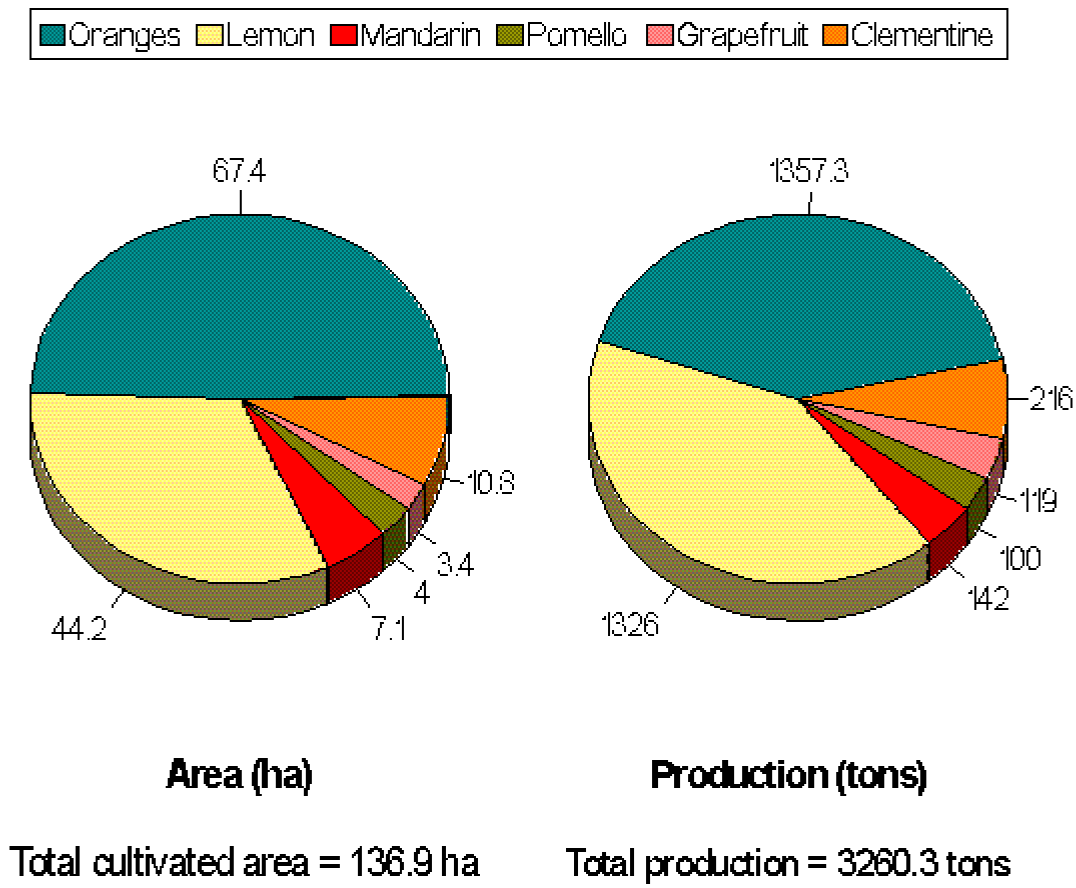


Figure 5.6 Total area and production of citrus trees in the Jericho district for the 1993/94 growing season.

Drip irrigation is the main system used for irrigating all types of orchards except for citrus trees. Citrus are mainly irrigated through basins, which uses more water than other methods of irrigation.

Crop Water Requirements

Crop water requirements vary from season to season depending on the amount of rainfall and planting date. Low rainfall, high rates of evaporation, transpiration and radiation, low relative humidity and relatively high soil salinity in the Jericho district make the crop water requirements higher than other districts in the West Bank.

Calculating water requirements for different cultivated crops give a realistic estimation of the total water consumption for the cultivated area. It also helps in projecting and planning the potential for the expansion of irrigated agriculture and modeling the types of crops to be grown, taking into consideration the amounts of available water and its sources.

There are many factors controlling the water required by the plant through its life cycle such as:

1. Climatic factors such as relative humidity, temperature, sunshine or radiation, rainfall and wind speed.
2. Soil factors such as the soil physical characteristics, water potential and hydraulic conductivity.
3. Plant factors such as the planting date, growth stage, type, the size (coverage percent), the leaf orientation and the stomata numbers (Najem & Badir, 1980).

The crop Zwater requirements based on water evaporation from the soil and transpiration of the plant are also calculated (Doneen & Westcot, 1988).

Several methods are used for calculating the crop water requirements. In this profile, the pan evaporation method was used to calculate the water requirement for different cultivated crops according to the cultivating period and cropping pattern (Water Data Base, ARIJ, 1995). Table 5.2 gives an estimate of the water requirements (evapotranspiration) based on estimates made using the pan evaporation method for different cultivated crops and cropping patterns in the Jericho district. The average total amount of water used by all crops under different cropping patterns in the Jericho district during the 1993/94 growing season was, given evapotranspiration, 18.42 MCM. This amount did not include that needed to make up the losses due to soil or the irrigation system (Agricultural Data Base, ARIJ, 1995). Of all types of crops in the Jericho district, fruit trees have the largest crop water requirement with 63% of the total water use, followed by vegetables with 32.2%, and field crops with 4.8%. Bananas alone consume approximately 51% of the total amount of irrigation water.

Future plans for agricultural improvement in the district must take into consideration both water consumption and income per crop, so as to optimize the water consumption in the most economical manner.

Table 5.2 Estimated water requirement (evapotranspiration) according to pan evaporation method for different cultivated crops and cropping patterns in the Jericho district.

Type	Crop water requirement (evapotranspiration) (CM/Hectare)	Total cultivated area (Hectare)	Total water consumption (MCM)
Fruit trees		771.1	11.61
Banana	16,690	560	9.34
Citrus	11,490	136.9	1.57

Others	9,450	74.2	0.701
Vegetables		1,503.8	5.93
Open field	3,930	1,497.6	5.89
Plastic houses	6,210	6.2	0.04
Field crops		145.5	0.88
Wheat & dry Forages	3,680	68.5	0.25
Barely	2,590	40.0	0.104
Green forages	14,570	36.0	0.525
Grand Total		2,419.4	18.42
Source: Water Unit, ARIJ, 1995.			

Irrigation Ponds

The irrigation pond is a water storage technique which allows for improving the conservation and efficiency in water use in the agricultural water delivery.

The first irrigation pond was constructed in the 1970 as a demonstration at the Jericho agricultural station with a capacity of 1,650 CM (Jericho Agricultural Station, 1994). The positive results achieved by this pond in increasing the productivity and improving the water use efficiency encouraged farmers to build these ponds and to use drip irrigation systems.

Soil irrigation ponds with plastic covers are most dominant in the Jericho district, with an average capacity of 3,403 CM/pond. Concrete irrigation ponds are less prominent and have a more limited capacity of just 300 CM/pond. A total of 45 concrete ponds and 186 soil ponds are located in the Jordan Valley. Of these, approximately 26 concrete ponds and 107 soil ponds are located in the Jericho district (Jericho Agricultural Station, 1994 &; Abed Al-Razaq &; Abu Saleh, 1991). Most of these ponds were established between the years 1970 and 1980. As shown in Figure 5.7, the rate pond construction in the Jericho district and Jordan Valley dropped in the 1980s (3.5 pond/year) and 1990s (1.3 pond/year) compared to the 1970s average of 6.1 pond/year (Abed Al-Razaq &; Abu Saleh, 1991). This is due to that in the 1981, the Israeli civil administration imposed constraints on building more ponds by requiring a license for each new irrigation pond. This license has been rarely granted. In addition to the high costs of construction and installation of an irrigation system using a pond.

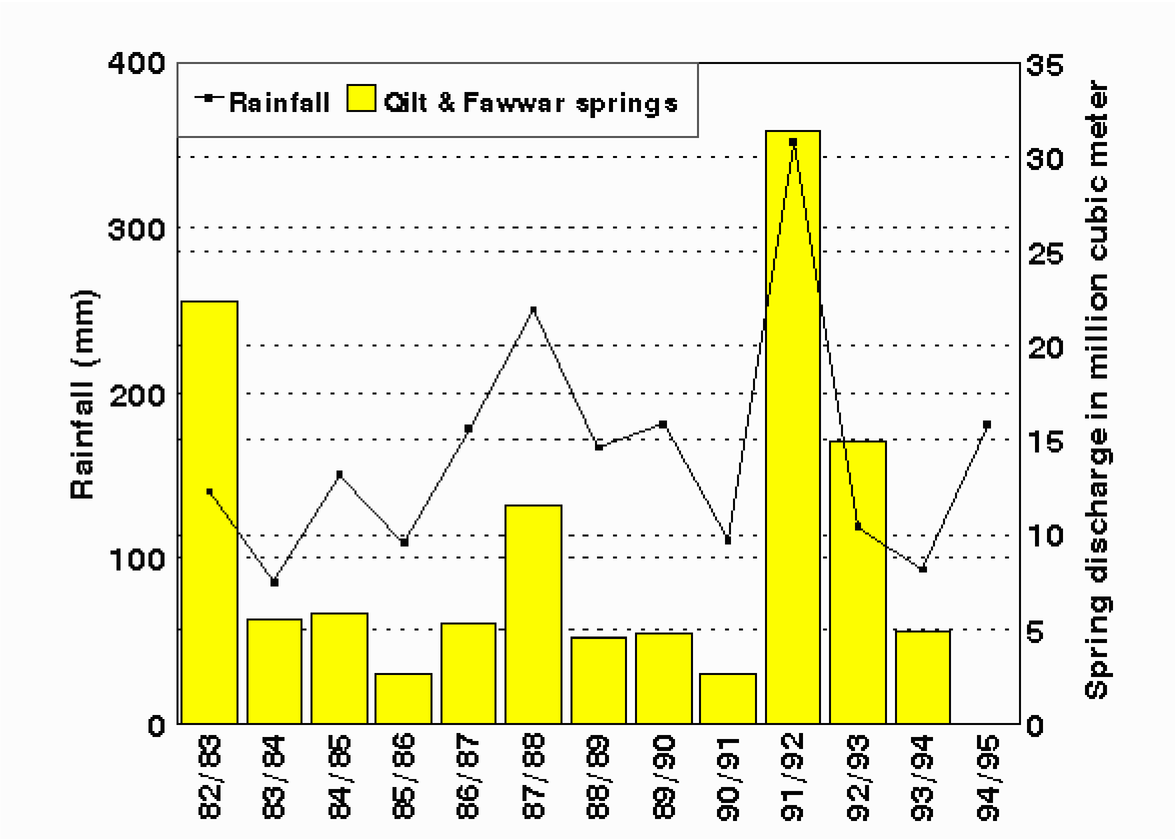


Figure 5.7 Total number and rate of pond construction in the years 1970-1994

Most of the ponds in the Jordan Valley were designed and constructed by specialized engineers, reflecting the awareness of the Palestinian farmers about the importance of applying this technique in a proper manner. Many factors affect the efficiency of this technology such as: pond location in the farm, natural slope of the land, location of the water resources, pond construction and plastic covering to prevent water seepage.

Irrigation ponds in the Jordan Valley get their water mainly from the springs. Agricultural wells are used as well, and occasionally they are fed from the Mekorot, which is used as the last resort when other sources become dry, especially in the Al-Auja area (Abed Al-Razaq &; Abu Saleh, 1991).

Drip irrigation has been proven to increase water use efficiency by up to 90%. It is also known to increase agricultural productivity and solves the problems of water losses, which are often as high as 35% when traditional irrigation methods are used (especially furrow and contour furrow systems which use open canals) (Abd Al-Razaq &; Abu Saleh, 1991). Also, drip irrigation has increased the average productivity of vegetable crops by 243%, citrus trees by 148% and banana trees by 125% (Jericho Agricultural Station, 1994 &; Abed Al-Razaq &; Abu Saleh, 1991). More than 50% of the total cultivated area in the Jericho district are irrigated using these ponds.

Agricultural ponds and drip irrigation have played an important role in production improvement through the following factors: allowing better control of irrigation process and thus crop management; improving water use efficiency and at the same time reducing the time and effort needed for irrigation; allowing the possibility of improving water quality by mixing the saline water coming from agricultural wells with less saline water coming from springs, and thus increasing the size of cultivated areas; improving the planted area production; enhancing the summer crops cultivation during winter season; and increasing the farmers income.

Increasing the number of irrigation ponds will be one of the factors in improving plant production in the Jericho district. Clearly this will involve alleviating the constraints on the installation of new ponds and finding sources of funding or credit for farmers.

One promising prospect for this technology is to invest in aquacultural activities. A recent study by Hosh showed that there is a potential to use these ponds for fish farming despite the fact that water quality is limited by many factors including high temperatures. Fish species which are suitable for the area such as, tilapia, carp and catfish, are available Besides increasing the income of farmers, this could improve the quality of irrigation water by supplying the water with nitrogen and phosphorus, and the production would help in improving the Palestinian animal protein intake (Hosh, 1995).

Photo 4: Irrigation pond at the Jericho Agricultural Station.

Livestock Production

Because of the hot climate in the Jericho district, the design of the animal and poultry livestock farms is completely different from those in the high-lands. Open shed system is the most prevalent in the area.

Poultry:

There are about 10-12 farms of broilers in the Jericho district, with an average capacity of 8,500 birds per farm per round. Approximately 4-5 rounds are reared during the year. The number of broiler chickens produced was around 430,000 in 1994. Layers are much less common than broilers due to their inability to produce well in high temperatures. There is only one farm of layers in the Arab Development Society Project (ADS), with a total number of 3,600 birds in 1994 (PARC & Arab Thought Forum, 1994).

Sheep & Goats:

The numbers of sheep and goats in the Jericho district vary from one season to another. Because of the district's warm winter and the availability of range plants for grazing, Bedouins (Palestinian nomad herders) graze their sheep and goats in the Valley from November until February, returning to the hills in the highlands in the remaining months of the year.

Local strains of sheep and goats are dominant in the district with a total number of 24,000 heads. The majority of the sheep are Awasi while most of the goats are Baladi. There are few improved strains such as Shami goats or Assaf sheep.

Like other livestock in the Jericho district, sheep and goats are facing problems associated with hot climate. The high temperature results in more water consumption per animal due to the increasing respiratory rates, which in turn affects the production and net profit.

Table 5.3: Total number and types of livestock in the Jericho district in 1994.

Type	Number
Dairy cows (Heads)	
Friesian	431
Local	20
Sheep & goats (Heads)	
Sheep	12,500
Goats	11,500

Poultry (Birds)	
Broilers	430,000
Layers	3,600
Beehives (Hives)	7,540

Dairy cows:

Approximately 451 dairy cows are reared in the district where almost 75% of these are at the ADS farm. Ninety-five percent of these are Friesian and the rest are local dairy cows (Table 5.3). The average daily milk production for both strains is nearly 15 Kg, which is 2.5 Kg/day below the average for the same strains elsewhere in the West Bank. This is due mainly to climatic conditions (PARC & Arab Thought Forum, No.2, 1994).

Beehives:

There are 7,540 beehives in the district, most of which are hybrid bees. The annual production of honey reached 113 tons, with an average yield of 15 Kg of honey per hive (PARC & Arab Thought Forum, No.3, 1994).

Agricultural Institutions

1- Jericho Agricultural Station:

This station occupies an area of 8 hectares of which approximately 4 hectares are planted with horticultural trees, such as bananas, date palms, and citrus. The remaining area is usually used for vegetable production, especially for agricultural demonstrations and experiments.

The goal of the station is the improvement of agricultural activities and increase of of the Jericho agricultural sector. It is now operating under the auspices of the Ministry of Agriculture in the Palestinian Authority. The office is staffed by agricultural engineers of different specialties working to rehabilitate the station's land and to provide services such as extension and research. Although the extension service and research are the main intended functions of this station, they have significantly deteriorated during the 27 years of occupation.

2- Arab Development Society Project (ADS):

This project was established in the mid-1940's by Mousa Al-Alami, on an area of 800 hectares. The Israeli authorities confiscated around 300 hectares of the project area after occupation in 1967 as most of this land was located in the Israeli declared military areas along the banks of Jordan River (ADS, 1992). The project aimed to achieve the following:

- Improve the socio-economic conditions of the Arab farmers.
- Improve the agricultural industries.
- Encourage the agricultural cooperative system.
- Encourage the planting of all types of suitable trees.
- Provide free agricultural and industrial training for poor people.
- Provide agricultural training on new technologies in agricultural production for farmers.

The project includes the following sections:

1. *cow farm:* There are approximately 300 heads of cattle, where approximately 117 of them produce 1.5-2.5 tons of raw milk daily.
2. *milk processing unit:* Usually operates as a training center for students about milk processing to produce yogurt, labaneh and white cheese.
3. *poultry farm:* This section contains 3,600 layers and was established to train students.
4. *Vocational Training Center:* The ADS runs a secondary school for boarding studentswhich provides certification for a Vocational Tawjehi in agricultural machinery, carpentry and metal work. The association offers free lodging, food, clothes, medical care, and teaching.

3- Jericho Agricultural Marketing Cooperative (JAMC):

The JAMC was founded in the 1959 with the main goal of helping the Jordan Valley farmers to market their vegetable and fruit products and to protect them from losses caused by marketing crises. With a current membership of 2,500 members, mostly farmers from the Jordan Valley, the cooperative has worked to find new markets outside the country to export excess production. Activities of the JAMC have included the following:

1. Helping to export agricultural products to Jordan and the Gulf markets.
2. Providing permits and documentation so that agricultural products can be accepted by the Jordanian Authorities. As part of this activity, the cooperative also compiled statistics of the annual cultivated areas and expected production in order to decide the volume of the exported vegetables and fruits (Jordanians often would allow imports based on estimated production and Jordanian absorption

potential). This activity has been ceased following the establishment of Palestinian autonomy over Jericho area .

3. Distributing the money received from the PalestinianJordanian Joint Committeein order to provide support to Palestinian communities in the occupied territories throughout the 1980s. For example, the cooperative used these funds to support the Palestinian farmers and to compensate them for crop loss due to frost damage in 1987.
4. Initiation a farmstore in the Jericho district to provide farmers with agricultural equipment and chemicals at acceptable prices.

4- Palestinian Agricultural Relief committee (PARC):

PARC is a Palestinian agricultural NGO operates through branch offices throughout the West Bank and Gaza Strip. One of the oldest branches is the Jericho branch, which was founded in the 1983. It carries out many activities such as:

4.1 Plant production:

The branch office contains a 40 hectares farm. While most of this land was uncultivated when it was acquired, the area has been converted into viable farmland and is now used by PARC staff for plant production. By the end of the 1994, approximately 7 hectares were covered with plastic houses, including high tunnels. These houses will be used in the coming season. Also, 5 hectares are cultivated with bananas and big part of the rest area is devoted to cultivating open irrigated vegetables.

4.2 Training and extension programs:

The farm is also used for training newly graduated agricultural engineers on the applications of the most modern of technologies in irrigated agriculture. The training programs usually involve extension visits to farmers as well.

4.3 The women agricultural unit:

This unit aims to improve the social status and standard of living of agricultural women. It supplies funding to development projects that support women's activities especially at the domestic level.

Major Problems and needs

In an attempt to improve the agricultural sector in the district of Jericho, many problems need to be addressed. These include:

1. Limited waer resources, in large part because of the restrictions on the amount of pumped water.

2. Most of the spring's water is conveyed to irrigate lands through an open concrete or earthen channels. This results in a very high water losses either through evaporation or seepage into the ground.
3. Water and soil salinity are continuously increasing due to the fact that soil leaching treatments are not often enough applied.
4. Intensive agricultural techniques, while increasing short term production, have negatively affected the environment. The intensive usage of pesticide, especially methyl bromide for soil fumigation, has had negative effects on humans, the environment in general, the ecological balance of soil profile and groundwater (see Chapter 9). Also, the increasing quantities of generated solid wastes resulting from the extensive usage of soil plastic mulches, tunnels and plastic houses have negative effects on the environment and livestock. These covers are either left at the peripheries of the farm, leaving the risk that livestock might eat the plastic, possibly resulting in death, or burned on the farm causing air pollution. Residues of plastic left in the fields may also hinder soil quality (see Chapter 8).
5. Marketing crises due to lack of agricultural planning and controls.
6. The ability to export produce is controlled by the continuously changing political situation, often causing heavy losses for farmers.
7. Ineffective extension services which do not reach most of the farmers in the district.
8. Directions of use on the pesticides and fertilizers containers is always written in either Hebrew or English language which is forming a problem for most of the farmers.
9. The type of land tenure, where most of the lands are owned by wealthy holders of large areas, while farmers often work under share cropping arrangements.

Recommendations

The following recommendations may be important in contributing to the improvement of the agricultural activities in Jericho district:

1. Modern irrigation techniques should be introduced especially in citrus orchards.
2. New crops of high potential productivity and profit should be introduced such as, flowers, prostrate tomatoes, certain salt-tolerant date palm varieties and grape varieties which mature early under plastic houses.
3. Drainage systems like sub-surface lines should be applied to reduce land and water salinization.
4. Effective plant rotations should be applied.
5. Suitable rules for protecting farmers and developing more fair systems of land tenure should be put in place.
6. An active extension and research system should be built to detect the farmer problems and find suitable solutions.
7. Grading and storage centers for surplus production should be constructed to meet the international standards of marketing and exporting for agricultural commodities.
8. New markets for exporting the surplus agricultural production should be opened.

Chapter Six
Historical And Archeological Sites

Historical Background

The Jericho district is extremely wealthy in historical and archeological sites. The city was inhabited during Mesolithic Period. One theory attributes derivation of the name from the moon (Yareah) cult practiced there by the Canaanites. Another theory attributes the name to the pleasant fragrance (reah) of its flora. Jericho was the first Canaanite city which was occupied by the Israelities in 1186 BC. Joshua who was their leader then, sent two spies to check out the city. They were concealed by the spy Rahab who informed Joshua about the inhabitants' fear of the Israelities. Consequently, the Israelities crossed Jordan and started marching around the city once every day for the next 6 days; "on the seventh day they marched around the city 7 times; on the seventh march they sounded the horns, the walls of the city collapsed, and the Israelities attacked the city and captured it. Then with the sword they destroyed everything in the city, both men and women, young and old, and even oxen, sheep and donkeys. None was survived except Rahab and her family. Joshua cursed the city and the man who should attempt to rebuild it" (Holy Bible, Jos 6).

After that, 'Ajloun the King of Moab, occupied Jericho and expelled the Israelities in the period of Judges (1170-1030 BC) and declared Jericho his capital (Encyclopedia Palestina, 1984).

During the Roman conquest in 63 BC-324 AD, Antony gave the city as a present to Cleopatra. Augustus Caesar returned it to Herod who built his winter palace and other buildings on a site known as Tel Abu Alayiq. The city became prosperous in this period. This Herodion Jericho was restored by Romans on the rift of Wadi Al-Qilt. During the period of 306 to 337 AD, Jericho became the center of Christianity, continuing to be an important city through the Byzantine Period (527-565 AD) (Encyclopedia Palestina, 1984).

In the seventh century, Moslems took control of Jericho, whose development of irrigated agriculture there earned it the description of the "City of Palms". Jews who were expelled from Arabia were settled in Jericho at that time. But this prosperity declined afterwards, changing Jericho from a green oasis to a poor desert, as mentioned by an English traveler who passed there at the end of the past century (Al-Dabbagh, 1991).

Historical Sites

Tell-es-Sultan:

Located northwest of present city, this site records inhabitation going back to prehistoric Natufian culture of the 11th-9th century BC, making Jericho arguably the oldest continually inhabited site on earth. In 8000 BC, Neolithic Jericho was a city of 2000 protected by fortifications. In the many excavations on the site, finds include a round tower from pre-pottery Neolithic Period, tombs from Chalcolithic Period, and walls from Early and Middle Bronze Ages and ensuing periods (Al-Dabbagh, 1991).

Ein-Al-Sultan (Spring of Elisha):

Close by the hill of Old Jericho is the "Ein-Al-Sultan" or the Spring of Elisha. The Bible tells of the prophet Elisha, disciple of Elijah, healing the water of the spring at the request of people of Jericho. This spring is still operating, providing an important water source for the inhabitants and their gardens (Al-Dabbagh, 1991).

Ancient Synagogue:

Not far from the Spring of Elisha, in a small Arab house standing in a grove of trees, there has been found a beautiful mosaic floor belonging to a synagogue of the 5th-6th century. In the center of the mosaic is a picture of Menorah (candelabrum), the emblem of Israel.

Tel Abu Alayiq:

Located about 2 km southwest of the city, on both banks of Wadi Al-Qilt, is the Herodion and Roman Jericho. Here, King Herod, in the first century BC, built his winter palace, and developed a complex water system. Impressive remains, especially of Herod's typically sumptuous building; decorated walls, water pools, bathhouses, halls and aqueducts can still be seen today at this archaeological site. (Al-Dabbagh, 1991).

Kypros:

On a nearby conic-shaped hill, 3 km southwest of Jericho city, are the remains of the ancient fortress of Kypros. The fortress is said to have been named after Herod's mother, who expanded the fortress and built a palace inside. On the site, are the remains of the foundations of a round tower, as well as those of a bathhouse, aqueduct, 4 reservoirs, a column and capitals from Herodion Period (Israel Ministry of Defence & Carta, 1993).

Khirbet el Mafjar (Hisham's Palace):

Extensive remains of a winter palace built by Umayyed Caliph Hisham Ibn Abd el Malik in the 8th century are located 1 km. northeast of Jericho. Ruined in an earthquake in 747 AD, shortly after its construction; it was never inhabited at all. The main features of the architectural design was the great courtyard with towers at corners. The site boasts elaborate stone friezes and mosaic ornamentation. There are intricate plaster molds of dancers, partridges and floral patterns. The most famous remains are that of a star-shaped window in a carved stone and the mosaic of the tree of life. Remains also include decorated slanting structures, mosque, bath-house, pool and mosaic floor (Al-Dabbagh, 1991).

Wadi Al-Qilt:

A water course in the Judean Desert, originates alongside Beit Hanina, north of Jerusalem, and empties into the Jordan River, 10 km southeast of Jericho. It is fed by several springs, the larger ones being Ein Fara, Ein Fawwar and Ein Qilt. In the river bed are many caves which were used by monks and hermits as early as the beginning of monasticism in the Byzantine period. An aqueduct runs along the water course which irrigates the Jericho region. Remains of the elaborate high and arched aqueduct, which irrigated Herodion Jericho, still exist alongside the modern one which waters the plantations of today's Jericho (Al-Dabbagh, 1991; Israel Ministry of Defence Carta, 1993).

It is worth mentioning that Mr. Muhyi Addin Al-Husaini worked hard in drawing the water from Ein Al-Qilt to the Jordan valley by digging a canal in 1907. The canal extended for 15 km and is a very important irrigating facility in that dry area. Mr. Al-Husaini also used the water-flow to power a grain mill which served the surrounding area. In 1975, the area of Wadi Al-Qilt was declared a nature reserve by the Israeli Government. This unfortunately placed restrictions on visiting this area for Palestinians (Qarra'in, 1992).

Deir Quruntul *(Monastery of the Temptation or of the 40 Days)*:

This Greek Orthodox monastery, 4 km. northwest of Jericho built onto side of sheer cliff, overlooking the Jericho oasis is one of the most fabulous locations in the Holy Land. Its name is derived from the Latin word (quarantena) meaning forty. According to Christian tradition it was here that Jesus fasted for 40 days and was tempted by Satan. The original monks who moved here early in the 4th century lived in the natural caves in the cliff. Later a monastery was built but it was destroyed by Persians. The present building was constructed by the Russian Orthodox Church between 1875 and 1905. Inside, beside Byzantine art treasures is a stone on which Jesus is believed to have sat during the Temptation (Al-Dabbagh, 1991).


Photo5: Deir Quruntul (Monastery of the Temptation or of the 40 Days)

St. George Monastery (Deir Mar Jiryis):

About 3 km to the west of Jericho, in the beautiful surroundings of Wadi Al-Qilt, is this picturesque Greek Orthodox monastery hewn out of the rock. It was built in the 19th century on the foundations of the Choziba Monastery dating back to 535 AD. Inside, there are Greek paintings and inscriptions. The main church floor has Byzantine mosaics. In a smaller church carved entirely out of the rock there are big oil paintings which show Elijah's Cave, where the prophet was hidden and fed by the crows (Al-Dabbagh, 1991).

Khirbet Mugheifir:

This settlement ruin 2 km south-east of Jericho, containes the remains of a large structure, apparently a castle or fortress built around a central courtyard with a pool. Alongside are remains of other buildings. Shreds indicate occupation from the Roman until the Early Arab Period (Israel Ministry of Defence & Carta, 1993).

Khirbet es-Samra:

The ruins of large fortress, 5 km north-east of Jericho, includes remains of a casemate wall, and at a short distance from the fortress-remains, there exist remains of two small farms. Finds also include pottery jar-handles impressed with the seal of Lamelekh (of the King). It is estimated to date from the 7th century BC (Iron Age) (Israel Ministry of Defence & Carta, 1993).

El-Masqara:

These ruins of a fortress are located in the Jordan Valley, 10 km. north of Jericho off the Beissan road. The Fortress enclosure measures 20x30 m. Alongside is part of an aqueduct, and other remains which indicate occupation during the Byzantine and Arab Periods (Israel Ministry of Defence & Carta, 1993).

Deir el Qaddis Yohanna el Mamadan (Saint John the Baptist Monstary):

Located 10 km. southeast of Jericho, one half km west of the Jordan River, this Greek Orthodox monastery, refered to locally as Qasr el-Yahud (Castle of the Jews) is believed to have been both the site where the Israelites forded the Jordan on their way to conquering Canaan. According to the Christian tradition, it is also the place where John the Baptist baptized Jesus in the Jordan. It was built in the 4th century AD and has been destroyed and rebuilt on more than one occasion, the last by the Roman Orthedox in 1882. The site contains the ruins of a Byzantine monastery, and alongside it there are other Byzantine remains, as well as a fortress and a church from the Crusader Period, and a new church (Al-Dabbagh,1991; Israel Ministry of Defence & Carta, 1993).

Deir Hajla:

Located to the southeast of Jericho, there is a wide Greek Orthedox monestary, referred to as the monestary of Gerasimus by in inhabitants, containing among other things a floor mosaic. To the northeast, there exists the spring of "ein hajla," with, alongside it remains of what is believed to have been a Canaanite village (Al-Dabbagh 1991).

Khirbet Al-Auja et Tahta:

A Palestinian village, adjacent to a refugee camp 10 km. north of Jericho, is the site of Archelais city, built by Archelaus, son of King Herod. It was given to Salome, Herod's sister, who in turn bequeathed it to the wife of Emperor Augustus. Remains of buildings from the Byzantine and Arab Periods can be found in the village and its immediate surroundings. South of the village are remains of a monastery and a small chapel with a mosaic floor and an open channel water supply network. Shreds and other remains indicate occupation in the Early Bronze Age and Iron Age (Dabbagh 1991; Israel Ministry of Defence & Carta, 1993).

Tel Jaljul:

These ruins of a Roman fortress lie 3 km east of Jericho. Finds include shreds, glass fragments and mosaics from Roman, Byzantine and Arab Periods. In immediate surroundings are additional remains of forts, aqueducts and buildings from Roman and Byzantine Periods. (Israel Ministry of Defense & Carta, 1993)

Tel el Mahalhil:

These ruins in the Judean Desert lie just off the Jerusalem-Jericho road, 1 km. from en-Nabi Musa. There are several round enclosures with remains of rooms which were attached to their perimeters. Apparently, it was inhabited during the Chalcolithic Period and in the Iron Age (Israel Ministry of Defence & Carta, 1993).

En-Nabi Musa:

A holy Moslem site in the Judean Desert, 1 km. south of Jerusalem-Jericho road, 20 km. east of Jerusalem. It is a mosque with a tomb inside. According to Moslem tradition, the tomb is that of Moses, or Nabi Musa. The mosque was built in 1269 by Mamluk Sultan Babyars and its compound is surrounded by a wall with a single gate facing the west. The minaret was built in 1500. Until 1947, every spring Moslems celebrated the week-long Nabi Musa festival here (Al-Dabbagh, 1991; Israel Ministry of Defence & Carta, 1993).

Na'aran:

Close to Dyouk spring, approximately 5 km. northwest of Jericho, this site contains the remains of both a Byzantine settlement and a 4th-5th century synagogue with a beautiful mosaic floor (part of which is currently stored in the Rockefeller Museum in Jerusalem). Its elaborate design includes commemorative inscriptions, flora and fauna inside geometrical designs, a Zodiac and two candelabra flanking the Holy Ark (Al-Dabbagh,1991).

Chapter Seven
Wastewater

Wastewater Disposal

Similar to other districts in the West Bank, the responsibility of wastewater management in the Jericho district is either through the municipalities, village councils or UNRWA in the refugee camps. Generally, wastewater disposal and management in the district is inadequate and could be considered the worst in the West Bank. There is no collection network in the district with all residents depending entirely on cesspits for wastewater disposal. This disposal method could have many environmental problems, including pollution of groundwater resources.

The cesspits are usually designed to serve a single house or sometimes a group of houses. Volume of cesspits ranges widely between 10-120 CM depending on space, nature of land and the economic situation of the people. Because of the prevailing weak soil structure, high salinity, low organic matter and low percentage of mineral clay, cesspits in Jericho tend to be lined with concrete on all sides, though not in the bottom (ARIJ, 1995).

Cesspits need to be emptied regularly by vacuum tankers. Jericho municipality does not own any vacuum tankers to serve the residents. Thus, this service is provided by the private sector resulting in an overflow and uncontrolled dumping of wastewater. The collected wastewater is disposed of at any open area regardless of the nature of the soil or the presence of groundwater. The known disposal areas are located to the east of Jericho city and to the south of Al-Auja village (ARIJ, 1995).

Wastewater Quality

For domestic wastewater quality, little work has been done to analyze the raw wastewater in the West Bank in general, and in the Jericho district in particular. This is due to the absence of a collection network in the district, as well as the lack of funds and expertise to construct laboratories specializing in such analysis. Due to the low domestic water consumption, the wastewater in the West Bank has a high biochemical oxygen demand (BOD), in the range 600-900 mg/l. The total estimated annual water consumption for domestic use in the Jericho district is around 2 MCM based on a yearly capita consumption of 94 CM. (Isaac et al, 1994) The high per capita consumption in the Jericho district is due to the usage of water for irrigation purposes. Though, the accurate amount of generated wastewater in the district is difficult to be calculated.

As for the industrial wastewater, the district has minimal industrial activities. Two factories are located in the Jericho city, one is involved in dairy products and the other in date processing (ARIJ, 1995). The characteristics of industrial wastewater produced from food processing industries is similar to that of domestic wastewater. Food processing wastewater, especially that produced from dairy industries, is generally rich in essential nutrients, such as nitrogen and phosphorus. Disposal of untreated wastewater can be considered hazardous if disposed in large quantities with high BOD concentrations. While not done currently, treatment of wastewater at source to a satisfactory level will be very important in preventing future pollution.

Environmental-Related Problems

1. *Water resources pollution:* The water resources in the district are exposed to different types of pollutants. Wastewater from settlements generally in the West Bank flows freely into nearby wadis without any consideration to its negative effects on the environment. None of the settlements has developed a wastewater treatment plant. The stream at Wadi Al-Qilt is contaminated from the wastewater flowing from the settlements at the eastern hills. During the survey, however, only the population of Al-Auja village complained of obvious water pollution, and that problem was rectified by the connection to the Mekorot.
2. *Wastewater Flooding:* Flooding of cesspits especially in winter time is a major environmental problem throughout the West Bank and in the Jericho district. Villages in Jericho district are suffering from wastewater flooding at winter time. This is a major source of infectious, disease transmission, bad odor or mosquito presence.

Recommendations

1. For Jericho city, a comprehensive collection network, wastewater treatment, and reuse strategy should be developed.
2. For rural communities, it is economically unfeasible to connect small communities with a collection network. Septic tanks and other new technologies for small communities, other than cesspits, for the disposal and treatment of wastewater are recommended.
3. Programs for the environmental awareness have to be started among all people. People and specially farmers have to be aware about the impact of irrigation with wastewater on the human health and environment.
4. Proper legislation regarding environmental pollution control and public health has to be set.
5. Irrigation with treated wastewater as an additional source of water should be encouraged. This could be accomplished by holding workshops and seminars for the farmers to educate them about the benefits and safe use of treated wastewater for irrigation of specific crops.
6. The topography of the Jericho district, which shows a continuous decrease in elevation, besides the availability of suitable land for agriculture, especially the eastern part of the district, promote the conveyance of treated wastewater from adjacent districts to Jericho to be used for irrigating tree crops.
7. Treatment and reuse of sludge as a natural fertilizer should be encouraged.

Chapter Eight
Solid Waste

During the past 28 years, management of solid waste throughout Palestine has been ignored. Israeli restrictions, lack of financial support and lack of expertise have led to the situation where the solid waste is dumped without any proper management. Handling of solid waste includes collection, transportation and disposal. The major sources of solid waste are domestic waste, industrial waste, agricultural waste and medical waste.

Domestic Waste

In the Jericho district, as is the case in the other districts in Palestine, solid waste collection and disposal is the responsibility of municipalities, village councils and UNRWA. From the survey conducted by ARIJ, out of the total population in Jericho district, 89% are receiving solid waste collection services through either Jericho municipality, UNRWA or Al-Auja village council. The collected solid waste is dumped either in a dumping site to the east of Jericho city or another dumping site to the south of Al-Auja village. The residents of Dyouk and Nuwe'ma villages are not receiving any solid waste services, and thus the generated waste is often dumped and burned in vacant areas and on road sides. The total daily quantity of generated solid waste in the district is estimated to be at 28 tons.

Collection of solid waste is generally made in plastic bags or metal containers. There are around 211 metal containers of 1.1 CM volume in the district with 200 of them located in Jericho city and the rest in Aqbat Jaber R.C.(Data collected from Jericho municipality & UNRWA). A large number of these containers were partially damaged during the years of Palestinian uprising. There are two vehicles, one agricultural tractor and 27 carts used for solid waste transportation (Table 8.1)(ARIJ, 1995).

Table 8.1: Solid waste management in the Jericho district

Locality	Popu-lation (Estimated)	Quan-tity	No. of Vehicles	Labor	Sugg-ested no. of Labors	Comm-unity Served (percent)	Disposal Site
Jericho	13,800	18	1 Truck 19 Carts	11	35	100	East Jericho
Aqbat Jaber R.C.	3,640	5	1 Truck 7 Carts	7	10	100	East Jericho
Ein Al-	1,182	1.5	1 Cart	1	3	100	random

Sultan R.C							
Al-Dyouk	1,200	1.5	0	0	3	0	random
Al-Auja	1,100	1.4	1 Agricult tractor	3	3	50	South Al-Auja
Nuwe'ma	600	0.7	0	0	2	0	random
Source: Data collected from Jericho municipality, UNRWA, and Village councils in the Jericho District							

There is no accurate information regarding the composition of the generated solid waste in Palestine. However, approximate estimate of the composition based on Jericho municipality officials is as follows: 67% organic, 7% papers, 6% glass, 17% plastic, 2% aluminum and 1% other.

Photo6: The solid waste dumping site located to the east of Jericho city

Industrial Waste

Agriculture is the back-bone of the economy in the Jericho district. Because of marketing problems, agricultural processing and other food related industries have been unable to play a complementary role to agriculture. Clearly this has meant that the industrial waste in the district has been until present negligible. However, the expected development in the industrial sector after peace settlement in the area would result in an increasing amount of the industrial waste. Regulations should be issued and the infrastructure put in place to manage and control the collection, recycling and disposal of the industrial waste.

Though clearly marketable, date-palms are found only on a small economical scale, which has encouraged some investors to work in date-packaging. From ARIJ survey, a small date-packaging factory is operating seasonally with a capacity of 120 tons of local source dates. The generated solid waste is sold as nutrient to the neighboring farms.

Arab Development Society Project is an important dairy product factory in the Jericho district. It is one of the oldest factories in Palestine, founded in the 1940s. It is a small scale factory that is processing 1.5-2 tons of milk daily to produce different dairy products marketed in Palestine (ARIJ, 1995). Products are marketed in Plastic containers of different sizes. Defective Plastic containers are the main source of solid waste generated, and they are disposed of and burned on-site near the factory.

Air conditioning industries are attempting to infiltrate the market in this hot climate. There is a small air-conditioning collective workshop that operates on a constricted range because of the marketing problems and lack of funding.

Agricultural Waste

The high-level of intensive irrigated agricultural activities in the Jericho district, have resulted in extensive usage of plastic covers, for tunnels and mulch, and plastic pipes used in drip irrigation. As a result, the amount of the yearly generated plastic solid waste has increased. The estimated yearly quantities of plastic covers at Jericho district amounts to 254 tons (Jericho Agricultural Station, 1994). Of the total amount of plastic covers used in agriculture, 30% is unrecoverable and remains in the soil changing the physical characteristics of the soil and reducing its productivity as it forms a barrier to water movement. The remaining plastic is either collected and left at the surrounding areas, where it is occasionally ingested by livestock causing death, or burned at the farm side causing serious air pollution problems.


Photo7: The plastic waste dumped at the farm side

Medical Hazardous Waste

Although the amount of generated medical waste is probably small, the possible harmful effects of these wastes are of serious concern because of the potentially infectious nature of the materials. Throughout the West Bank, proper precautions are not taken in handling, sorting, labeling, transporting and disposal of medical products and waste. Medical centers lack both official dumping sites and adequate incinerators.

In the Jericho district, there is only one government hospital located in the city and other small medical clinics and laboratories distributed in the nearby villages. Field survey shows that the generated wastes are either disposed of in municipal waste collection containers or burned on-site near the medical centers. The burning sites are very close to the residential areas, where children can easily reach the site and scavenge the wastes.

The government hospital at Jericho city dumps off most of its hazardous waste into the municipal containers including operational wastes, urine and stool samples. Needles are being held in special containers, since they are sharp enough and could easily harm people dealing with them. All blood samples are incinerated nearby the hospital. No bacterial culture is done in the hospital laboratory, all the tests are usually done in private laboratories in the Jericho city. The dangerous effect beyond these actions lie in the possibility of bacterial and viral transmission. The quantities of generated medical waste in Jericho district is estimated at 2 tons/yr. (ARIJ, 1995)

The expected economic development will subsequently result in a growth in hazardous waste production. Therefore, it is important to organize the collection and treatment of hazardous wastes before the situation explodes.

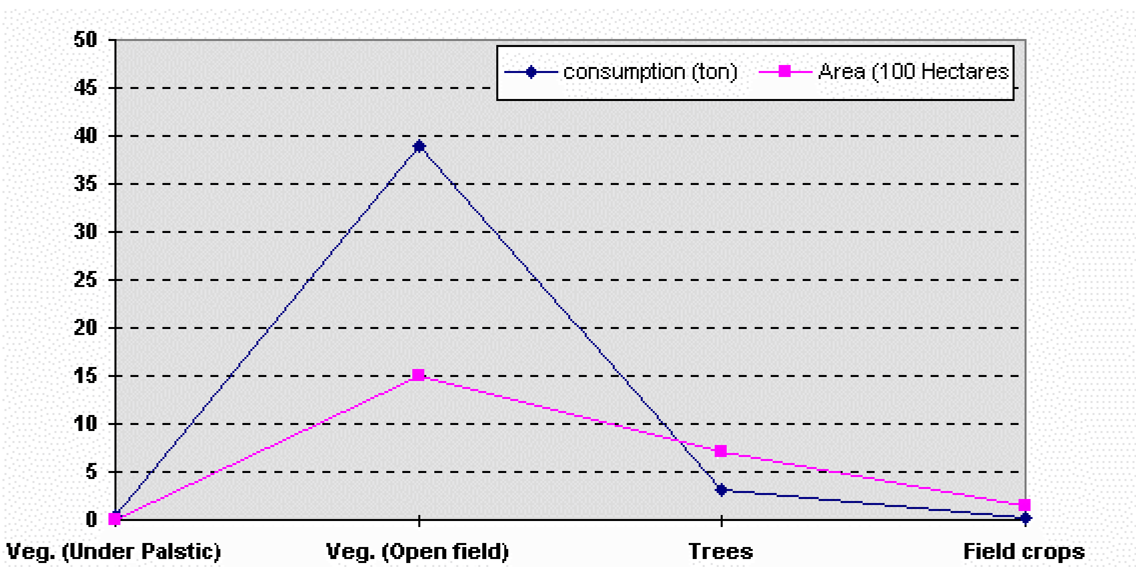
Recommendations

1. A center responsible for the solid waste management at the Jericho district should be established. Such center will be responsible for the collection, transportation and disposal of the solid waste.
2. A new solid waste collection containers and vehicles should be provided to the municipality and village councils.
3. Hydrological and soil studies for the Jericho district should be conducted to determine the best available site of solid waste landfill.
4. A proper landfill should be constructed in the Jericho district. The landfill has to be lined and provided with a leachate monitoring to insure the protection of the ground water.
5. Studies on the solid waste composition should be conducted. Determining the composition will help in studying the feasibility of solid waste recycling. The organic materials is comprising more than 65% of the generated solid waste in the Jericho district. So, composting is considered one of the feasible methods in the solid waste management in the district.
6. The problem of plastic disposal should be addressed as plastic is a non degradable material. Recycling is the most proper way of disposal. From other countries experience, recycling of plastic is found to be a successful and profitable business.
7. Proper elimination and disposal of hazardous waste generated by hospitals and clinics. This can be accomplished through an in-house incineration or at a special hazardous waste dumping site.

Chapter Nine
Pesticide Usage

The intensive farming in the Jericho district enhances the risk of many problems, of which pest and disease have been shown to be the most serious. These problems result in the intensive use of chemicals, thereby causing many problems that most farmers are unaware of such, as air and ground water pollution, destruction of soil microorganisms and poor health for the farmers and their families who take part in spraying the pesticides.

The Jericho district consumes more pesticides than any other district in the West Bank. Its annual consumption is approximately 70.4 tons. Of the total, 27.7 tons are methyl bromide, used by farmers as a fumigant for controlling soil born pests. Although many countries have banned its usage for its known negative side effects on the ozone layer, human health and microorganisms, farmers continue to use it, since alternatives are more difficult to implement. Vegetables make up a large percentage of production in the Jericho district, and are heavily treated with pesticides, with a seasonal consumption (excluding methyl bromide) of 26 Kg/hectare in the open irrigated field, and 60 Kg/hectare under plastic (Saleh et al, 1995).



Consumption (ton)	0.372	38.938	3.07	0.291
Area (100 Hectares)	0.062	14.976	7.141	1.455

Total pesticide consumption = 42.7 tons

Figure 9.1: Treated area (100 Hectares) and amount of pesticide used in the Jericho district for 1993/94 growing season

Extension services in the Jericho district are of higher quality than other districts in the West Bank, where farmers are receiving more visits from extension agents. This might be due to the concentrated potentials that attract international agencies along with some NGOs to carry out research projects in the district. However, the role of extension agents does not exceed giving recommendations to farmers about the type and recommended dosage of pesticides to be used for each crop. Their advice does not include information about behavior and attitude that farmers must follow to protect their environment or themselves from excessive exposure.

ARIJ Survey indicated that farmers in the Jericho district are not taking adequate safety precautions. For example, only one third of the farmers were found to use one or more of the protective gear (gloves, overalls, masks, etc.), available 69% dispose of the excess pesticide solution into the soil, and 90% dispose of the empty containers randomly on the farm. In relation to the attitude and behavior, while 69% of the farmers understand the meaning of the pre-harvest waiting period concept, but unfortunately, most of them do not pay attention to this concept especially when the crop reaches a good price in the market. Also, 88% of the farmers believe that they have developed an immunity against pesticides through repeated usage and exposure.

Photo8: Misuse of Pesticides

Recommendations

1. Many agricultural concepts are misunderstood by farmers. Therefore, extension programs should concentrate on training growers and pesticide applicators. Programs should include pesticides usage, safety precautions and storage techniques, in addition to generating and diffusing information on improved pest management technologies that can substitute for pesticides.
2. Research must be conducted to find other alternatives for chemicals such as using resistant varieties, conserving and applying natural enemies, and using muslin cover to protect against insect pests.
3. Different methods of pest control must be part of the agricultural practices. These methods include:

    - The use of crop rotation so that to break the pest life cycle.
    - Manipulation of planting dates with respect to the pests population levels and breakouts.
    - The early spreading of plastic mulch during summer so as to be used for both soil solarization and planting, this will help in minimizing the use of methyl bromide. Soil solarization has been researched in both Jordan and Israel and found to be efficient in combating serious soil pests.

4. Health problems caused by pesticides are of major concern. Farmers should be educated through seminars, pamphlets and other means of outreach; highlighting certain issues like, the safe use of chemicals, first aid in case of poisoning and the safe handling of hazardous pesticides.

Chapter Ten
Air And Noise Pollution

Air Pollution

Though air pollutants are formed and emitted through natural processes, near cities and other populated areas, more than 90% of the volume of air pollutants is the result of human activity. The main sources of air pollution are, energy production, transportation and industry.

Jericho district is not densely populated and has only minimal industrial activities; those factors play a significant role in the low level of air pollution in the district. Most pollution here is the result of dense vehicular traffic mainly in summer time when the visitors enter and exit the country through Jericho. Black soot emitted from diesel-powered vehicles is the cause of visible changes on buildings such as soiling, discoloring or darkening the surface. Dust levels are naturally high throughout Palestine, because of frequent dust storms which flow in from the surrounding deserts.

The inhabitants of Jericho district make up around 1% of the West Bank population, but own 2.5% of the total number of vehicles. The vehicles (a total of 2707), including cars, buses, trucks and motorcycles, emit pollutants such as carbon monoxide, sulfur oxides, nitrogen oxides, lead and particulate matter. Types and numbers of transportation vehicles in Jericho district are shown in Table 10.1 (Transportation Officer, Beit Eil, 1995). There is little or no emission control and most vehicles still run on gasoline which contains lead.

Table 10.1 Types and numbers of transportation vehicles in the Jericho district

Type	Private	Commercial	Bus	Taxi	Truck	Motorcycle	Other	Total
Number	1564	495	30	52	280	31	86	2707

Source: Transportation officer, West Bank Department for vehicle Licensing, Beit Eil

Political changes in the region are expected to increase the traffic volume in the district. Higher usage of buses, taxis, trucks and rental vehicles will contribute to higher emission of gases into the atmosphere, and will demand new programs in traffic management and control to reduce congestion and emission levels. Table 10.2 shows the contribution of the vehicles to air pollution.

Based on the WHO transportation air emission inventories, rough calculations show that the annual emission of air pollutants due to gasoline combustion is close to 0.6 tons per vehicle. Furthermore, an estimated 1,266 tons of CO, 90 tons of SOx, 104 tons of NOx, 154 tons of VOC and 1.8 tons of Pb are emitted each year in the district due to local driving only.

Table 10.2 Transportation air emission inventories

Year of production	Engine capacity	Unit U	CO (kg/u)	SO_x(kg/u)	NOx(kg/u)	VOC(kg/u)	Pb(kg/u)
Up to 1971	< 1400	1000	45.6	1.9	1.64	3.86	0.13
	1400-2000		45.6	2.22	1.87	3.86	0.15
	> 2000		45.6	2.74	2.25	3.86	0.19
1972-1977	< 1400	1000	33.42	1.66	1.64	3.07	0.11
	1400-2000		33.42	1.92	1.87	3.07	0.13
	> 2000		33.42	2.2	2.25	3.07	0.15
1978-1980	< 1400	1000	28.44	1.39	1.5	2.84	0.09
	1400-2000		28.44	1.68	1.72	2.84	0.11
	>2000		28.44	2.13	1.97	2.84	0.14
1981-1984	< 1400	1000	23.4	1.39	1.58	2.84	0.09
	1400-2000		23.4	1.68	1.92	2.84	0.11
	>2000		23.4	2.13	2.57	2.84	0.14
1985-1992	< 1400	1000	15.73	1.27	1.5	2.23	0.09
	1400-2000		15.73	1.62	1.78	2.23	0.11
	>2000		15.73	1.85	2.51	2.23	0.14

Source: World Health Organization Geneva 1993

Photo9: Air pollution resulted from burning solid waste

Vegetation can be damaged from dust and polluted rain (acid rain) has resulted from the high level of CO, NO and SO in the atmosphere and can sometimes leave residues in the produce. Wildlife can be impacted through their consumption of polluted vegetation and water, or through the penetration in the skin and feather protective layers upon contact with polluted rain water. High lead concentration in the air can also effect the blood system, the nervous system and the renal system.

However, lacking raw data on air quality, an air monitoring system is needed that can detect the different pollutants and figure out their concentration in the atmosphere. This will provide the needed data for the establishment of regulations and standards of air quality.

Noise Pollution

Scientific measurements and data about noise levels in Jericho district are lacking. However, field observations have indicated that sources of noise include military activities, roadway traffic, especially the large amount of traffic transporting people to and from Jordan. The need for well enforced regulations specifically addressing the noise pollution issue is justified by the fact that sustainable loud noise may cause health problems to humans including loss of hearing and damage to the nervous system. Moreover, it may also interfere with normal speech, communication and sleep, affect inter-room privacy and cause annoyance in addition to its effects on the wildlife and their habitat.

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