Environmental Profile for the West Bank

Volume 4

RAMALLAH DISTRICT

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Environmental Profile for The West Bank Volume 4 Ramallah District

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Introduction

As the peace process between Palestinians and Israelis advances, and agreements are signed, several changes have taken place. The Israeli military forces have pulled out fully from the major cities in the West Bank, including Ramallah and Al-Bireh cities and since then, January 1996, the Palestinian National Authority (PNA) has governed these areas. After 28 years of Israeli occupation, there are many challenges facing the new authority in all areas of society. During the Israeli occupation, much of the infrastructure of the West Bank was left unattended, development that did take place did not keep up with the rate of population growth. Now, the PNA is working to rehabilitate the Palestinian infrastructure. Several infrastructure projects have been initiated and many more are likely to be initiated in the near future. These projects, coupled with the expected increase in economic activity and population pressure are likely to lead to widespread environmental pressures all over the West Bank. In the building of a Palestinian government and administrative structures, legislation and regulations must be adopted to provide guidelines for development and to authorize power for enforcing these requirements.

Due to the fragility of the West Bank's ecosystem, it is necessary to prepare a framework for assessing and directing development in a sustainable manner. Unless precautionary steps are taken, an unsustainable development pattern may emerge. Environmental profiles are greatly important at this stage, for assessing the status of the environment and providing a background for a program to promote sustainable development.

The Applied Research Institute-Jerusalem launched a two year project supported and financed by the Federal Government of Austria, Department for Development and Cooperation, through the Society of Austro-Arab Relations in Jerusalem (SAAR). The aim of the project is to build an environmental database and produce a series of environmental profiles for each district in the West Bank. The following environmental profile is the fourth in the series. It describes the present status of the environment in the Ramallah District, and focuses on recommendations for environmental management programs required for the future. This profile addresses issues related to the major components of the environment in the district. It includes information supported with maps concerning the topography, climate, soil, geology, land use, water resources, agriculture, wastewater, solid waste collection and disposal, pesticide usage and air and noise pollution. In addition, it covers the socio-economic situation and the existing historical and archeological sites existing in the Ramallah District. Flora and fauna will be included in the comprehensive Environmental Profile of the West Bank.

Most of the information and data used in this profile are based on the primary field investigations and personal interviews conducted by the project team. All maps included are produced by the GIS unit at ARIJ using ARC/Info and PAMAP software.

Chapter One
Topography And Climate

Location And Land Use

Location

Ramallah District is located in the middle part of the West Bank. For technical reasons, the definition of the boundaries of the Ramallah District used by ARIJ in this profile, as seen in Figure 1.1, is a combination of the pre-1967 Jordanian administrative classification and the current Israeli designation of the boundaries. After the Israeli occupation in 1967, the Israeli government redefined the boundaries of Jerusalem and included 68.17 hectares from the Ramallah District as well as 1632.7 hectares from Bethlehem District.

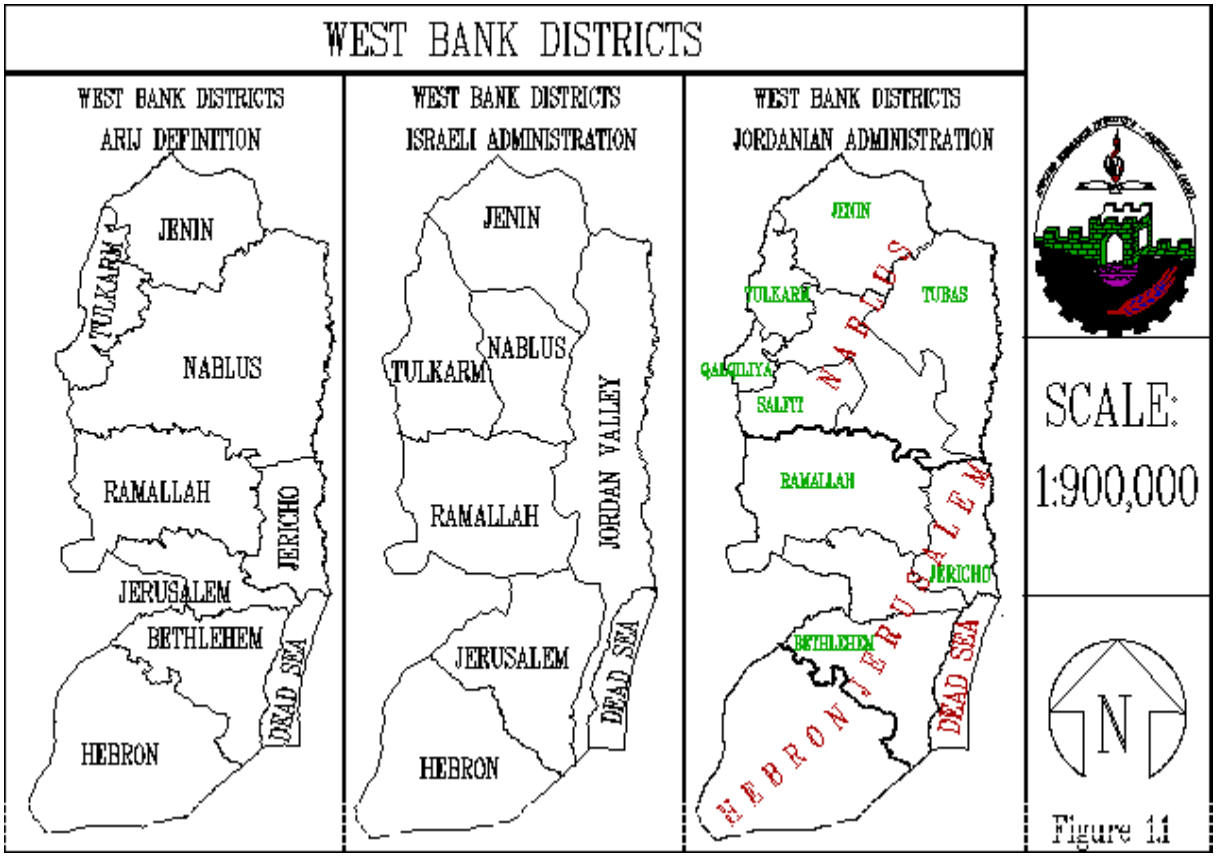


Figure 1.1

Accordingly, the Ramallah District, covered by this profile, extends from Jerusalem District in the south to Nablus District in the north and from Jericho District in the east to the 1948 cease-fire line between Israel and Jordan from the west (Figure 1.2).

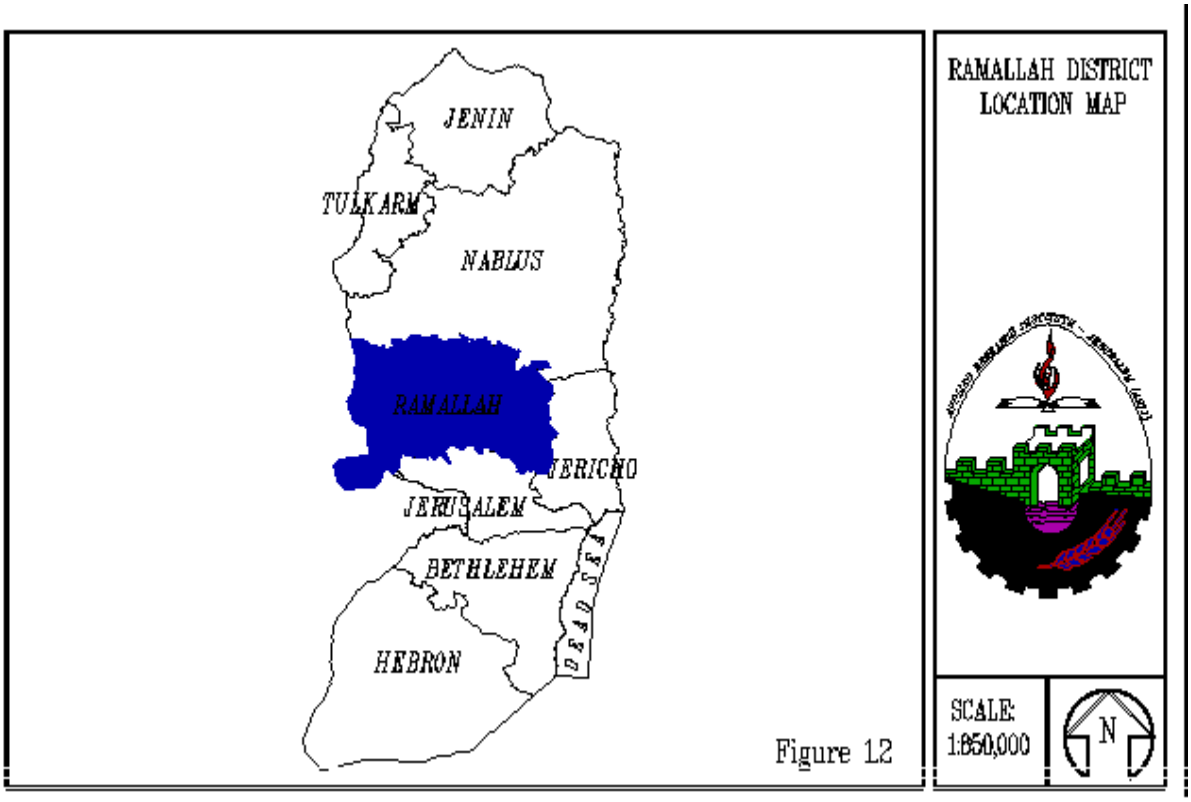


Figure 1.2

Land use

Land designations in the West Bank are defined by the recent "Oslo II" interim agreement and the functional land uses required for the Palestinian community, and the Israeli occupation control which continues today. Land availability determines the Palestinians potential to sustainably develop the community.

The "Oslo II" interim agreement between the Palestinians and Israelis, has divided the West Bank land into three areas, Area A, Area B, and Area C which are differentiated by a different level of control by the Palestinians. According to these divisions, the populated Palestinian cities representing 3% of the total area of the West Bank, is completely within the control of the Palestinians (Area A). Area B which includes all the Palestinian villages and small towns cover 27% of the total area of the West Bank. Palestinians now have full control over civil society except that Israel continues to have overriding responsibility for security. Area C, which includes some Palestinian built up

areas as well as Israeli settlements and military outposts, covers the remaining land. Palestinians have responsibility for civil life in this area such as economics, health and education, however Israel retains control of security and power related to territory. During the further redeployment phases, powers and responsibilities in Area C will be gradually transferred to the Palestinians, to be completed 18 months from the inauguration of the Palestinian Council.

At this time, the Palestinian National Authority (PNA) has not been able to assume complete sovereignty on Palestinian land and the division of areas into A, B, and C hinders the potential of dealing with the Palestinian areas as a geographic integrity as an essential ingredient for sound environmental management. The final fate of Area C will be negotiated in the final status negotiation that began officially on May, 1996.

Ramallah District measures approximately 84,362.1 hectares. This area is divided by the "Oslo II" interim agreement as follows:

"Area A", which includes the Ramallah and Al-Bireh cities in addition to Al-Ama'ri and Qaddura refugee camps, and covers 1,957.1 hectares (2.3%) of the district's land (Figure 1.3). Since January, 1996, the Israeli army has pulled out fully, and all responsibilities for internal security and public order are held by Palestinians.

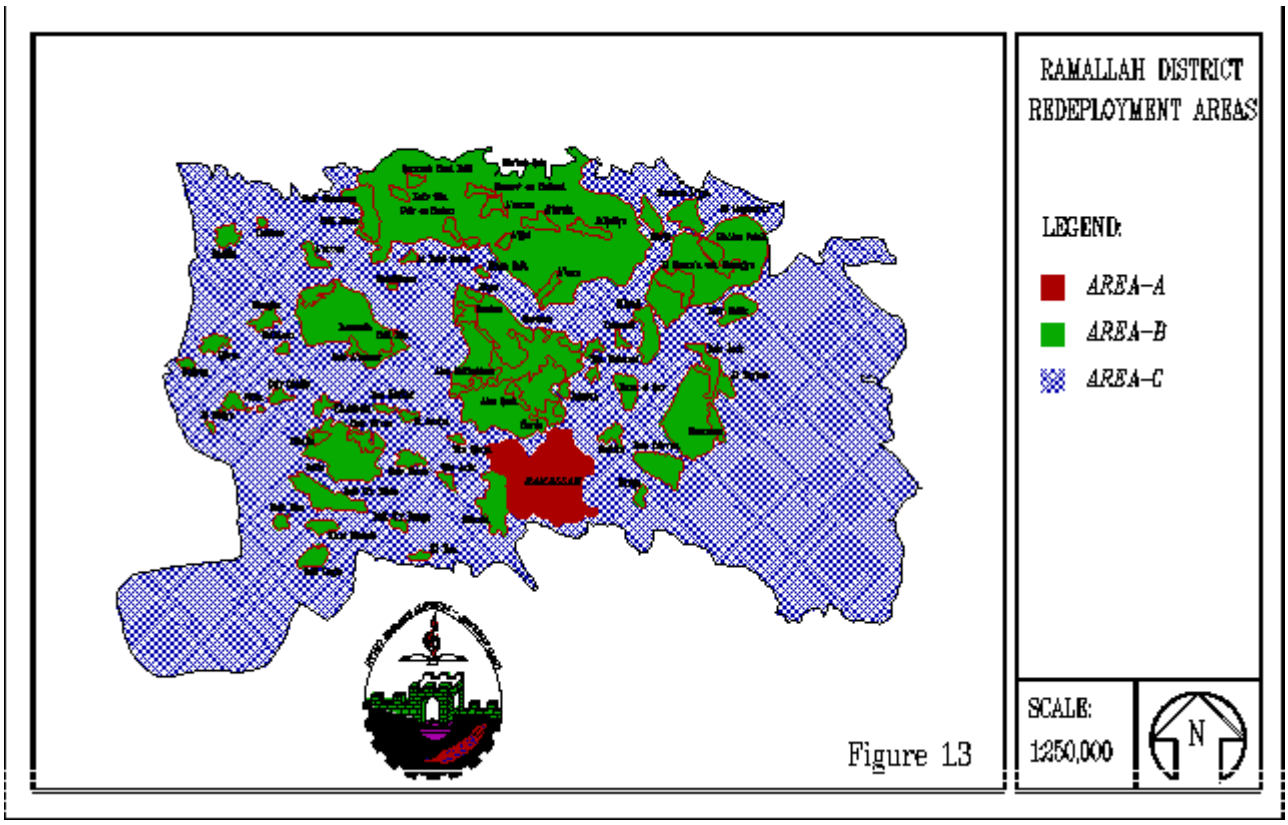


Figure 1.3 Redeployment map

"Area B" is the populated villages, camps and the built-up area of the hamlets as shown in Figure 1.3. It accounts for approximately 22,429.3 hectares (26.6% of the total area of Ramallah District).

"Area C", which covers 71.1% of the district's land, includes areas of Israeli settlements, closed military areas, and military bases.

Functionally, there are eight major land use classes within the Ramallah District boundaries, serving both the Israelis and Palestinians. These are Palestinian builtup areas, Israeli settlements, closed military areas and bases, nature reserves, forests, cultivated areas, and industrial areas (Figure 1.4). The Ramallah District occupies approximately 14.5% of the West Bank and 13.6% of Palestine (Gaza Strip and West Bank). Currently, only 4.35% of the Ramallah District is inhabited by Palestinian built up areas, while approximately 20.3% is occupied by either Israeli settlements, nature reserves or closed military areas.

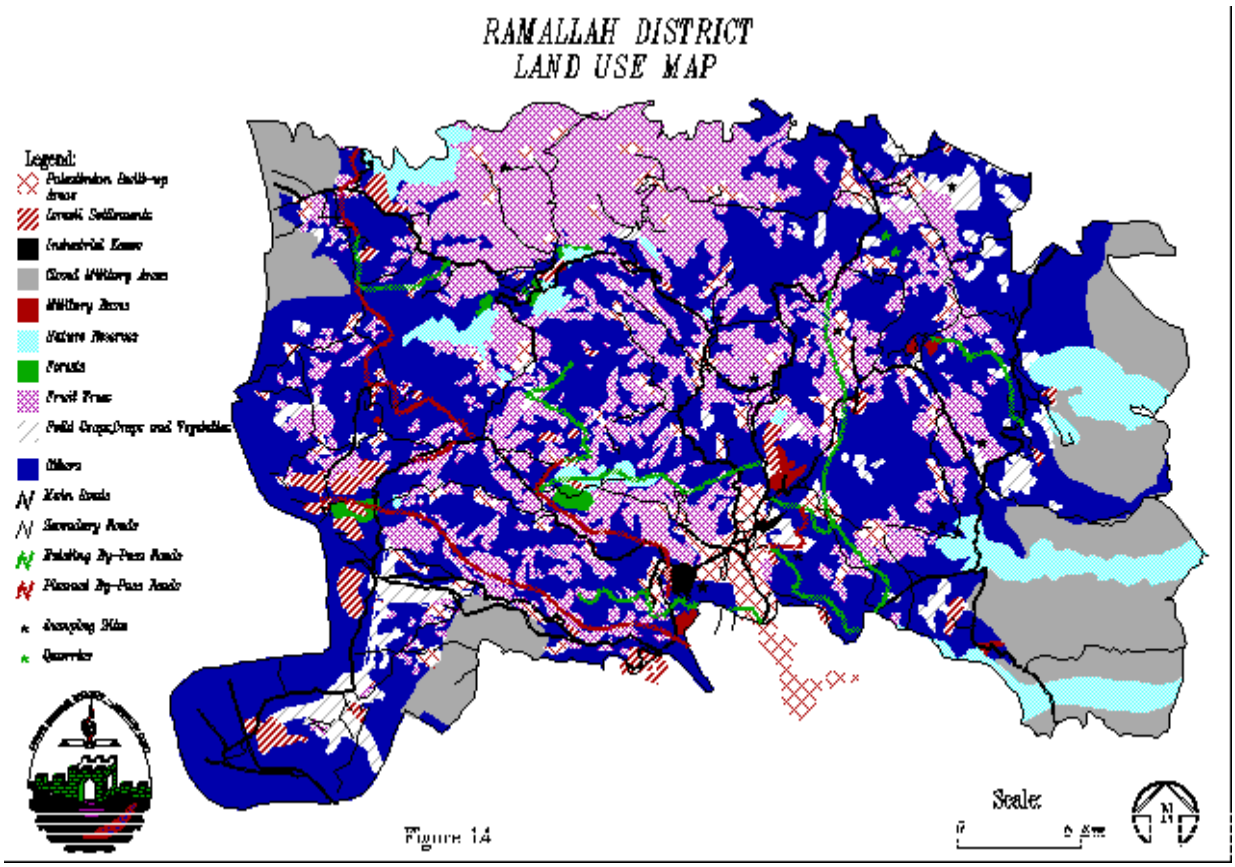


Figure 1.4 land use map

Palestinian Built-up Areas

There are 76 Palestinian builtup areas in the district. Ramallah, Al-Bireh, Silwad, Bani Zeid, Bir Zeit, Deir Dibwan and Bitunia are the only communities designated as municipalities. Other built-up areas are governed either by village councils or village mukhtars. In addition, there are four refugee camps, Al-Ama'ri, Qaddura, Al-Jalazone, and Deir A'mmar. Due to the restrictions imposed by Israelis on giving building permits for the Palestinians, the Palestinian built-up areas are very limited and comprise only 4.35% of the Ramallah District area. On average, the population density is reaching to more than 730 person/km^2. Figure 1.5 shows the distribution and names of the various built up areas in the district. These areas are mainly located on more than one soil association such as brown rendzinas and pale rendzinas soils, and terra rossa, brown rendzinas and pale rendzinas soils. These soil types constitute the most suitable land for agricultural purposes in the district.

Israeli Settlements

There are 27 Israeli settlements in the Ramallah District, occupying approximately 1,438.5 hectares of the district's land (1.63% of the total district area). Most of these settlements are located near the cease-fire line, to the west of the district. In 1992, it is estimated that at least 18,000 settlers are living in these settlements. Giva't Ze'ev and Kokhav Ya'aqov settlements are located at the border between Ramallah and Jerusalem Districts. During the past two years, there was a gradual and progressive expansion in the Israeli settlements.

Table 1.1 shows the name, type, establishment date and number of families for the settlements in Ramallah District and Figure 1.5 shows the distribution of these settlements.

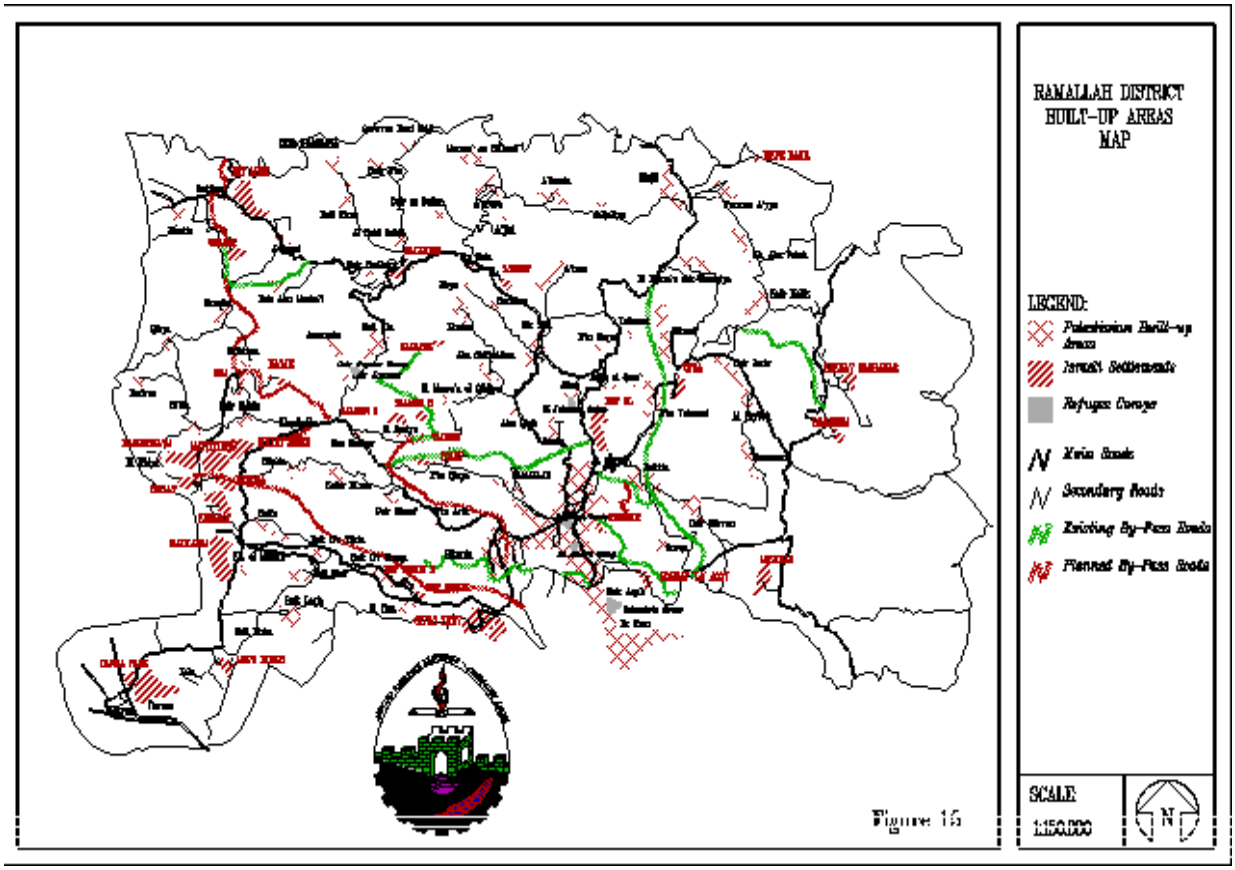


Figure 1.5

Table 1.1: Information about settlements in the Ramallah District

Name	**Establishment Date**	**Number of Families**	**Projected Number of Families**
Kokhav Ya'aqov	1984	85	4100
Rimmonim	1980	85	170
Kokhav Hashaher	1975	195	215
O'fra	1975	240	3400
Bet Horon	1977	125	350
Giva't Ze'ev	1983	1900	6000
Mevo Horon	1969	60	105
Qiryat Sefer	1991	-	1000
Mattityehu	1981	31	400

Shelta	1977	180	N/A
Hashmona'im	1985	230	1000
Hallmish	1977	148	250
Talmon	1989	47	N/A
Dolev	1983	118	1000
Nahli'el	1984	190	N/A
O'farim	1989	10	3000
Bet Arye	1981	280	750
Na'ale	1989	39	5000
Nili	1981	84	650
Bet El B	1979	220	800
Bet El	1977	250	N/A
A'teret	1981	35	250
Ma'ale Mikhmas	1981	80	2250
Pesagot	1981	120	250
Source: Tufakji, 1994; Ester Goldberg, 1993			

Closed Military Areas and Bases

The Israeli army occupies approximately 10,725 hectares (12.7% of the total area) of the Ramallah District, claiming that these areas are important both as security zones and for military training purposes. Furthermore, there are eight military bases, with a total area of about 235 hectares (0.28% of the total area). The closed military areas cover almost the entire eastern border while the military bases are distributed throughout the district. The closed military areas and bases are located on the following soil associations:

1. Alluvial arid brown soil, on which irrigated crops can be grown;
2. Brown lithosols and loessial arid brown soils, in which annual fieldcrops, mainly wheat and barley can be grown;
3. Terra rossa, brown rendzinas and pale rendzinas, which are the most suitable soils for agricultural purposes;
4. Brown rendzinas and pale rendzinas, which are also suitable for agricultural purposes.

Nature Reserves

The Israeli Authorities are used to declare a piece of land as a nature reserve in the West Bank in order to prevent the Palestinians from using this land for construction or agriculture. Experience has shown that land confiscated for being nature reserves became

after a while an Israeli settlement. There is a serious doubt about the true environmental significance of the currently declared nature reserves. Currently, Israel had declared 15 nature reserves in Ramallah District with a total area of almost 4,724 hectares (5.6% of Ramallah District area), most of which are located within the Israeli-declared closed military areas.

Forests

There are 6 forested areas in the district with a total area of about 308 hectares (0.36% of the total area). Most of these forests are located on fertile soil types (terra rossas, brown rendzinas and pale rendzinas) and in areas of favorable climatic conditions for agriculture.

Cultivated Areas

During the 1993/94 growing season, cultivated areas in the Ramallah District covered approximately 23,831 hectares (28.2% of the total area) **(**Ramallah Agricultural department, 1994). Rainfed agriculture is dominant in the district, occupying approximately 23,737.7 hectares (99.6 % of the cultivated areas) while the rest is irrigated. The agricultural areas are divided into the following:

1. *Fruit trees,* located mainly in the central mountains, occupying an area of approximately 18,959.6 hectares (79.7% of the total cultivated areas). Olive trees are the dominant, occupying 15,186.64 of the area of fruit trees. Fig trees are the next most common, covering an area of 1,170.7 hectares. Grape trees, stone fruits and pome trees are also found in the district, they are grown on 811, 1,705 and 17.5 hectares respectively.

Irrigated orchards of fruit trees are found on small amounts of land and in few villages. Lemon trees cover the largest area (12 hectares), followed by other varieties such as pomegranate, orange, and guava.

2. *Field crops and forages,* covering an area of 4,059.7 hectares (17% of the total cultivated area) in the 1993/94 growing season. Approximately 60% of the field crops and forages are grown in the eastern region of the district and the remaining 40% are distributed throughout the central and western regions.

3. *Vegetables* are located in the central and western regions of the district and covering an area of 791.7 hectares for the rainfed and irrigated vegetables in the 1993/94

growing season. Tomatoes are the most common followed by squash and snake cucumber.

Roads

Road network in the Ramallah district is in poor condition where it is not expanded or maintained for many years. There are 220.3 km of main roads and 250.1 km of secondary roads. These lengths include only the external roads that connect the cities with nearby villages until 1993. Another road system is newly constructed by Israel within the West Bank area. These by-pass roads are designed to link Israeli settlements within the West Bank with each other and with Israel. These roads will be used only by Israeli settlers living in the West Bank. The Israeli forces is confiscating thousands of hectares of Palestinian land for this purpose. The by-pass roads are designed in a way that will hinder the future expansion of the Palestinian built-up areas and dividing Ramallah District into cantons (Figure 1.5). The existing by-pass roads passing through Ramallah District have a total length of 64.7 km and the proposed by-pass roads are planned to include another 49.1 km (ARIJ, GIS unit).

Industrial Areas

There are two industrial areas in Ramallah District, one is located to the south of Ramallah city and the other to the east of Al-Bireh. Together they cover approximately 134.2 hectares.

Table 1.2: Land use classification.

Land Use	**Area (Hectares)**	**% of land**
Palestinian Built-up Areas	3,665.9	4.35
Israeli Settlements	1,438.5	1.7
Closed Military Areas	10,725.2	12.71
Military Bases	235.4	0.28
Nature Reserves	4,723.9	5.6
Forests	307.8	0.36
Cultivated areas	23,831	28.2
Industrial areas	134.2	0.16
others*	39,300.2	46.59
Total	84,362.1	100

**others include unused land, roads or land used for grazing.*

Chapter Two
Topography And Climate

Topography

A Digital Elevation Model (DEM) containing Z-value with pixel size of 100 m was created for Ramallah District. In generating the DEM, the GIS unit at ARIJ depends on the topographic maps of the US Army Crops of Engineers and the British maps produced in 1942. It was constructed using the finite difference technique of the Topographer Model of the Pamap GIS software version 4.2. 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 represented by three dimensional lines with varying elevation.

Figure 2.1 shows the produced 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. A contour map based on the created digital elevation model was constructed with contour intervals of 50 m (Figure 2.2).

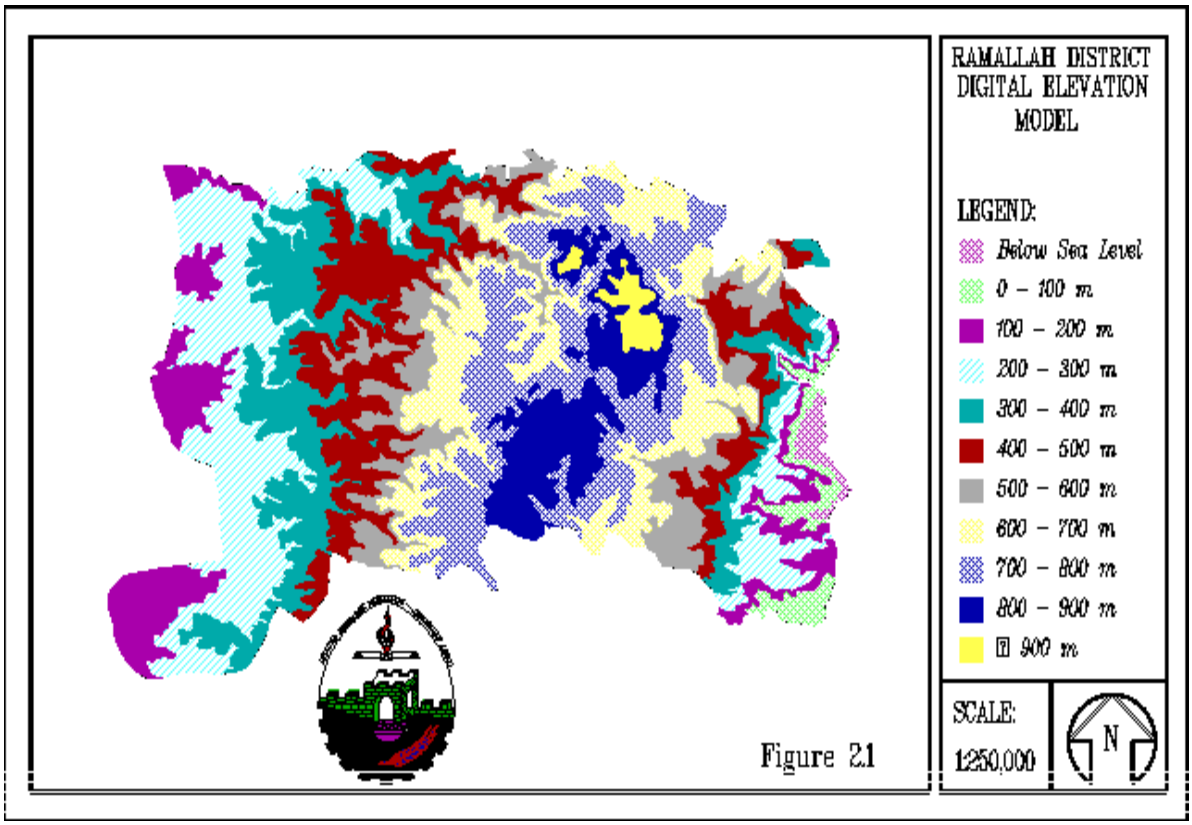

RAMALLAH DISTRICT
DIGITAL ELEVATION
MODEL
LEGEND:
Below Sea Level
0 – 100 m
100 – 200 m
200 – 300 m
300 – 400 m
400 – 500 m
500 – 600 m
600 – 700 m
700 – 800 m
800 – 900 m
900 m
SCALE:
1:250,000
N
Figure 2.1

Figure 2.1

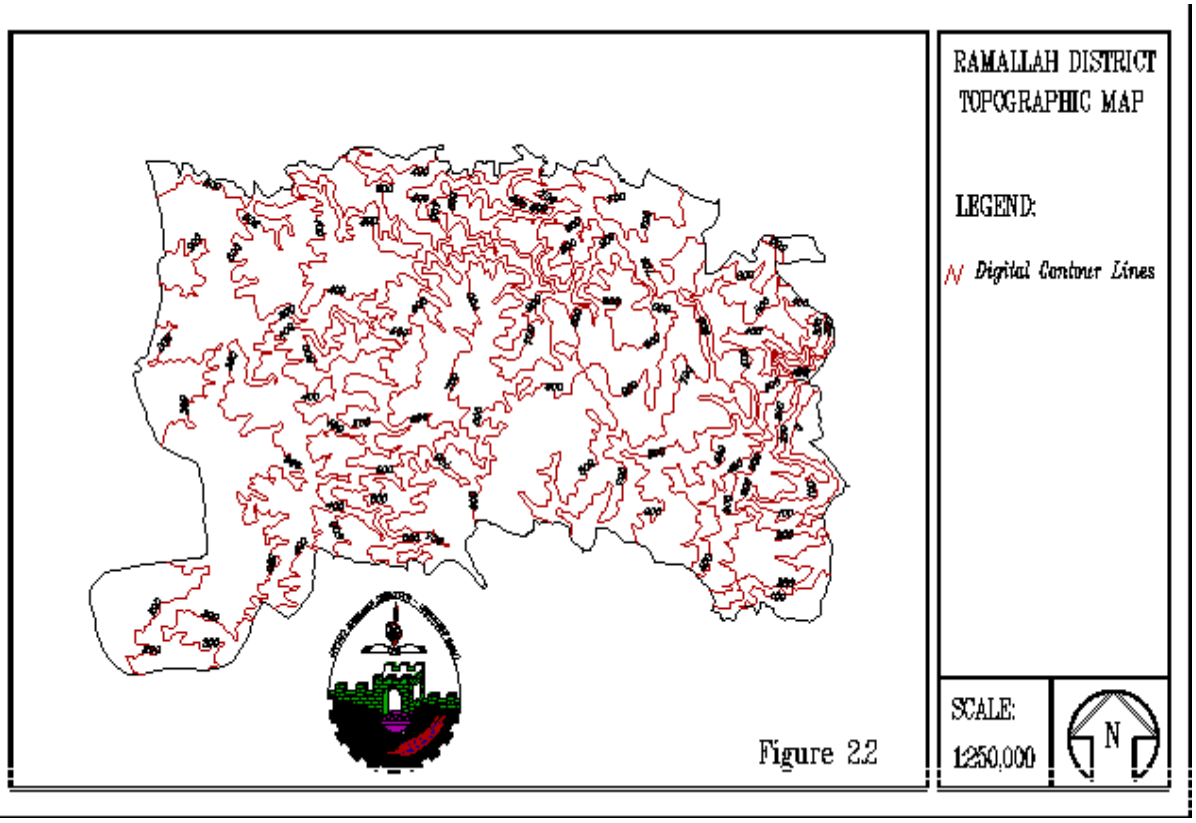


Figure 2.2

A three dimensional model for Ramallah District is created using the perspective model of the Pamap GIS software version 4.2, (Figure 2.3). The view is facing to southeast with exaggeration factor of 15.

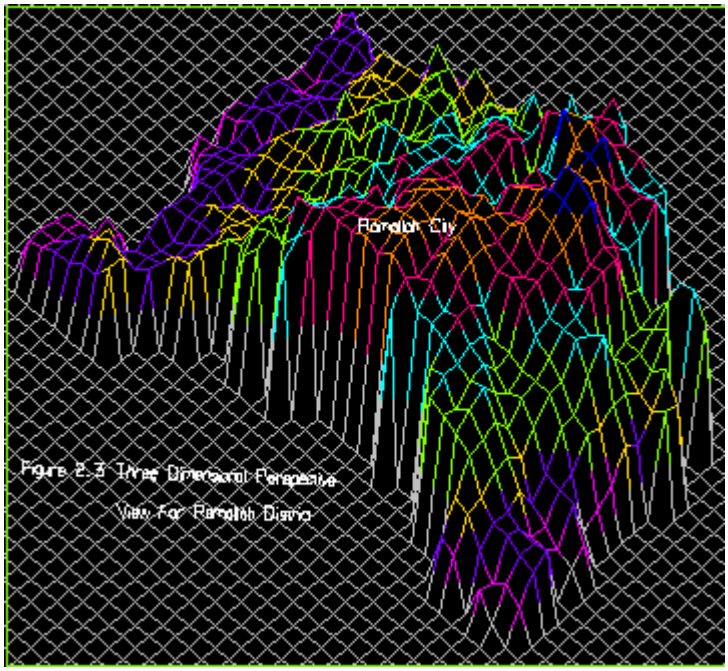


Figure 2.3

The topography of Ramallah District can be divided into three parts: the eastern slopes, mountain crests and western slopes. The eastern slopes are located between the Jordan Valley and the Mountains. They are characterized by steep slope which contribute to forming young wadis such as wadi El-Maquk. Mountain crests form the watershed line and separate the eastern and western slopes. Elevation ranges on average between 750 and 800 meters above sea level. Western slopes, characterized by gentle slopes, and have elevation ranges between 250500 meters above sea level. The highest point in Ramallah District is 1022 m above sea level at Tal A'sur, and the lowest elevation is 24 m below sea level at the southeast corner of the district.

Two main drainage systems are distinguished in the Ramallah District (Figure 2.4). The first system runs to the west towards the Mediterranean such as wadi Sarida, wadi El-Shamiyah, wadi El-Durlb, wadi Salman and wadi El-Kabeir. The second system runs to the east towards the Jordan River, such as wadi El-Maquk and Wadi El-Ein.

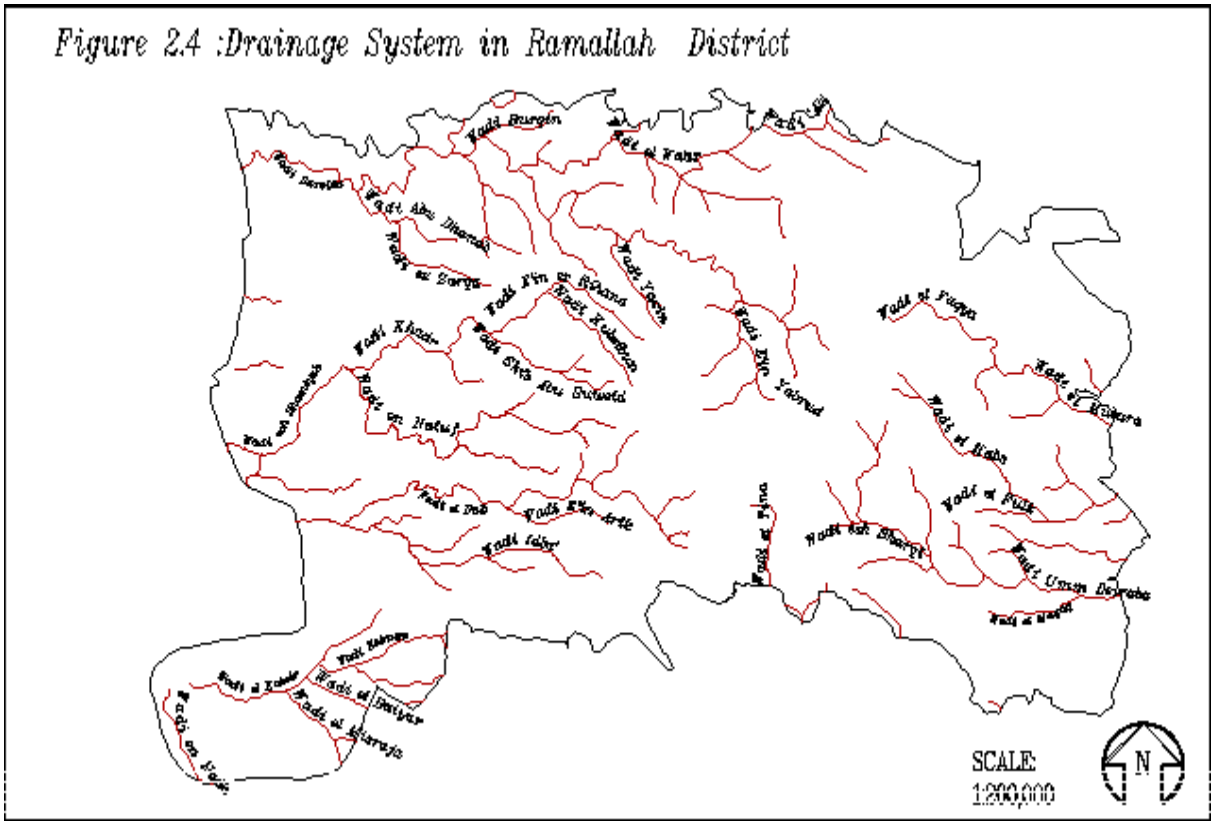


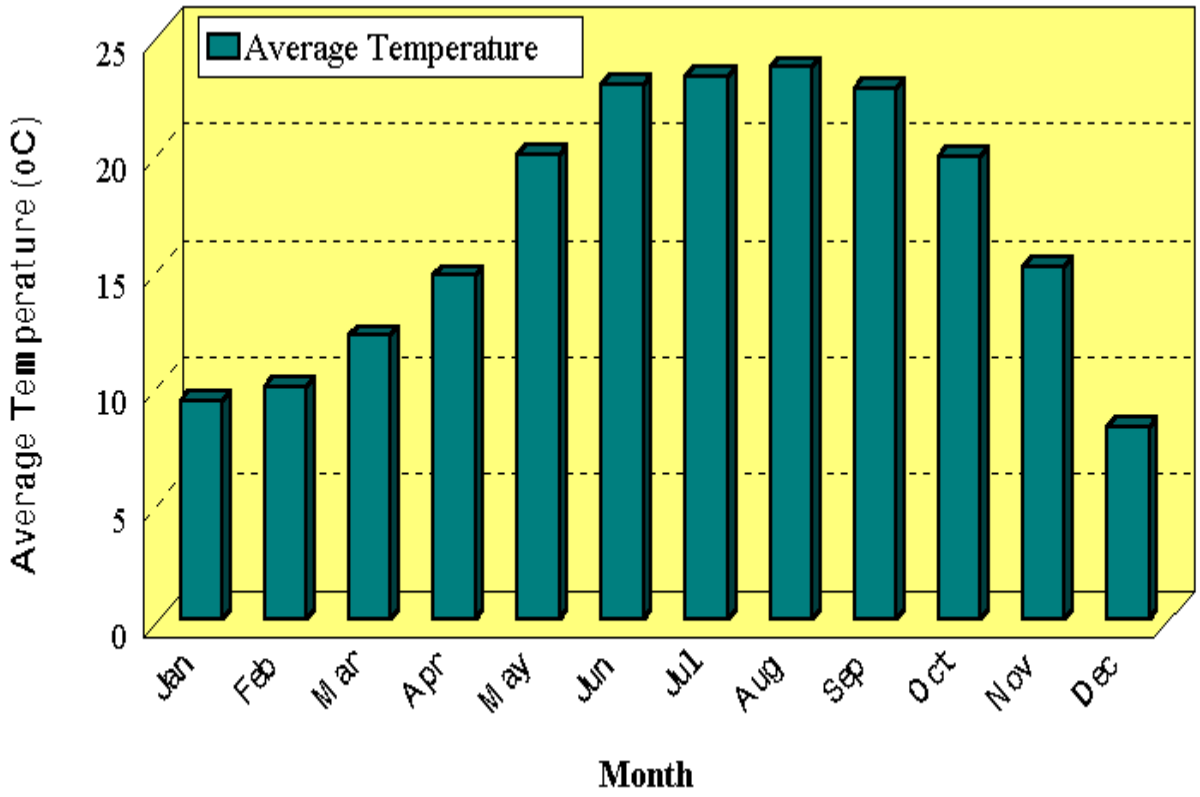
Figure 2.4:Drainage system in the Ramallah District

Climate

The Ramallah District is influenced by the Mediterranean climate, a rainy winter and dry summer. Little climatic data are available for the Ramallah District. The climatic data from October 1994 up to September 1995 were taken from the recently installed weather station at Bir Zeit University, and the rainfall data for the past 20 years were obtained from the Ramallah Department of Agriculture.

Temperature

Ramallah District is part of the Hill Regions which have lower temperatures than other places in the West Bank. Table 2.1 shows the variation in temperature for the year 1994/95. Like other districts in the West Bank, January is the coldest month and August is the hottest. During the 1994/95, the highest temperature was registered at 37.5 ^{0}C in May 1995 and the lowest at 1.2 ^{0}C in February 1995. The mean annual temperature ranges between 15-20 ^{0}C. The temperature of the coldest month (January) is 6-12 ^{0}C, while the hottest month (August) ranges between 22-27 ^{0}C. Figure 2.5 shows the variation of average monthly temperature throughout the year.



Rainfall

Winds from the west and southwest which are saturated with moisture from the Mediterranean Sea precipitate a mean annual rainfall of 694 mm on the Ramallah District. This amount is distributed over an average of 59 days; and almost 85% of the total rainfall occurs between November and February. Table 2.2 shows the variation of long term annual rainfall for a period of 20 years (1974-1994) and the number of rainy days per year. In years of extreme rain, such as 1982/83 and 1991/92, floods and extensive soil erosion is likely to occur because of the intensity of the rainfall. The steep slopes of Bir Zeit and Bitunia receive most of the precipitation ranging between 400-900 mm. The areas that are wide spread on or near mountain summits like Beit U'r Tihta have an annual precipitation ranges from 300-700 mm. Figure 2.6 shows the variation of the monthly rainfall among the year.

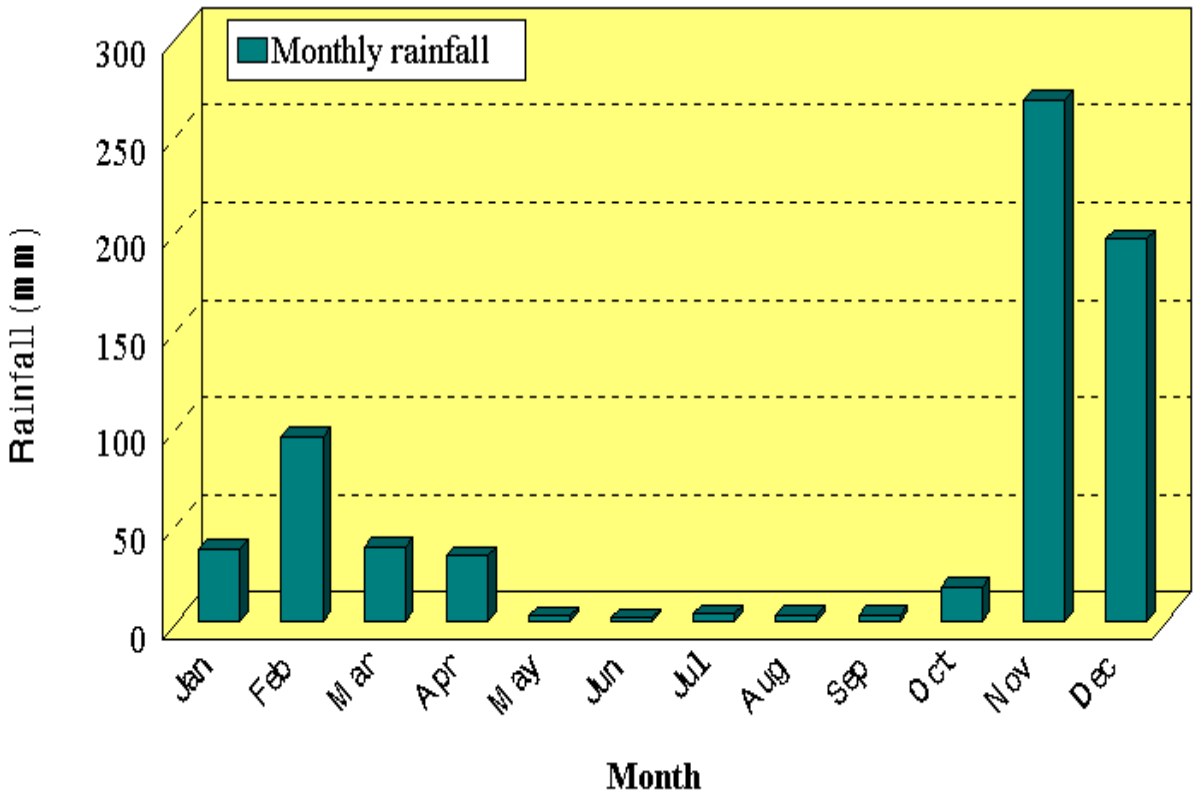


Figure 2.6: Monthly rainfall for 1994 /95.

Little data are available on the amount of snow in the Ramallah District. There is infrequent snow fall during the winter period. The largest snowfall on record came on February 9, 1920 when one and quarter meters of snow fell on Ramallah.

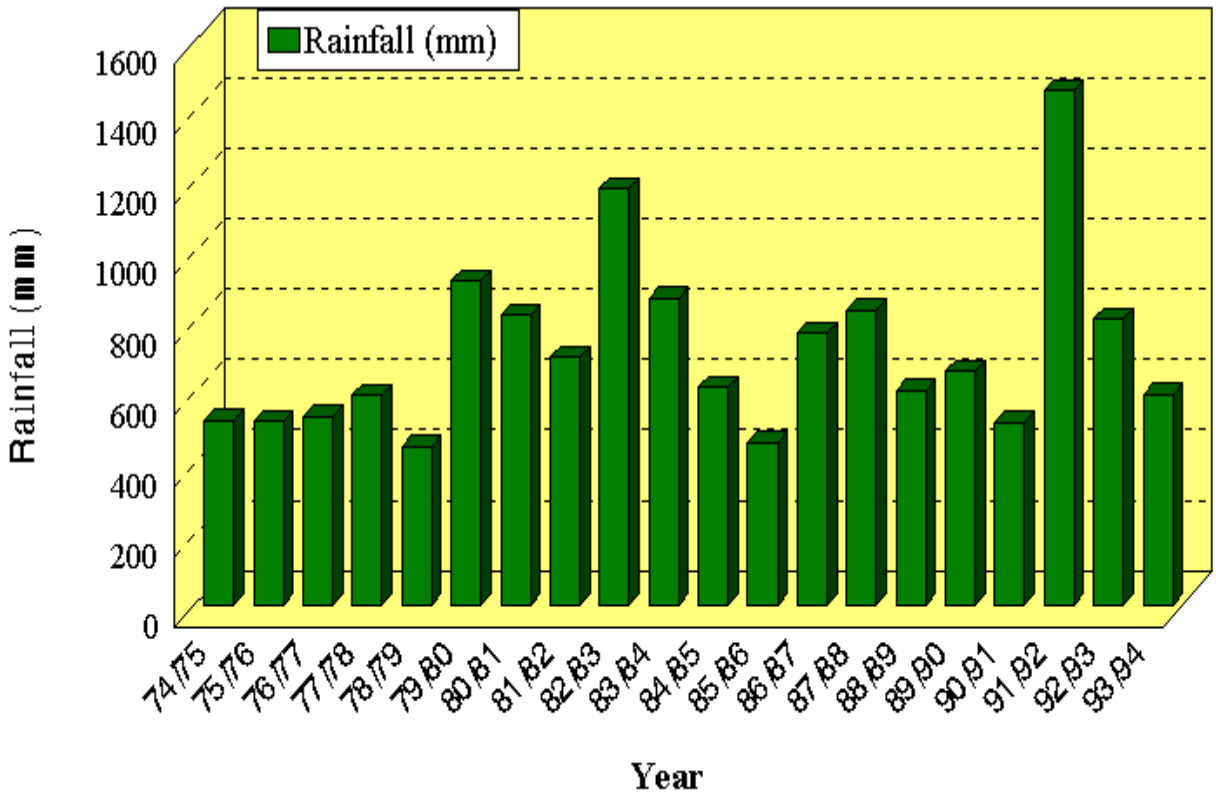


Figure 2.7: Annual rainfall in mm for 1974-94.

Humidity

The mean humidity level in 1994/95 was 70.2% in the Ramallah District. The minimum relative humidity was registered in May at 57.2% and the maximum in December with a value of 77.1%. Figure 2.8 shows the variation of monthly relative humidity in 1994/95.

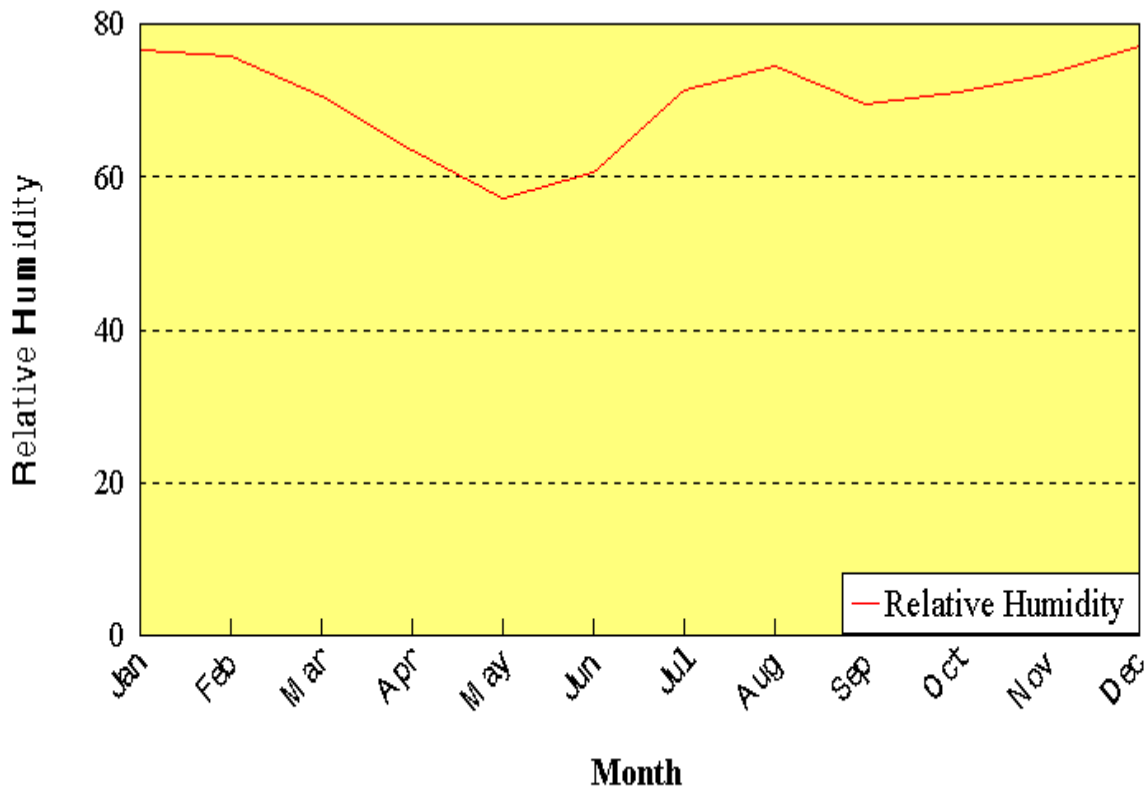


Figure 2.8 Monthly relative humidity for 1994/95

Evaporation

The high temperature in the summer time, the intensive insulation under a cloudiness sky, with 306.3 wattm^2 as maximum energy reached to the soil surface in June, and the low air humidity results in a high evaporation rate. The evaporation rate decreases in the winter due to high humidity, and low radiation of 98.3 wattm^2 reached to the soil surface in December. The monthly variation in radiation for the year 1994/95 is shown in Figure 2.9

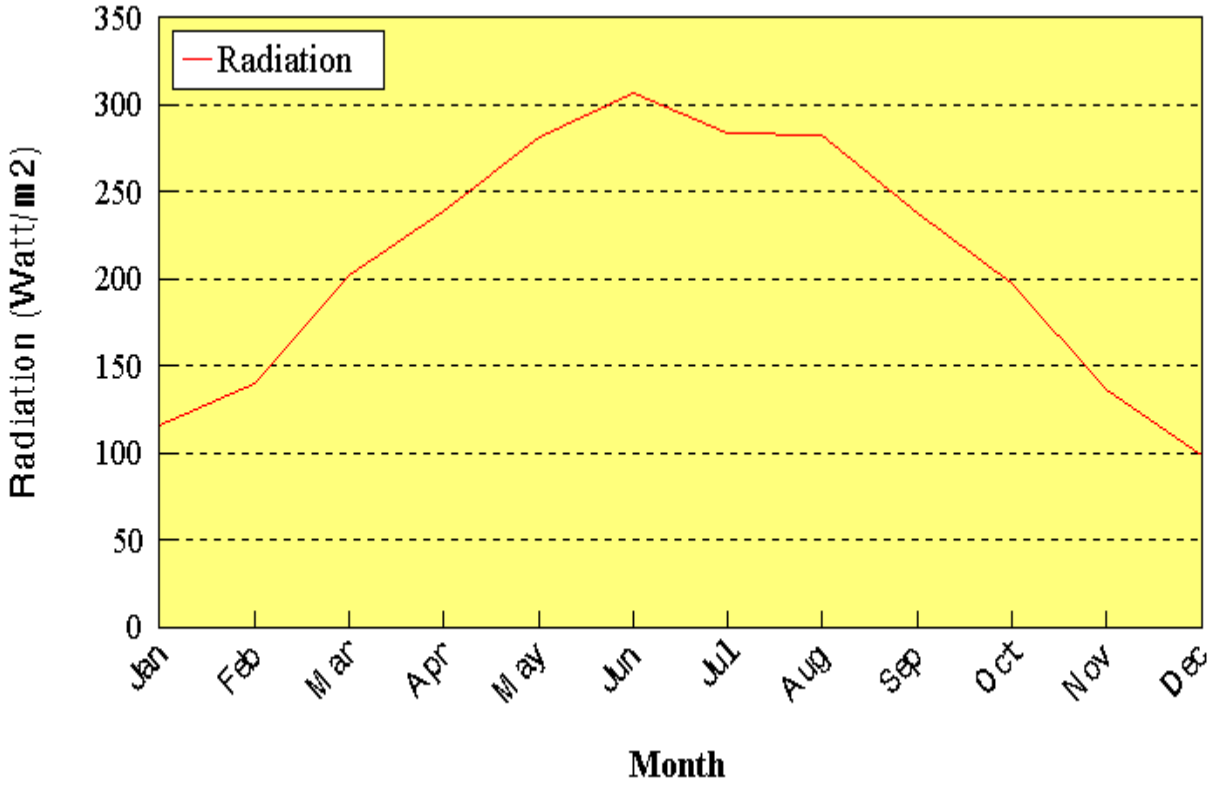


Figure 2.9: Monthly radiation for 1994/95

Wind

During the summer, the area is influenced by regional winds with an average daily wind speed of 216 km in August. During the winter season, the rain-bearing winds move in a general west-east direction with an average daily wind speed of 294 km in December, causing precipitation. Between April and June the area is influenced by *Khamseen* winds which blow frequently from the Arabian Desert, full of sand and dust. This wind brings high temperature and reduced humidity.

Table 2.1 Climatic Parameters in the Ramallah District from October 1994 to September 1995.

Month	**Rainfall (mm)**	**Relative Humidity (%)**	**Min Temp (^{0}C)**	**Max Temp (^{0}C)**	**Average Temp (^{0}C)**	**Radiation (watt/m^2)**	**Wind Speed (m/sec)**	**Wind Direction (deg)**
October	17.3	71.2	13.1	26.5	19.8	198.1	2.8	202.3

November	267.2	73.4	11.2	24.3	15.1	137.2	3	198.4
December	195.6	77.1	1.4	20.2	8.2	98.3	3.4	192.9
January	36.4	76.6	3.6	17.4	9.3	115.7	2.6	192.1
February	94.6	75.9	1.2	17.8	9.9	140.1	2.8	185.3
March	37.6	70.7	3.7	21.3	12.1	202.2	2.5	214.1
April	33	63.6	3.9	29.7	14.7	238.6	2.8	210.6
May	2.2	57.2	8.8	37.5	19.9	281.2	2.3	221.7
June	1.2	60.5	13.5	35.2	22.9	306.3	2.3	250.9
July	3.4	71.5	16.3	35.1	23.2	283.7	2.5	254.3
August	2.8	74.6	17.5	34.3	23.6	282.7	2.6	263.2
September	2.8	69.6	16.1	33.5	22.7	238	2.3	227.4
Total Average	694.1	70.2	9.2	27.7	16.8	210.2	2.66	217.8

Table 2.2 Annual rainfall and number of rainy days per year for the years (1974-1994).

Year	**Rainfall (mm)**	**No. of rainy days**	**Year**	**Rainfall (mm)**	**No. of rainy days**
74/75	522.7	48	84/85	615.7	46
75/76	520.8	58	85/86	458.5	49
76/77	535.5	55	86/87	769.5	74
77/78	593.9	52	87/88	835.6	76
78/79	449.4	41	88/89	609.6	52
79/80	918.2	71	89/90	662.5	69
80/81	821.4	62	90/91	518.6	47
81/82	701.2	59	91/92	1460.2	77
82/83	1180.3	80	92/93	809.3	56
83/84	871.2	46	93/94	598.3	55

Chapter Three
Socio-Economic Characteristics

Demography and Population

Demographic trends in the Ramallah District, as is the case of other districts in the West Bank, have been closely related to the political situation. In 1922, the total population of Ramallah District was approximately 3,000 inhabitants. By the end of the 1945 and 1966, the estimated population of Ramallah District reached approximately 47,280 and 134,288 inhabitants respectively (Encyclopedia Palaestina, 1984).

According to the population statistics estimated by the Palestinian Bureau of Statistics (PBS) for the Palestinian cities, towns and villages in 1994, and the UNRWA estimation for the refugee camps, the total population in the Ramallah District was estimated at 176,154 people, close to 12 % of the total population in the West Bank. This number includes the four refugee camps, Al-Ama'ri, Al-Jalazone, Qaddura and Deir A'mmar (PBS, 1994, UNRWA report, 1994).

It is difficult to draw a clear distinction between urban and rural communities in the Ramallah District. In this profile, urban areas will be defined as the communities administrated by municipalities and with population of more than 10,000 inhabitants, semi-urban communities for those with population between 5,000 and 10,000, while rural areas are those with population less than 5,000 people. Ramallah, Al-Bireh, Silwad, Qarawat Bani Zeid, Bitunia, Bir Zeit and Deir Dibwan are the only Palestinian built up areas administrated by municipalities in the Ramallah District. Ramallah and Al-Bireh are the only Palestinian communities in the district which have a population of more than 10,000 people. The population of Ramallah and Al-Bireh comprises approximately 26% of the total population of the district, while those living in rural areas represent 65% of the total population. Approximately, 9% of the people (16,500) live in the four refugee camps (PBS, 1994; UNRWA Report, 1994).

Age Composition:

According to the statistics, prepared by the Palestinian Bureau of Statistics (PBS) in 1995 for the elections, there are 78,076 people registered to voting in the Ramallah District. This gives a rough estimate of the number of people over age 18 in the district.

Table 3.1: The percent distribution of individuals over 18 years of age in the Ramallah District

Age	18-19	20-29	30-39	40-49	50-59	60-69	70+
%	8.3	31.7	23.8	13.4	9.2	8.0	5.7

Source: Al-Quds Annex "People and Election" Page 12

In comparison with the total population of Ramallah District in 1995, the Ramallah District has a very young population with 58.4 % less than 18 years old.

Sex composition:

The total gender distribution for Palestinians living in the Ramallah District has almost 50% male/female ratio. Table 3.2 shows the total number of males and females for certain age categories in the Ramallah District.

Table 3.2: Male/female distributions with ages more than 18 years in the Ramallah District.

Age	18-19	20-29	30-39	40-49	50-59	60-69	70+
Male	3537	12943	9561	5130	2876	2488	2332
Female	2901	11841	8979	5293	4313	3725	2157

Source: Al-Quds Annex "People and Election," Page 12.

Economy

The dominant economic activity in the Ramallah District is the manufacturing industry. The major industrial activities are centered around food processing and the manufacture of pharmaceuticals (Center for Engineering and Planning, 1993). The economy of Ramallah District is affected by the political situation in the area. Industrial facilities in the Ramallah District, as well as in the West Bank, are mainly dependent on Israel in providing the raw materials needed. The frequent closure of the West Bank stops the flow of goods and materials into the territories which interrupts the continuity of these facilities.

The unemployment rate is fluctuating considerably, as thousands of Palestinians depend on jobs in Israel and East Jerusalem. The continuous closure of the West Bank by Israelis prevents people to travel from the West Bank to Jerusalem or Israel for work which

increases the unemployment rate significantly. Even when the border is "open", all Palestinians still require permission from the Israeli Authority to enter, and the granting of such permit is getting more and more difficult. These limitations have had a severe impact on the economy.

Approximately 63.2% of the working age population (16-59) is employed. Out of which 81.3% are permanently employed, 6.1% have seasonal employment, and 12.6% have part-time jobs. The unemployment rate of nearly 36.8% (PARC & Arab Thought Forum, 1994).

A large number of people from Ramallah District have immigrated to other countries especially to the United States of America. Those people retain their strong relations with their families and their homeland and send money back to be invested in economic activities. With these added resources, Ramallah became the economic center in the West Bank. During the past two years, Ramallah city has developed at a high rate where many new commercial centers and housing projects have been constructed and many investors started their own businesses. As Israel continues to impose limitations on Palestinian travel to Jerusalem, many organizations, both governmental and nongovernmental, are using Ramallah as a temporary center for Palestine.

Institutions, Societies and Organizations

Many associations, non-governmental organizations (NGO's) and societies to provide the necessary services for the Palestinian community are located in Ramallah. A list of the main institutions in the Ramallah District is found in Appendix1.

Infrastructure - Utilities

Management of most of the infrastructure services in the West Bank has been handed over to the new Palestinian National Authority (PNA). With very limited resources, the authority is working to increase the quality of these services.

Piped Water Supply

According to the survey conducted by ARIJ in 1995, approximately 90% of the population in the Ramallah District has access to the piped water supply through either the Jerusalem Water Undertaking, which covers 72% of the population, or the West Bank Water Department, which covers approximately 18% of the population. People in the district who do not have access to piped water depend upon cisterns or local springs for water supply. The Palestinian Economic Council for Development and Research (**PECDAR**) is working to construct new water networks for some of the villages that currently lack a piped water supply such as **Beit U'r Tihta**, **Beit Leqia**, **Saffa and Kharbatha Al-Misbah**.

The quality and continuity of the water supply are better in Ramallah District than other districts in the West Bank. Water quality of the piped water is generally considered to be good, although quality problems are likely as water comes through pipes intermittently. The Jerusalem Water Undertaking is conducting regular testing of water supplied through the network. Not all areas can depend on a continuous supply of water, some villages suffer from water shortages, especially in the summer.

Sewage Disposal Facilities

According to the survey conducted by ARIJ in July 1995, approximately 21% of the houses in the Ramallah District are connected to the sewage network. This sewerage collects wastewater from approximately 70% of the population of Ramallah and Al-Bireh cities and the entire population of Al-Ama'ri Refugee Camps (R.C.). All the villages in the Ramallah District, as well as other districts, lack sewage collection networks and are therefore dependent on cesspits and open channels as a way for sewage disposal.

Solid Waste collection Services

According to ARIJ field survey conducted in July 1995, only 56% of the population has organized solid waste collection services. All of the urban areas and refugee camps and some of the villages have access to the services. These communities are served either by the municipalities, village councils, associations or UNRWA. The rest of the population lacks any system of solid waste collection, therefore solid waste is dumped on road sides or vacant lands.

Electric Services

The Jerusalem District Electricity Company (JDEC) supplieselectricity to the Ramallah District. According to the Health Development Information Project (HDIP), approximately 99% of the total population in the Ramallah District has access to 24-hour/day electricity. The remaining 1% gets power from a local community generator or home generator (Barghouthi & Daibes, 1993). The per capita electrical energy consumption in the Ramallah District is 962 kwh/year. Although it is the highest consumption when compared to other districts such as Nablus, Jenin, Hebron and Tulkarm, but it is considered low if compared with other neighboring countries such as Jordan which has an average of 1045 kwh/capita/year (Palestinian Energy Research Center, 1995).

Infrastructure - Services

Health Care Sector

The status of health care in the West Bank and Gaza Strip is very poor due to Israeli policies, military orders, and regulations that greatly impeded the development of the health care services. As responsibility for health care has been handed over to the Palestinian National Authority (PNA), the Palestinian Ministry of Health, has been

established and is responsible for health services in Palestine. The officials in the Ministry is taking the responsibility to improve the level of health services introduced to the people.

The health sector in the Ramallah District includes the following health services:

Primary Health Care Clinics

There are approximately 83 primary health care clinics in the Ramallah District, 51 are sponsored by NGOs, 28 are provided by the public sector and UNRWA runs four clinics serving the refugees (PCH, 1994).

Hospitals

Five hospitals provide medical services to the people in the Ramallah District. Table 3.3 shows the type of hospital, number of beds, number of physicians and number of nurses at each hospital. In total, there are 186 hospital beds which are insufficient to provide satisfactory health services to more than 176,154 people in the district. The public hospital is always crowded and patients must wait several weeks for an appointment. While there are higher quality hospitals in Jerusalem, closure of Jerusalem greatly restricts people living in Ramallah District from using these facilities even though they are only few kilometers away.

Table 3.3 Distribution of beds, physicians and nurses in the hospitals at Ramallah District

Number & Type of Hospital	Number of Beds	Number of Physicians	Number of Nurses
1 public	136	50.5	109
1 NGO	15 + 3 incubator	4	9
3 private	35	9	12

Source: PCH, 1994.

There are four rehabilitation centers, one for motor disabilities, one for vision, one for hearing and the last one is for mental rehabilitation (PCH, 1994).

Ramallah District has 6 ambulances, the Red Crescent Society owns three, UNRWA owns two and the government hospital owns one (PCH, 1994).

Health-Care Personnel

The 1996 statistics of the number of dentists and physicians in the Ramallah District was compiled from information provided by related associations. There are 166 physicians representing 14.1% of the total number of physicians in the West Bank and 61 dentists representing 14.4% of the dentists in the West Bank. According to the survey conducted by the Planning and Research Center in 1993, there are 65 pharmacists representing 15.3% of the total number of pharmacists, 166 nurses representing 7.3% of the nurses in the West Bank, 147 technicians represent 11.8% of the total number of technicians in the West Bank (Abu Libdeh, 1993).

Educational Sector

The education sector has been greatly undeveloped over the years of occupation. Since 1948, the curriculum and teaching materials from the Jordanian educational system was used in the West Bank. After the Israeli occupation in 1967, control over the government schools was placed under Israeli jurisdiction who continued to use the Jordanian curriculum. The content of the curriculum especially in the areas of history and Palestinian culture was censored and therefore limited. In September 1994, the Palestinian National Authority established the Ministry of Education which took control over the education system and are producing new curriculums and teaching materials for all schools.

Three different educational systems operate in Ramallah District, as in all the districts: government, private and **UNRWA**. In 1942/43, there were three governmental schools and six non-governmental schools in the Ramallah District. By 1966/67, five governmental schools (three for boys and two for girls), three **UNRWA** schools, and six private schools were serving 4,299 students in the district. The district also had at that time four community colleges (Encyclopedia Palaestina, 1984).

By 1994/95, the total number of schools in the Ramallah District had grown to approximately 289. Government schools comprise the largest sector of the school system in the Ramallah District as in other districts of the West Bank. There are 154 government schools, 113 private schools and 22 **UNRWA** schools (PBS, 1995).

Of the 289 schools in the district, seventy-nine are kindergartens, 147 are basic (Elementary + intermediate) and 63 are secondary schools. These schools host close to 73, 584 pupils.

Table 3.4 Distribution of pupils by educational level and sex in 193/94.			
	Kindergarten	**Basic**	**Secondary**
Male	3513	31462	2669
Female	3400	30426	2114
Total	6913	61888	4783

Table 3.4 shows the total number of pupils and the distribution of pupils by educational level and gender in the district (PBS, 1995). Data shows that equal opportunity for education is given to both female and male pupils in the Palestinian community. Figure3.1compares the number of pupils/teachers and pupils/classroom in each of the government, private and **UNRWA** operated schools. It is very obvious that government and UNRWA schools are suffering from overcrowding in the classrooms and a high pupil/teacher ratio, both can have a negative effect on the progress of the students. The educational system is in need of great attention and review.

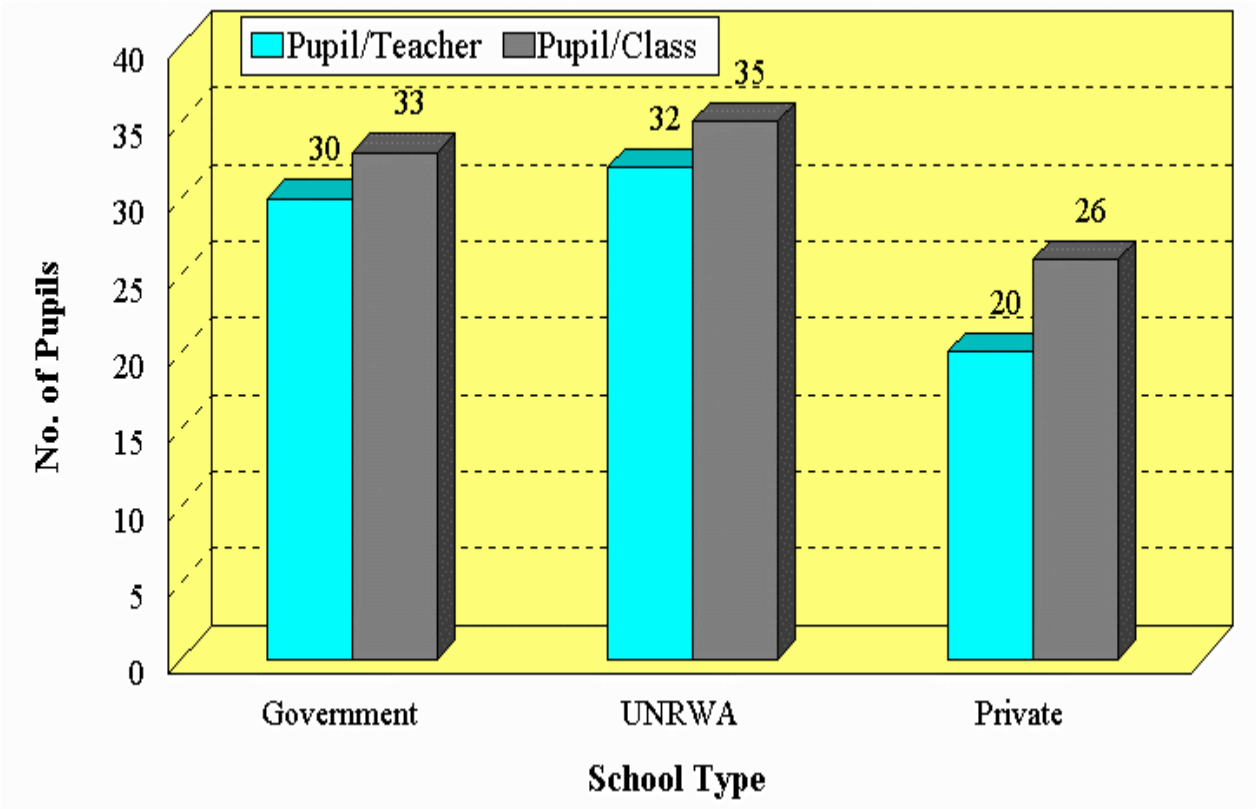


Figure 3.1 Average number of pupils/teacher and pupil/classroom for the different school types.

Higher Education

There are two types of institutions for higher education in the Ramallah District, universities and community colleges. The universities offer a bachelors degree and the community colleges offer programs at post-secondary level that lead to an intermediate diploma degree.

Bir Zeit University is one of the oldest and most distinguished universities in Palestine. It is located at Bir Zeit village, to the north of Ramallah city. The University offers bachelors degrees in engineering, arts, science, and commerce. It also offers a masters degree in education.

According to the 1993/94 statistics, there were nearly 2,852 students in Bir Zeit University, of which 1,872 were males (66%) and 980 were females (34%). There were 318 graduate students at the University in 1992/93, of which 28% were females (The Council of Higher Education, 1995).

There are several community colleges in the Ramallah District which offer diploma degrees in different subjects. A list of the major community colleges in the Ramallah District is found in Appendix 1.

Chapter Four
Geology And Soils

Introduction

The geological formations of Ramallah District range in age from Lower Cretaceous to Quaternary. Lithological composition of these formations consists mainly of limestone, dolomite, marl, chalk, cherts and alluvium (Figure 4.1).

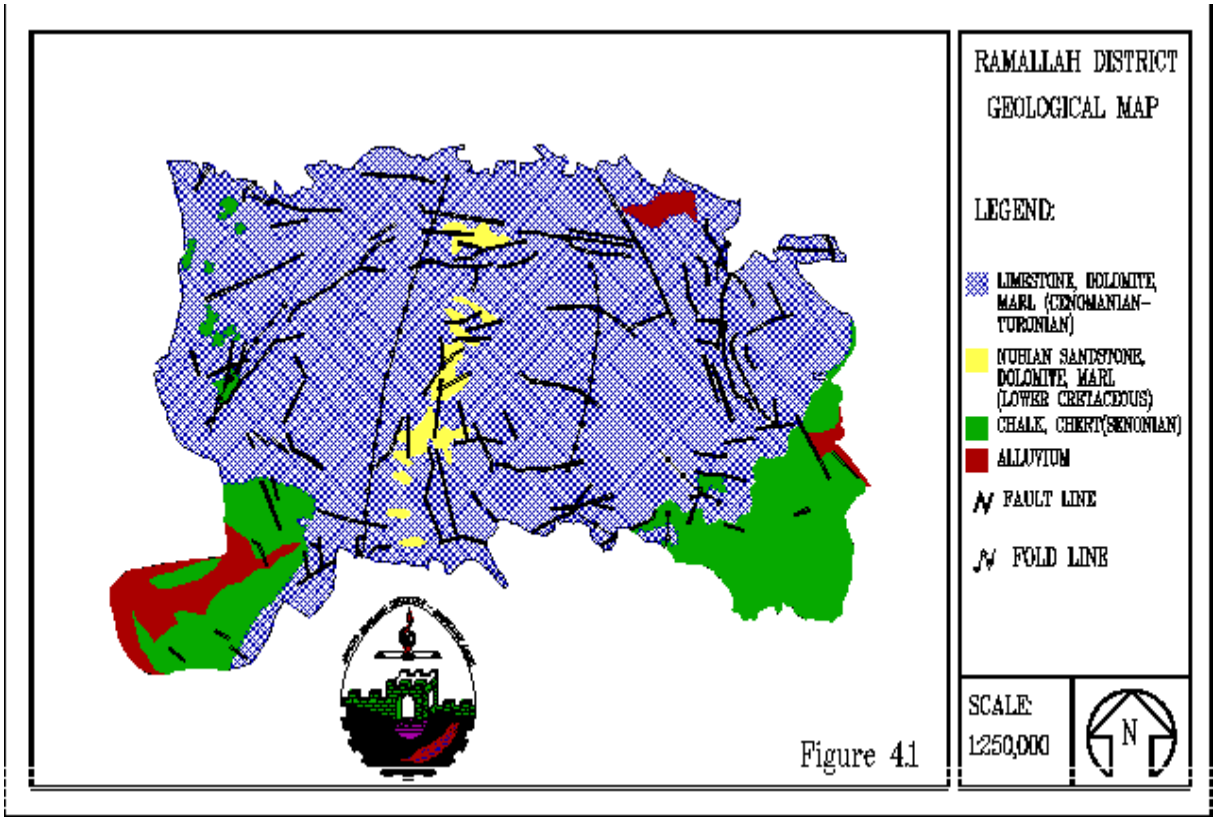


Figure 4.1

Geological Formations

The detailed geology of Ramallah area, as outlined in Table 4.1 shows the following formations:

Table 4.1: Geological column in the Ramallah District.

Geological Formation	**Geological Time Scale**	**Lithology**	**Thickness (m)**
Nari Formation	Recent	Limestone	10 - 15
Lisan Formation	Pleistocene	Marl, limestone	Unknown
Khan El Ahmar Formation	Maestrichtian - Danian	Marl, limestone	Variable
Abu Dis Formation	Senonian	Chalk, chalky limestone	60 - 220
Jerusalem Formation	Upper Cenomanian - Turonian	Limestone, cherts	75 - 130
Bethlehem Formation	Upper Cenomanian	Chalky limestone	90 - 150
Hebron Formation	Upper part of middle Cenomanian	Dolomitic limestone, Dolomite	170
Yatta Formation	Lower part of middle Cenomanian	Marl, limestone, chalks	110
Upper Beit Kahil Formation	Upper part of lower Cenomanian	Marly limestone, dolomitic limestone	180 - 205
Lower Beit Kahil Formation	Lowest part of lower Cenomanian	Dolomitic limestone, massive limestone	216
Kobar Formation	Aptian - Albian	Limestone, marl, sandstone	180

1. Lower Cretaceous Rocks

They are regarded as equivalent to the Pre-Aptian stage. Their main composition consists of limestone, marl, shale and clay.

2. Upper and Middle Cretaceous Rocks

They are divided into the following formations:

- Kobar Formation: It ranges in age from Aptian to Albian. Outcrops exist in the west of Ramallah. The formation consists mainly of brown ferruginous limestone,

marl and sometimes of interbedded limestone. The Albian rocks deposited with unconformity over the Aptian rocks. Total thickness of this formation is approximately 180 m.

- Lower Beit Kahil Formation: It forms the lower part of the lower Cenomanian. It is composed mainly of thin bedded dolomitic limestone at the bottom which become massive towards the top. The total thickness is about 216 m.

- Upper Beit Kahil Formation: It forms the upper part of the lower Cenomanian. The lower part of the formation consists of marly limestone with marly partings and of bedded limestone, somewhat dolomitic at the top. The total thickness is around 180-205 m.

- Yatta Formation: It is the lower part of the middle Cenomanian. The main composition of this formation consists of marl, limestone and chalk. It has a thickness of about 110 m.

- Hebron Formation: It corresponds approximately to the upper part of the middle Cenomanian. The lower part of the formation consists of hard dolomitic limestone and dolomite. While the upper part consists of dolomitic limestone. The total thickness is about 170 m.

- Bethlehem Formation: It forms the upper Cenomanian. It has the following lithological succession: well bedded cream-gray chalky limestone at the bottom, and recrystallized chalky limestone at the top. It has a thickness of about 90-150 m.

- Jerusalem Formation: It ranges from the upper Cenomanian to Turonian. The lower part of the formation consists of massive limestone which is becoming more thinly bedded upwards. The total thickness is about 75-130 m.

- Abu Dis Formation: It is composed mainly of chalk and cherts of Senonian age. The chalk is usually white and in some parts of the formation takes the dark color due to the presence of bituminous materials. The formation has a thickness of about 60-220 m.

- Khan el Ahmar Formation: It extends from Maestrichtian to Danian stage. Lithology and thickness vary greatly because of erosion. Lithology changes from bituminous and phosphatic marl to variegated marl and soft limestone. Total thickness is approximately 115 m.

3. Quaternary Rocks

They are divided into the following formations:

- Lisan Formation: It consists mainly of thinly laminated marl with occasional limestone, marginally of gravel and poorly stored pebble beds. The pebbles are sometimes siliceous or calcareous.

- Nari Formation: It is well developed in the high rainfall areas. Limestone forms the main composition of the formation. It forms a thin coating over the limestone with a thickness of about 10-15 m.

Structural Pattern

Ramallah District was affected by several tectonic movements which determined the general structure of the area. First, the compressive forces from northwest and southeast dominated, producing the main folds. Second, the minor folds were formed, and finally, forces of shear dominated, producing the main faults.

Folding

There are many folds in the Ramallah area. The most important one is the E'in Qinya anticline, which was formed by compressive forces from southeast and northwest. It trends north-south. The general structure of the anticline is symmetrical, but near Biddu it

becomes less or more symmetrical. Between Beit Leqia and Beit U'r Al-Tihta, the western limb is steep, about 35° slope. The western side of the anticline forms two minor folds trend northeast and southwest. The eastern side also forms two pairs of syniclines trend northeast with the first begins north of Al-Bireh and dies near Deir Dibwan and the second passes through E'in Samia (Figure 4.1).

Faults

Most of the faults trend north-south and east-west. The northern part of the area, where the main faults exist, is more faulted than the southern part. Majority of the faults extended for 5-6 km and have throws less than 50 m. Large faults have throws of about (50-150)m, however, they are rarely in the area and die out over 1-2 km. Figure 4.1 shows the distribution of faults and their directions.

Joints

Joints are well developed in the dolomite and limestone especially in Lower Beit Kahil, Hebron and Bethlehem formations. Joints are often up to one meter wide at the surface. Chalky and marly rocks are less affected with joints and solution channels than limestone and dolomite. The presence of joints and karst caves make the formations good aquifers.

Soils

The soil classifications and references to major vegetation were adopted from the document entitled, *The Soil of Israel*, 1976. The major soil associations found in the Ramallah District are as follows (Figure 4.2):

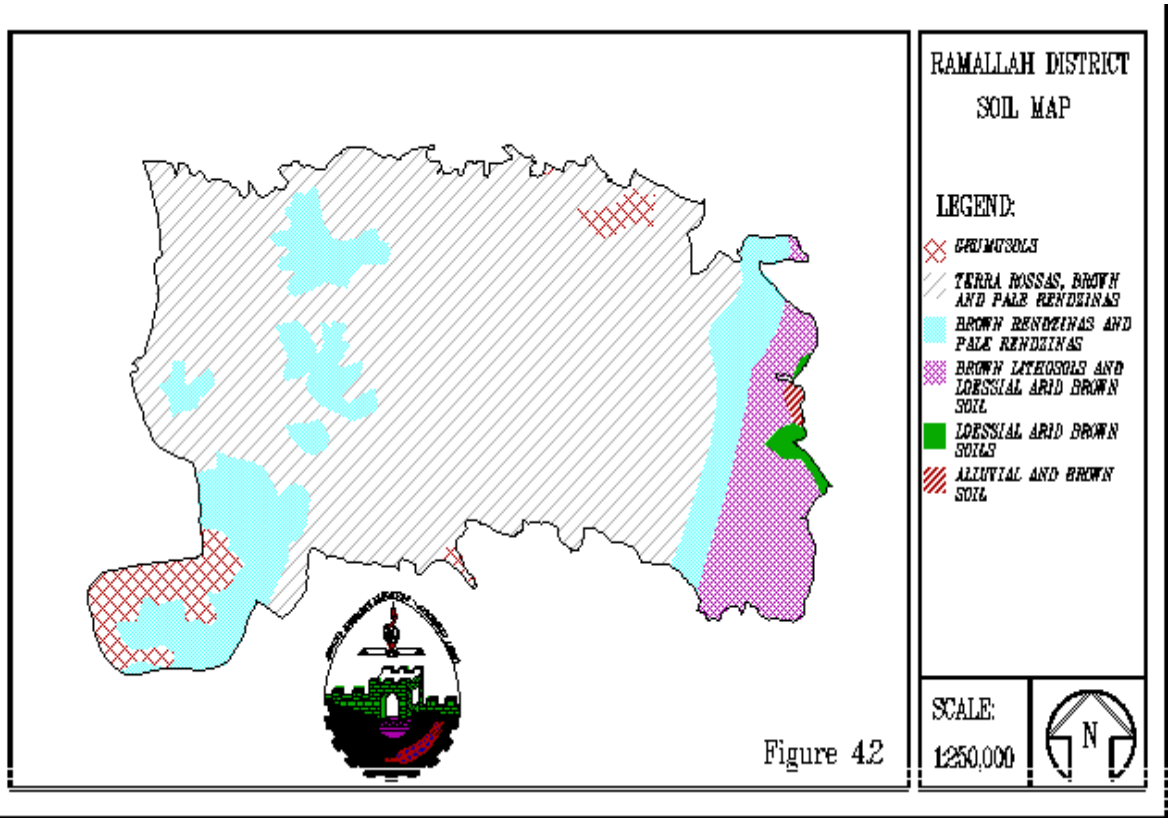


Figure 4.2

Grumusols

This type of soil association covers approximately 817 hectares of the district. It is found in areas with smooth to gently sloping topography. The soil is originally formed from fine textured alluvial or aeolien sediments. Primary natural vegetation was destroyed. Today, what appears is segetal vegetation of the *Prosopis farcata* - *Scolymus maculatus* association. The use of this soil type for agricultural production purposes is currently limited to cultivating wheat. The American great classification that represents this soil is *Xererts.*

Terra Rossa, Brown Rendzinas and Pale Rendzinas

These types of soil associations occupy a total area of approximately 58,504 hectares, nearly 70% of the Ramallah District. Around 3050% of these soils are outcropped with rocks. The major native vegetation cover are *Quercus calliprinos, Pistacia palaestina, Pistacia lentiscus, Pistacia atlantica, and Amygdalus korschinskii.* Particularly on valley

shoulders, these soils are used to cultivate field crops, mainly wheat and barley, vineyards, olive and fruit trees. The American great group classifications that represent these soil associations are *Xerochrepts and Haploxerolls*.

Brown Rendzinas and Pale Rendzinas

These types of soil associations dominate the area of Deir A'mmar, Jammala, Al-Nabi Saleh, Beit Rima, Kafr Ni'ma, Beit U'r Al-Tihta, Beit Sira, Beit Leqia and Beit Nuba. These soils cover an area of about 15,870 hectares. Similar to the previous soil types, 30-50% of these soils are outcropped with rocks. Major vegetation is *Pinus halepensis, Pistacia lentiscus, Pistacia palaestina, Quercus ithaburensis, Ceratonia siliqua* and *Ballotetalia undulatae*. On such areas, cultivation of grapes and olives, field crops (wheat and barley), and grazing is the main land use, especially in shallow and steep sloping areas. The American great group classifications that represent these soil association are *Xerorthents, and Haploxerolls*.

Brown Lithosols and Loessial Arid Brown Soils

These types of soil associations cover an area of about 6,866 hectares of the Ramallah District. These soils characterize the eastern slopes of the district and are mainly found on steep to moderate rocky and eroded slopes. Brown lithosols are found in the pockets among the rocks. Loessial arid brown soils are found on flat hilltops, plateau and foot-slopes. The parent rocks of this soil association are chalk, marl, limestone and conglomerates. Major vegetation is *Ballotetalia undulatae and Artemisietea herbaealbae*. The American great classifications group that represent these soils are *Haploxeralfs Torriorthents* and *Xerochrepts*.

Loessial Arid Brown Soil

This type of soil association is found at the eastern border of the Ramallah District, covering an area of about 440 hectares. The soil is formed originally from conglomerate and/or chalk and mainly found on gently sloping plateau as well as dissected plateau with locally hilly topography. The major vegetation type found in this region is *Achilleetum santolinae.* The dominant land use is cultivation of various field crops such as wheat, barely and sorghum which are grown as dry-farming crops and cultivation of some irrigated crops. The American great group classifications that represent this soil association are *Palexeralfs, Haploxeralfs* and *Xerochrepts.*

Alluvial Arid Brown Soil

This type of soil association is also located at the eastern border of the district. It covers an area of about 178 hectares. It exists as 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.

no	**Soil Assoc-iation**	**Area (hectares)**	**American Class-ification**	**Location**	**General Charac-teristics**	**Natural Vegetation**	**Rainfall (mm)**	**Mean temper-ature (c)**
1	Grumusols	817	*Xererts*	Area with smooth to gently sloping topography	Parent material are fine textural alluvial or aeolien sediments	*Prosopis farcata-Scolymus maculatus*	300-700	19-21
2	Terra rossas, brown and pale rendzinas	58,504	Xerochrepts *Haploxerolls*	central mountains Small plateau of the mountains	Terra rossa type, the parent materials are dolomite and hard limestone, the soil depth varies from shallow to deep (0.52m) Xeric moisture regime, deep in hilltops and shallow in sloppy mountainous areas. Soil has a reddish brown color with subangular blocky structure. Same as Xerochrepts with the exception that it has a base saturation of 75%	Quercus calliprinos, Pistacia palaestina and Pistacia lentiscus. *Pistacia atlantica, Amygdalus korschinskii and Pistacia palaestina.*	400700	15-20
3	Brown & pale	15,870	*Xerorthents*	Hilly slopes	Xeric moisture regime, it has a	*Pinus halepensis*	600700	1519

	rendzinas				reddish brown color. Soil structure is crumbly. Texture is loamy or clay, about 30% is stony. Parent material is soft chalk and marl.	and *Pistacia palaestina*.		
			Haploxerolls	Valleys and depression s	Xeric moisture regime. It has dark reddish brown color with clay and with gentle slope. Parent rocks are marl and chalk.	*Quercus ithaburensis , Pistacia lentiscus, Ceratonia siliqua*and *Ballotetalia undulatae.*	300700	1820
4	Brown lithosols & loessial arid brown soils	6,866	*Haploxeralfs* *Torriorthents* *Xerochrepts*	eastern slopes	marl, chalk, limestone and conglomerates parent rocks. Xeric moisture regime, the soil has ochric surface epidon with low organic matter < 0.6% and massive structure. Parent material is loessial sediments.	*Ballotetalia undulatae, Artemisietea herbae-albae.*	200350	19-21
5	Loessial Arid Brown soils	440	*Palexeralfs* Haploxeralfs *Xerochrepts*	gently sloping plateau and dissected plateau	Parent rocks are conglomerate and chalk.	*Achilleetum santolinae*	150-250	20-21
6	Alluvial Arid Brown soils	178	Haplargids *Camborthids*	alluvial fans and plains	Formed as a result of erosion of calcareous silty and clay materials.	Herbaceous vegetation of desert annual halophytes and glycophytes	150-200	23

Chapter Five
Water Resources

Introduction

Until the 1950's, Ramallah District depended upon rainfall collection cisterns and small local springs for its water supply. However, the growth in population and the influx of thousands of refugees from the nearby cities and villages, have multiplied the demand on drinking water. The existing infrastructure could not provide the needed water, so the municipalities of Ramallah and Al-Bireh and the municipal council of the Arab sector of Jerusalem established the Ramallah and Al-Bireh Water Company. This company expanded the water supply by drawing water from the E'in Fara springs northeast of Jerusalem and from E'in Qinya springs. Even after these two projects, the water supply could not meet the domestic water needs. In 1963, the Jordanian government concluded an agreement with the International Development Agency (IDA) to construct new drinking water projects in Jordan. One of these projects was the E'in Samia Water Project designed to supplement the Ramallah District with drinking water supply. Also, the IDA agreed with the Jordanian Government to establish the Jerusalem Water Undertaking in 1966 (JWU, 1991). Since that time, the Jerusalem Water Undertaking (JWU) is responsible for administrating water sources and providing domestic water for most of the population in the Ramallah District and some villages in Jerusalem District.

Hydrogeological Status

Groundwater Aquifer Systems

The Ramallah District overlies two main aquifer systems:

- Lower Cenomanian Aquifer System

The geologic formations representing this aquifer system are the Lower and Upper Beit Kahil. Lower Beit Kahil constitutes the lower part of the Lower Cenomanian that is composed of gray marly and dolomitic limestone with some joints forming an aquitard (Rofe & Raffety, 1963). Upper Beit Kahil constitutes the upper part of the Lower

Cenomanian and consists of dolomitic, chalky, and marly limestone with karstification and well-jointed features forming a good aquifer confined by the overlying Yatta aquitard (Rofe & Raffety, 1965). The E'in-Samia wells No. 3 and No. 4 tap this aquifer system.

- Upper Cenomanian Aquifer System

The geologic formation comprising this aquifer system is the Hebron formation, and is composed of limestone and dolomitic limestone with chalky bands and chert nodules. Karsts and joints give this formation excellent aquiferous characteristics (Rofe & Raffety, 1963). Figure 5.1 shows the groundwater basins and the exposed aquifers in the West Bank.

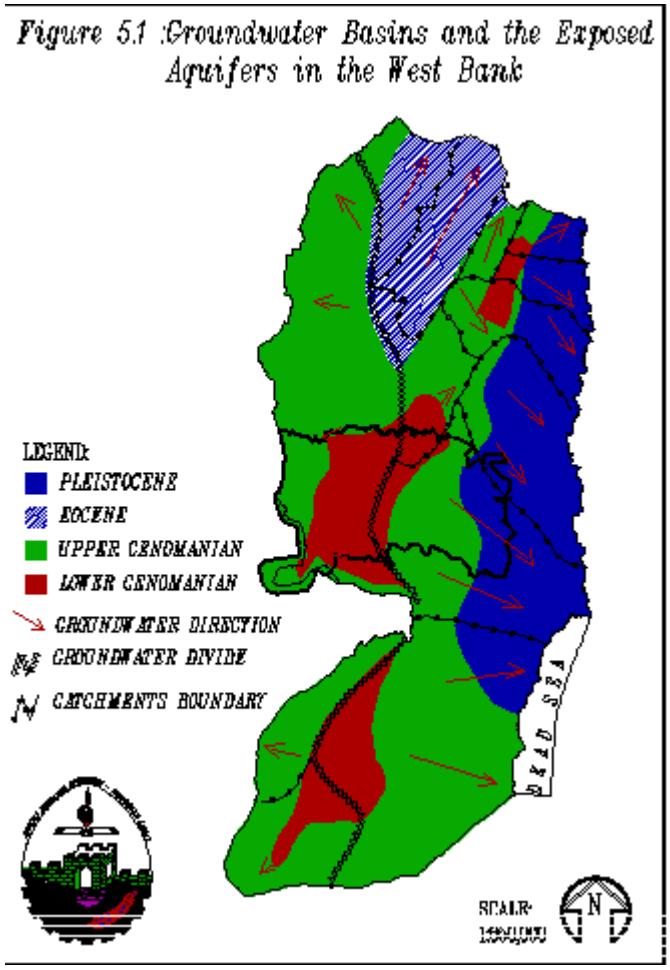


Figure 5.1 groundwater basins

Groundwater Basins

Groundwater basins in the Ramallah District are divided as follows:

1. The western groundwater basin (Auja Tamaseeh sub-basin): This basin underlies approximately 65% of the Ramallah District and its water flows towards the west. Shebtin wells tap this basin.
2. The eastern groundwater basin: This basin underlies the eastern part of the Ramallah District (35%). Its water flows towards the east and southeast. A large part of the eastern area of the Ramallah District is underlain by the Jerusalem-Ramallah sub-basin.

Sources of Water

Table 5.1 outlines in details the water sources in the Ramallah District and Figure 5.2 shows the location map of these sources. These water sources could be divided as follows:

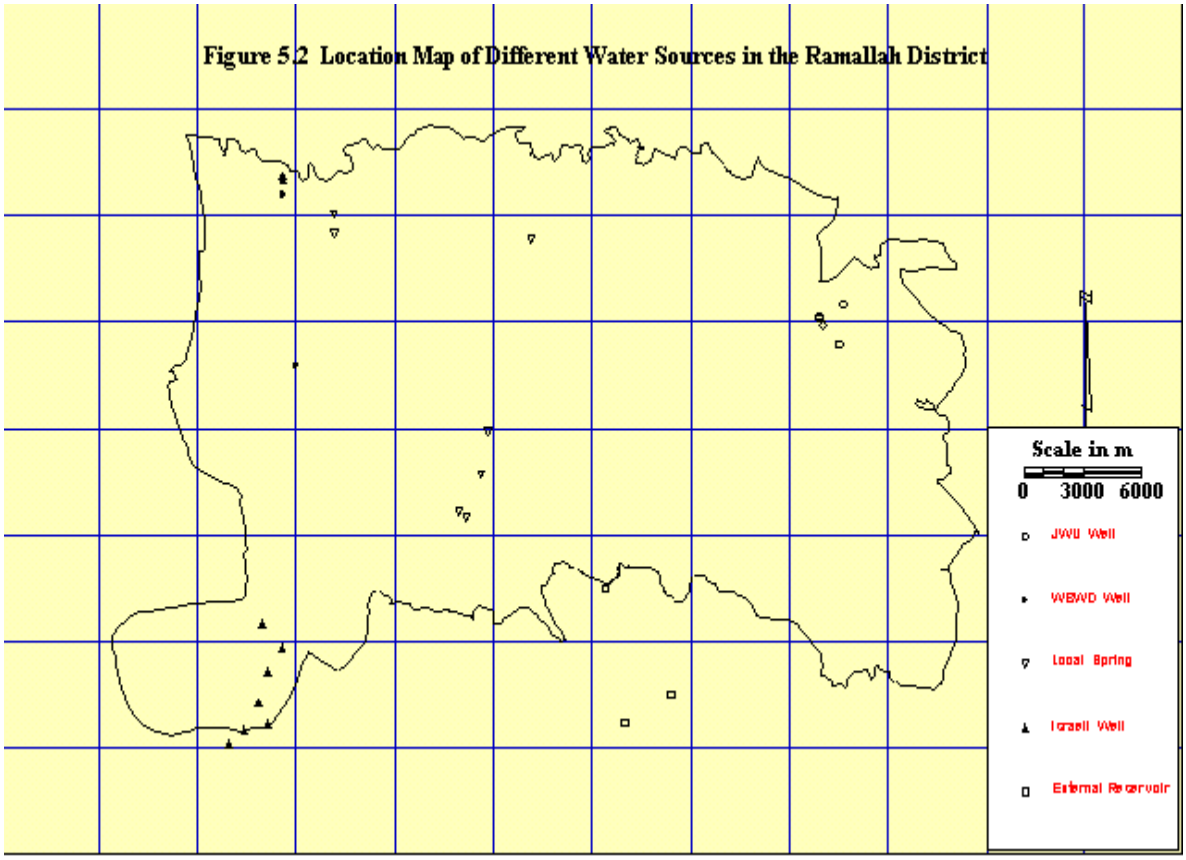


Figure 5.2 location of wells

Table 5.1: Basic details on different water sources in the Ramallah District

Source ID	Source Name	SWL(m)	SWD(m)	WD(m)	PR/Hr(m3)	PR/Month (m3)
W6001	E'in Samia No.1	403	37	60	100	72000
W6002	E'in Samia No.2	260	154	235	35	25200
W6002a	E'in Samia No.2a	260	154	250	225	162000
W6003	E'in Samia No.3	234	198	529	175	126000
W6004	E'in Samia No 4	88	344	616	60	43200
W6006	E'in Samia No.6	-	150	250	125	90000
W6007	Shebtin Well	-	-	-	90	64800

	No.4 1No.5					
W6008	Shebtin Well No.5	-	-	-	85	61200
IW6001	Eshtaol No.6	13.64	279	605	10	6900
IW6002	Eshtaol No.3	15.08	274.7	462.5	300	216100
IW6003	Havi Yahuda	21.05	309.77	537.8	N/A	N/A
IW6004	Modiin No.3	21.13	279	1151	328	235900
IW6005	Modiin No.4	-36.77	288	1118	295	212300
IW6006	Modiin No.2	20.85	227.85	1029	106	76300
IW6007	Modiin No.1	16.63	203.91	533	21	15400
IW6008	Shebtin Levona	31.87	148.13	492.5	38	27500
IW6009	Shebtin No.15	-27.37	207.37	510	41	29300
S6001	Ajjul Spring	-	0	-	0.417	300
S6002	Delbeh&Legtan Spring	-	0	-	4.92	3540
S6003	Zarqa Spring	-	0	-	9.38	6750
S6004	Harrasheh Spring	-	0	-	2.63	1890
S6005	Dilba Spring	-	0	-	8.3	5970
S6006	Arik Fouqa Spring	-	0	-	7.79	5610
S6007	Arik Tahta Spring	-	0	-	5.75	4140

Table Notes:
Source ID: Identification Number PR/Mo : Pumping Rate per Month
SWL : Static Water Level SWD : Static Water Depth
WD : Well Depth PR/Hr : Pumping Rate per Hour

Groundwater Wells

The groundwater wells, supplying domestic water to the people in the Ramallah District, are controlled by the Jerusalem Water undertaking (JWU), Mekorot and Jerusalem Municipality. Israeli companies are also controlling other groundwater wells in the Ramallah District directed to provide the Israeli settlers living in the West Bank with domestic water.

Wells owned by the Jerusalem Water Undertaking(JWU)

The Jerusalem Water Undertaking (JWU) owns five wells at E'in-Samia area to the east of Ramallah city. These wells are located to the east of the regional groundwater shed, tapping the eastern basin aquifer. They contribute to only one third of the current water supply in the district. Basic information about E'in-Samia wells are shown in Table 5.1. Well No. 1 is a seasonal well depending on the annual rainfall, while well No.2 is used

mainly for irrigation purposes. Well No.2a is a new well, constructed as an alternative for well No.2 at the same location and expected to operate soon at a pumping rate of 300 m^3/hr. These wells (E'in-Samia wells No.1, No.2, and No.2a) tap the Upper Cenomanian aquifer system. Recently, the E'in Samia well No.3 was equipped with a higher yield pump to increase its capacity. The well is pumping at its new capacity since December, 1995. Wells No.3 and No.4 tap the Lower Cenomanian aquifer system. The JWU had constructed a well at E'in Sinya close to Jifna village. Drilling failed to tap any aquifer and stopped at a depth of 500m. They are planning to construct a new well at E'in Samia (No.6) that will be funded by the German Government through GTZ.

Israeli sources

A large quantity of water is purchased from Israeli sources and from Jerusalem Municipality to supplement the low water production of the E'in-Samia wells. The Israeli water company, Mekorot, controls over Shebtin wells No.4 and No.5 in the Ramallah District. These wells located to the west of the groundwater shed and tap the Upper Cenomanian aquifer system.

Mekorot is also responsible for supplying domestic water to 22 villages and 6 Israeli Settlements within Ramallah District through the West Bank Water Department (WBWD). The total water supply from Mekorot sources is about 6.5 MCM/yr (Mekorot, 1995). Approximately 4.3 MCM/yr were purchased from Mekorot and distributed by JWU, while 2.2 MCM/yr were distributed by WBWD.

Israeli controlled Wells

There are nine other Israeli wells that are controlled by Israel in the Ramallah District. These tap the western groundwater basin and are connected with the Israeli national carrier to exclusively serve the Israelis. Table 5.1 shows their names and basic details.

A comparison between well depth and depth to water of the Palestinian wells and Israeli wells is shown in Figure 5.3. Clearly, the depths for Israeli wells are much deeper than those of the Palestinians which means that the Israeli wells tap multi aquifer and so abstracting more water.

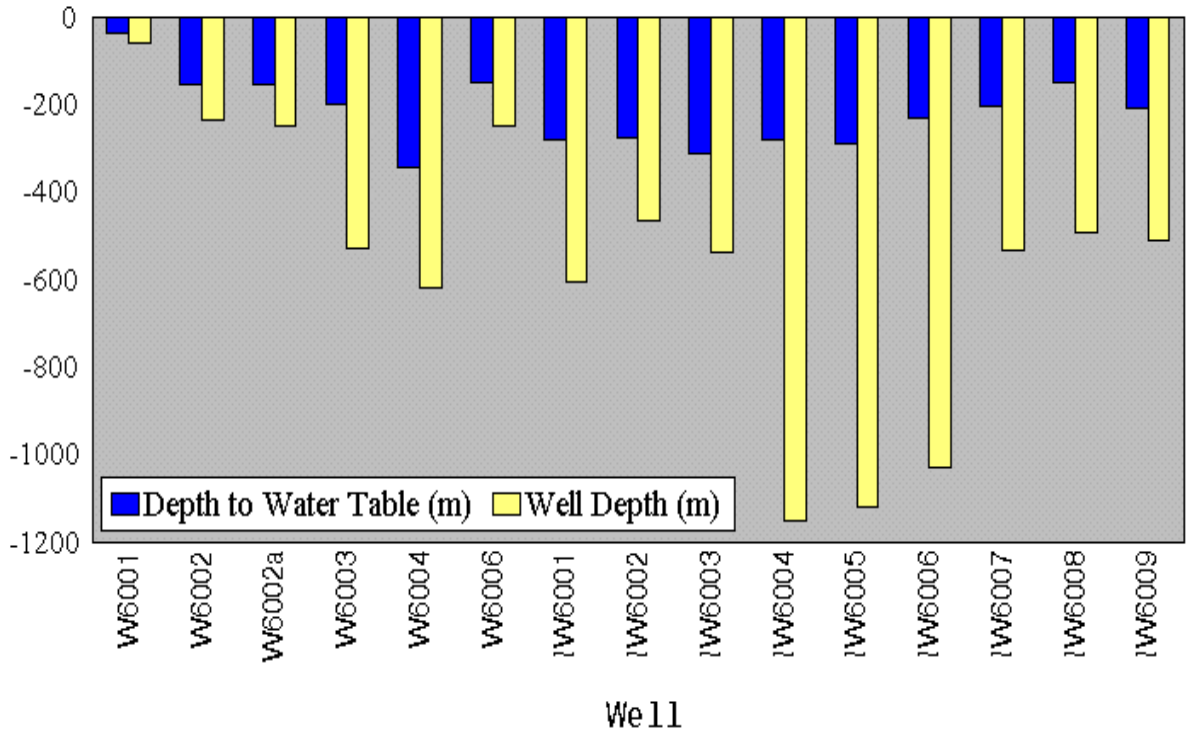


Figure 5.3 Well depth and depth to water table for different groundwater wells in Ramallah District.

Springs

Springs are a major source of domestic water for many villages in the West Bank. Villages not connected to municipal water are depending on spring water for their living. In the Ramallah District, there are 122 minor springs with an average discharge little exceeding 0.01 liters/sec. Some of these springs are used for domestic and low scale irrigation purposes and many of them are not utilized. The water of these springs flows in open channels causing water losses by evaporation and percolation through the ground to be very high. However, the total average annual discharge (1970-1994) of the seven major springs in the district is estimated to be 3.83 MCM, about 90% of the total discharge of all springs in the Ramallah District (Nuseibeh & Nasser Eddin, 1995). The basic details of these seven major springs are shown in Table 5.1. Figures 5.4-5.7 show the annual discharge variation with rainfall of the main springs in the Ramallah District from 1982 to 1994 (Nuseibeh & Nasser Eddin, 1995).

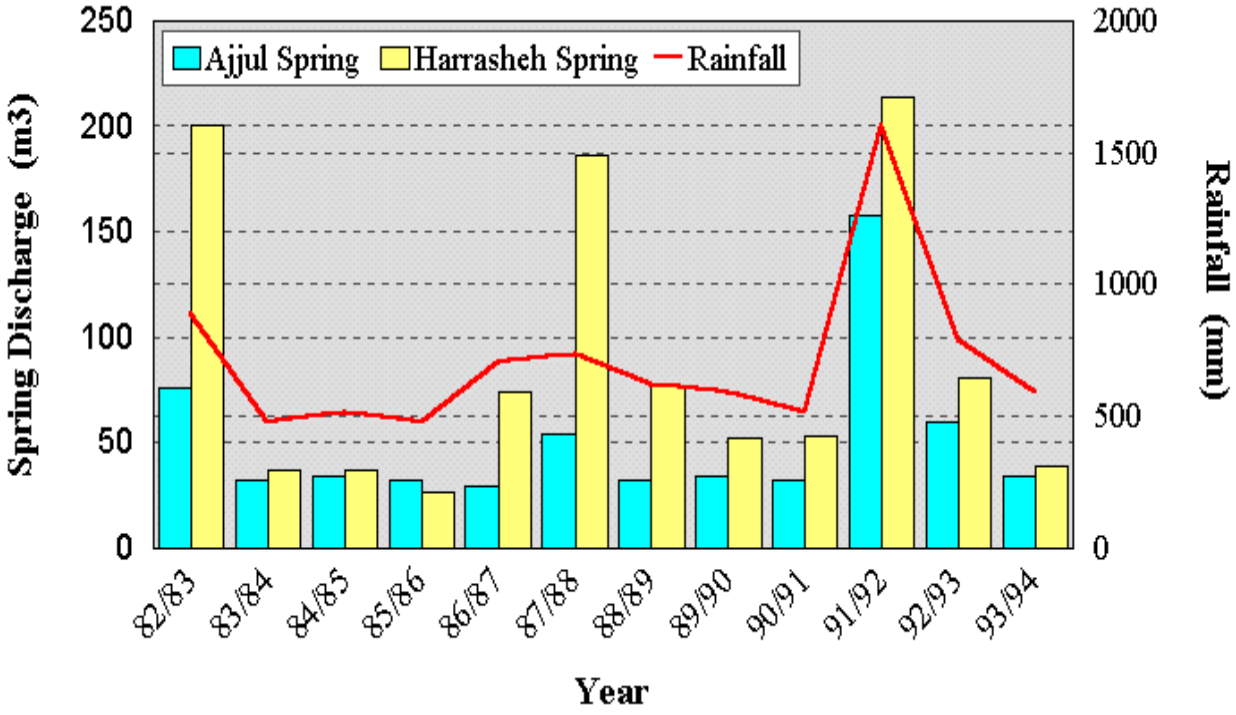


Figure 5.4: Variation in discharge of Ajjul and Harrasheh springs relative to rainfall, from 1982/83 to 1993/94.

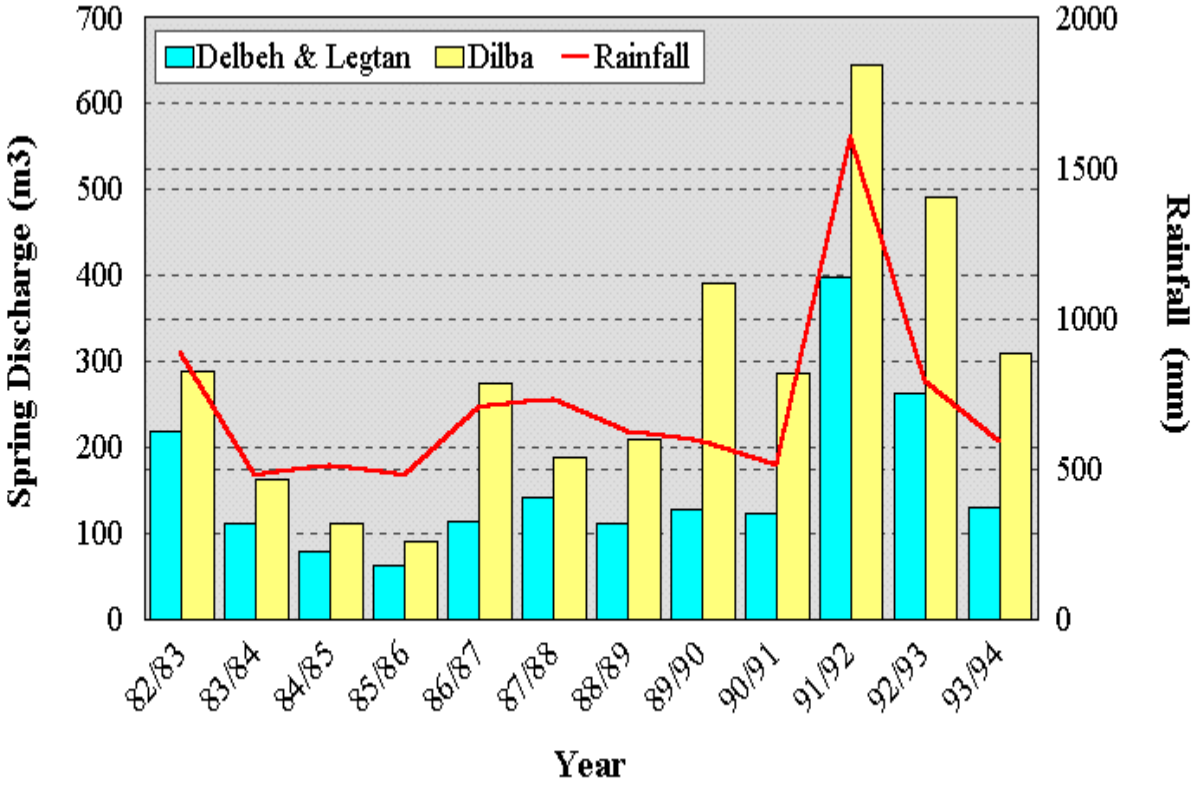


Figure 5.5: Variation in discharge of Delbeh & Legtan and Dilba springs relative to rainfall from 1982/93 to 1993/94.

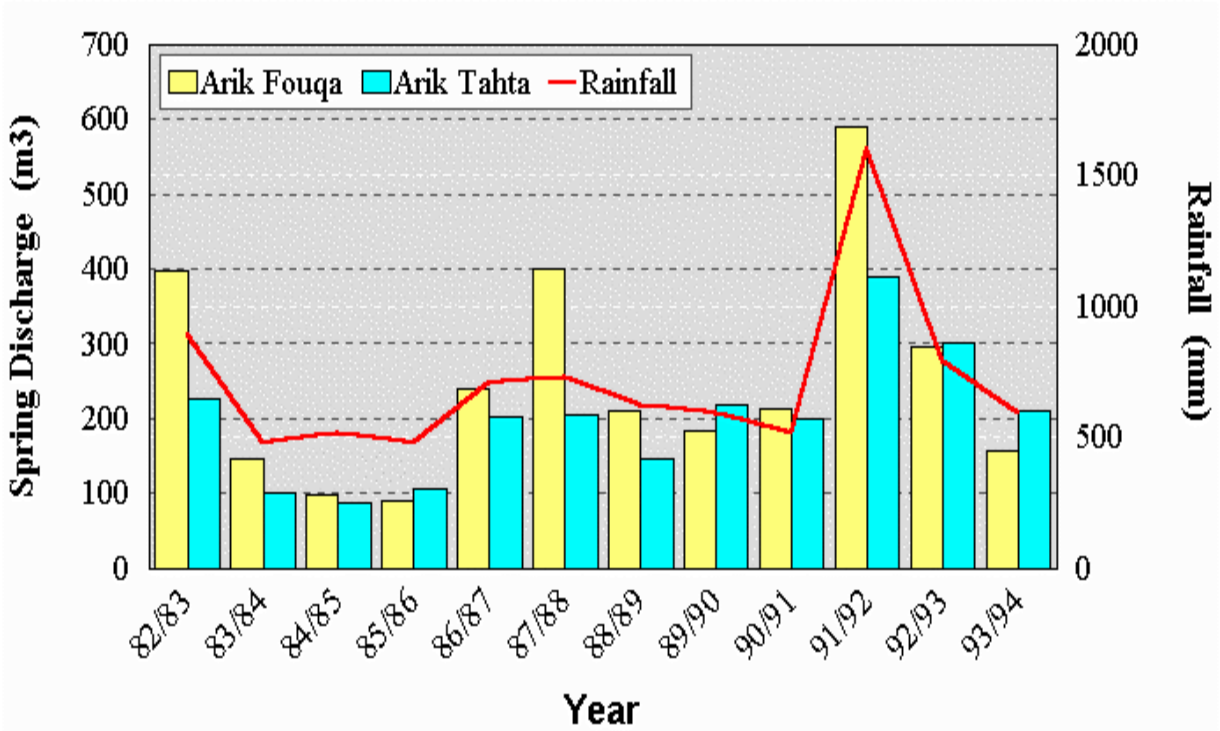


Figure 5.6: Variation in discharge of Arik Fouqa and Arik Tahta springs relative to rainfall from 1982/93 to 1993/94.

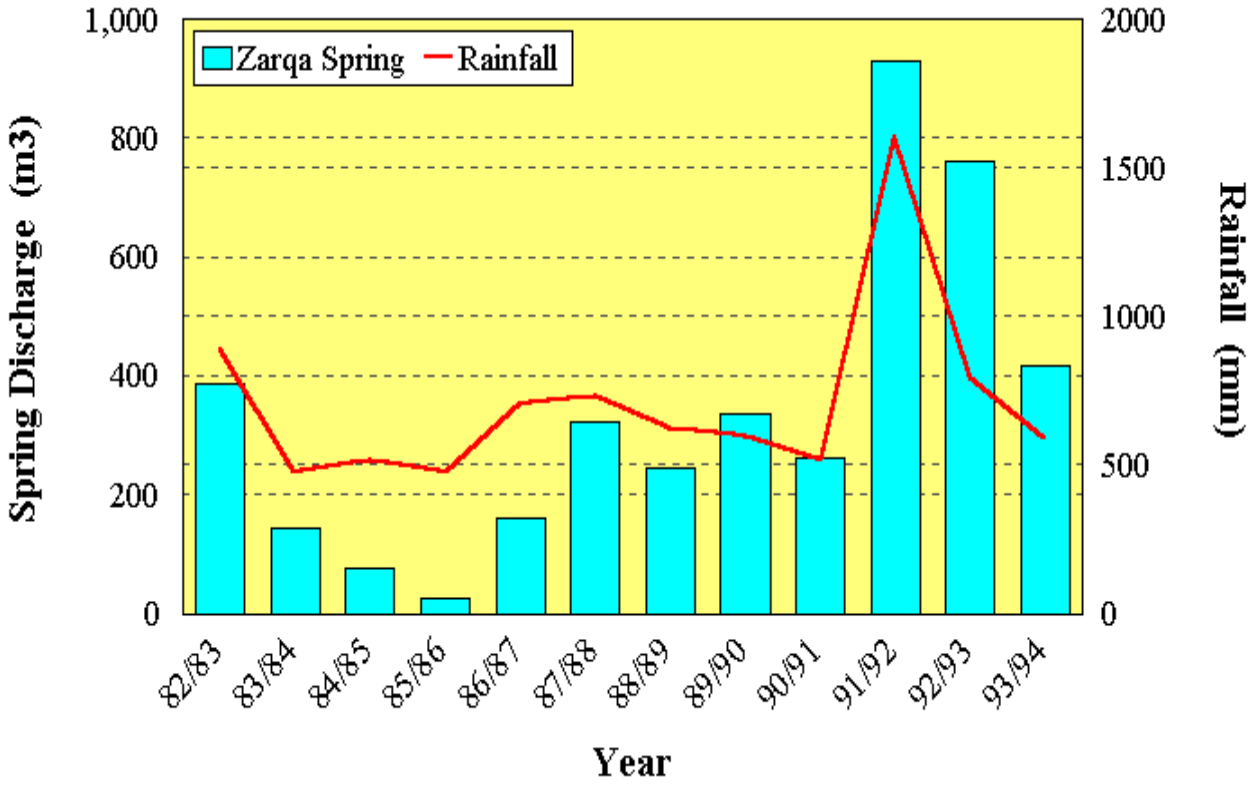


Figure 5.7: Variation in discharge of Zarqa spring relative to rainfall from 1982/93 to 1993/94.

Rainwater harvesting

Cisterns are widely used as a supplementary source of water supply in the Ramallah District. Most Palestinians use the rooftops of their houses as a catchment area to collect rainwater during winter time. This water is stored in cisterns of different volumes constructed underneath or next to the houses. The average capacity of the existing cisterns is 70 m^3. This source of water is very important to Palestinians all over the West Bank but more important to those Palestinians who are not connected to a water distribution system and where there is a shortage of water during the summer.


Photo 1: Mismanagement of E'in Jariout Spring in Bitunia.

Water Quality

Water is tested periodically by the JWU and the WBWD to insure the quality of the water supply. The chemical analysis is conducted at the Center of Environmental and Occupational Health Science at Bir Zeit University. Results of chemical and physical analysis indicate that the water fits within the parameters for drinking water.

Physical Water Quality Tests

These tests include measurements of the electrical conductivity (EC), hydrogen activity product (pH), total dissolved solids (TDS), and turbidity. Results are available for E'in Samia wells No.1, No.2, and No.3, Shua'fat connection and Ramallah station from five samples taken between 1991-1995. Table 5.2 shows the variation over time in electrical conductivity (EC) and total dissolved solids (TDS) for the E'in Samia wells, Shua'fat connection and Ramallah station.

Table 5.2: Variation over time in electrical conductivity (EC) and total dissolved solids (TDS) for the E'in Samia wells, Shua'fat connection and Ramallah station

Water Source	Date	pH	EC (mS/cm)	Turb-idity (NTU)	TDS (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)	K (ppm)	F (ppm)	Cl (ppm)	NO_3 (ppm)	SO_4 (ppm)	Hard-ness Mg Ca CO_3
E'in Samia No.1	Apr-91	7.79	526	1.8	263	54.57	26.7	-	-	0.22	30.08	21.3	12.57	245.87
	Apr-93	7.2	521	1.6	261	-	-	24.7	0.8	0.19	12	9.7	20	-
	Oct-93	7.57	527	1.5	264	44.8	30.8	-	-	0.1	21.5	-	-	238.7
	Oct-94	7.16	516	12.75	261	68.9	27.9	19.7	2.27	0.36	26.3	21.2	15.9	231.2
	Apr-95	7.5	524	0.45	265	63.8	21.5	15.46	3.9	-	23.5	18.62	13.74	275
E'in Samia No.2	Apr-91	7.74	508	0.3	254	54.57	22.7	-	-	0.2	35.3	15.99	8.9	239.78
	Apr-93	7.3	532	0.4	265	-	-	28.7	1.9	0.17	18	9.8	30	-
	Oct-93	7.48	508	0.45	254	41.9	42.1	-	-	0.1	26.4	-	-	277.7
	Oct-94	6.75	493	0.11	249	63.11	22.5	16.9	4.56	0.35	27.7	16.72	13.2	212.8
	Apr-95	7.48	509	0.08	254	58	21.2	16.48	2.62	-	35.1	14.72	11.97	265
E'in Samia No.3	Apr-91	7.45	585	0.3	291	60.27	22	-	-	0.26	30.08	13.37	12.77	280.42
	Apr-93	7.22	600	0.8	299	-	-	27.3	3.1	0.2	16	5.9	75	-
	Oct-93	7.34	589	0.65	292	45.8	38.7	-	-	0.1	20.5	-	-	273.7
	Oct-94	6.9	564	0.17	286	59.14	21.6	17.7	2.75	0.48	25.2	12.1	12.6	261.7
	Apr-95	7.65	571	0.09	289	63.1	30.9	15.98	1.54	-	21.6	10.46	10.04	338
E'in Samia No 4	Oct-94	7.15	602	0.24	304	65.3	32.6	18.5	1.73	0.48	25.2	8.6	14.6	275.9
Shua'fat Connection	Apr-91	7.5	873	0.5	445	63.52	30.5	-	-	1.11	165.54	10.89	11.16	302.09
	Oct-93	7.47	807	0.6	411	49.8	46.5	-	-	1.2	66.4	-	-	315.6

	Oct-94	7.14	561	-	280	69.6	28.4	-	-	0.35	32.8	15.3	14.8	249.5
	Apr-95	7.48	762	0.1	409	72.5	31	55.88	2.96	-	75.18	11.88	15.69	329
Ramallah Station	Apr-91	7.48	613	0.2	308	65.15	26.3	-	-	0.22	51.26	19.1	20.99	282.45
	Apr-93	7.28	586	0.8	293	-	-	29	2.7	0.18	14	8.9	25	-
	Oct-93	7.4	796	0.75	394	47.7	34.9	-	-	0.6	73.6	-	-	262.7
	Oct-94	6.89	560	0.96	281	72.1	36.7	20	1.78	0.38	29.8	16.4	14.4	246.5
	Apr-95	7.47	823	0.13	414	72.7	31	35.68	2.82	-	79.17	11.73	15.57	331

Chemical Water Quality Tests

These tests include routine chemical analysis of major cations and anions for E'in Samia wells and partial chemical analysis for chloride and nitrates in the Israeli wells and the major springs in the Ramallah District (Tables 5.2 and 5.3). Table 5.2 shows the variation over time of the major cations and anions of water in wells No.1, No.2, and No.3, Shua'fat connection and Ramallah station.

Diagrams and contour maps are used to model the hydrochemical data to identify the quality of the groundwater. The Wilcox diagram (1955) is used to classify water for irrigation purposes depending on the conductivity (EC) and the sodium adsorption ratio (SAR) values. The Wilcox diagram for water sources in the Ramallah District, E'in Samia wells No.1, No.2, No.3, and No.4 as well as the water purchased from Mekorot at the connection sites, is shown in Figure 5.8. The water of the E'in Samia wells has medium salinity hazard and low sodium hazard and is therefore suitable for irrigation. The external water sources received at Ramallah and Shua'fat connection sites have greater values of EC as they are located in the region of high salinity and low sodium hazard.

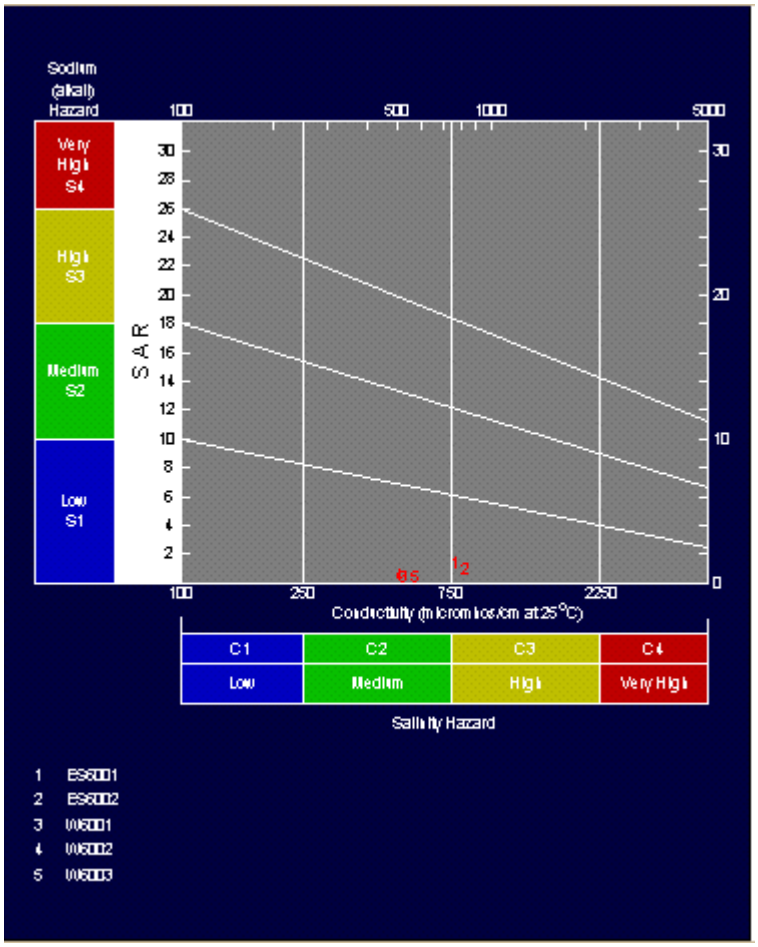


Figure 5.8

The Piper Diagram (Figure 5.9) identifies types of the water sources in the Ramallah District. The figure shows that all water sources are earth alkaline with prevailing bicarbonate except that of E'in Samia well No.2 and the water purchased from Mekorot. These two sources have earth alkaline water with prevailing bicarbonate and increased portion of alkalis.

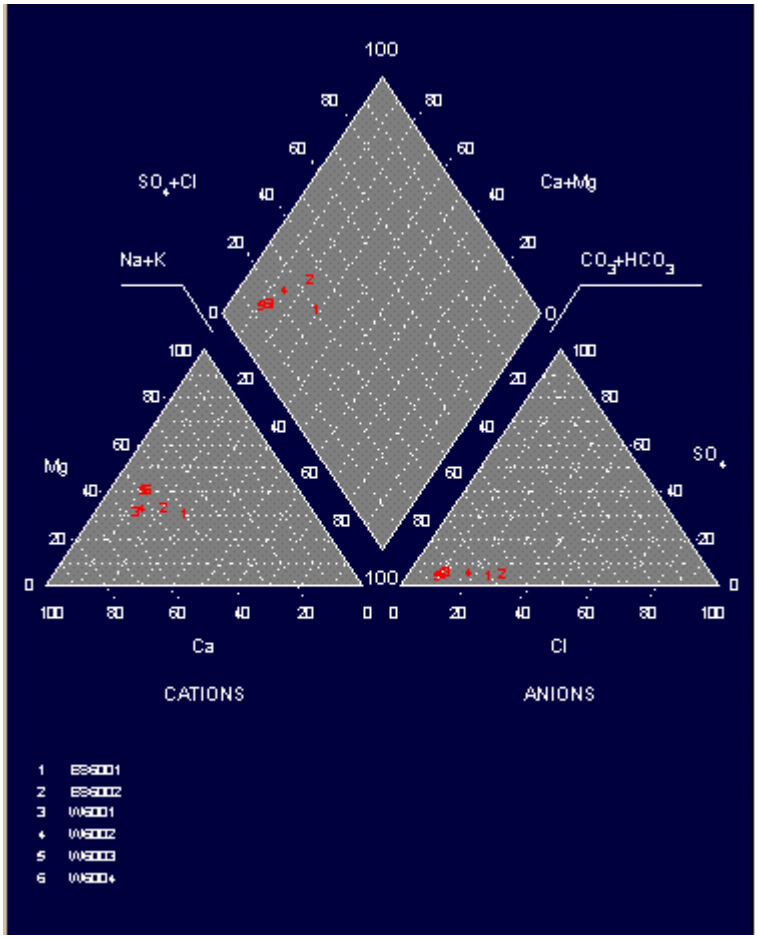


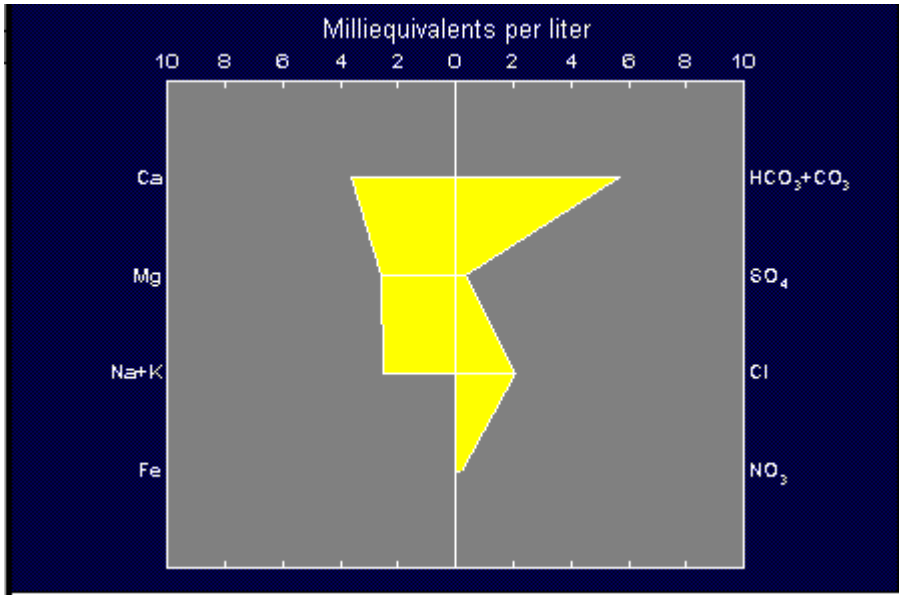
Figure 5.9

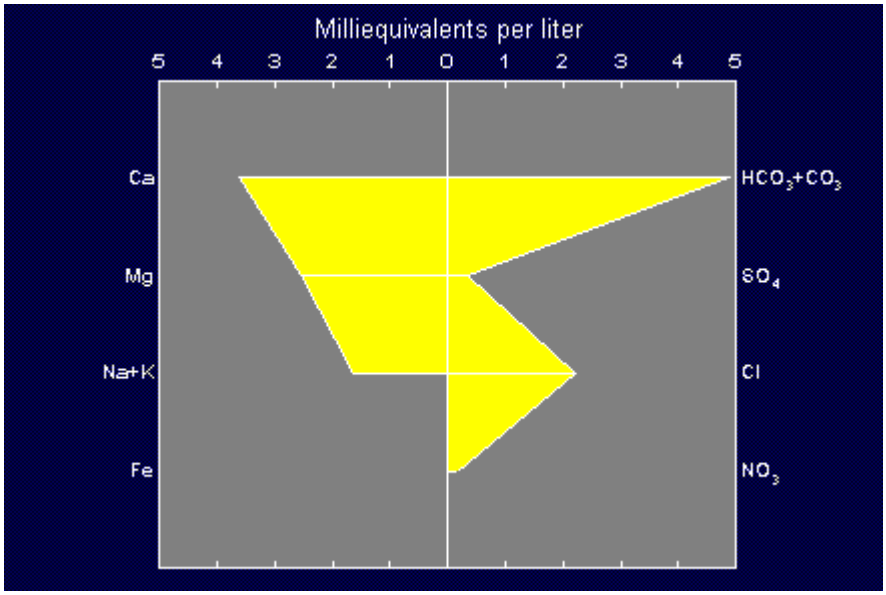
Table 5.3: Chloride and nitrates concentrations in the Israeli controlled wells and major springs in the Ramallah District

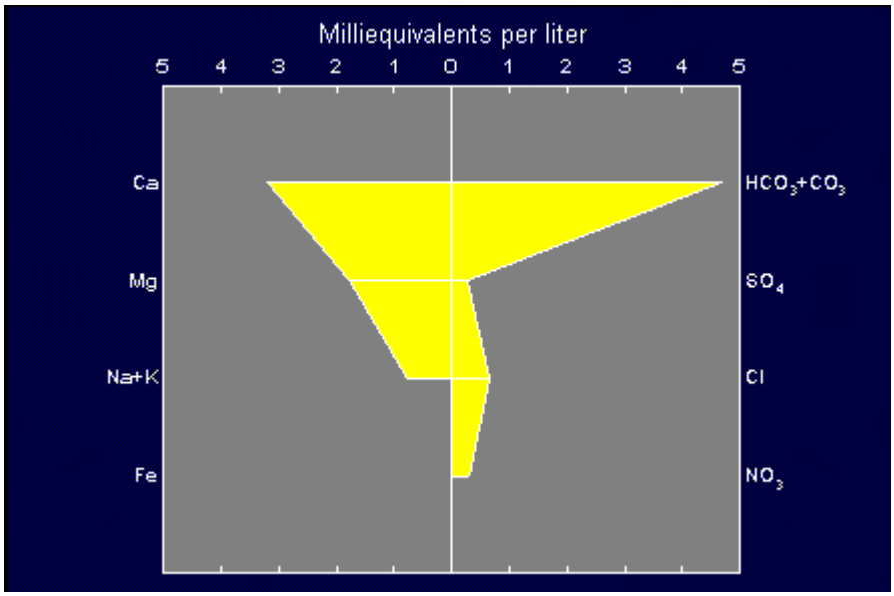
Source ID	Water Source	Cl(ppm)	NO_3 (ppm)
IW6001	Eshtaol No.6	137	9
IW6002	Eshtaol No.3	117	13
IW6003	Havi Yahuda	-	-
IW6004	Modiin No.3	40	9
IW6005	Modiin No.4	37	12
IW6006	Modiin No.2	40	14
IW6007	Modiin No.1	65	3
IW6008	Shebtin Levona	30	6
IW6009	Shebtin No.15	30	8
S6001	Ajjul Spring	41	39
S6002	Delbeh & Legtan	28.2	-

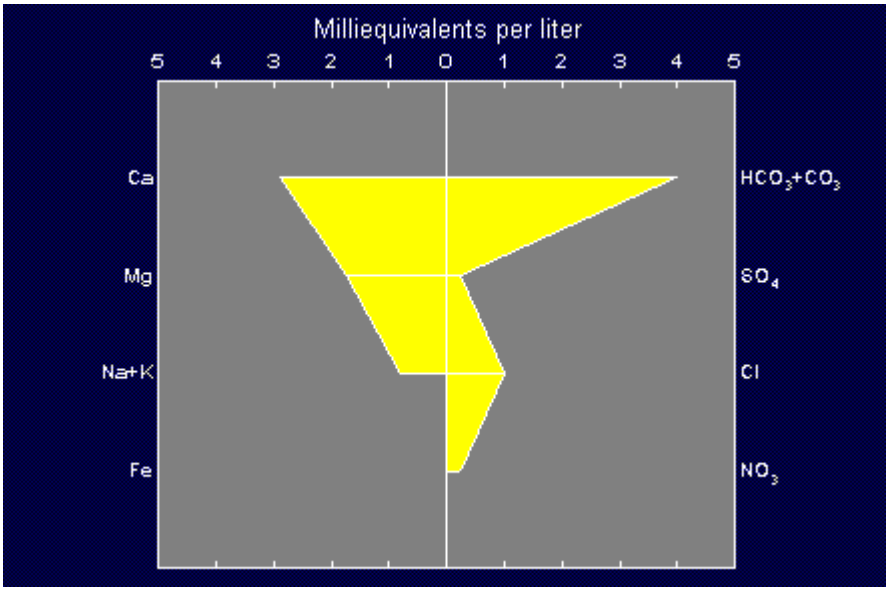
	Spring		
S6003	Zerqa Spring	28	3
S6004	Harrasheh Spring	22	1
S6005	Dilba Spring	25	4
S6006	Arik Fouqa Spring	24	1
S6007	Arik Tahta Spring	37	21
"Sources: Israeli Hydrological Services, 1995, Nuseibeh and Nasser Eddin,1995."			

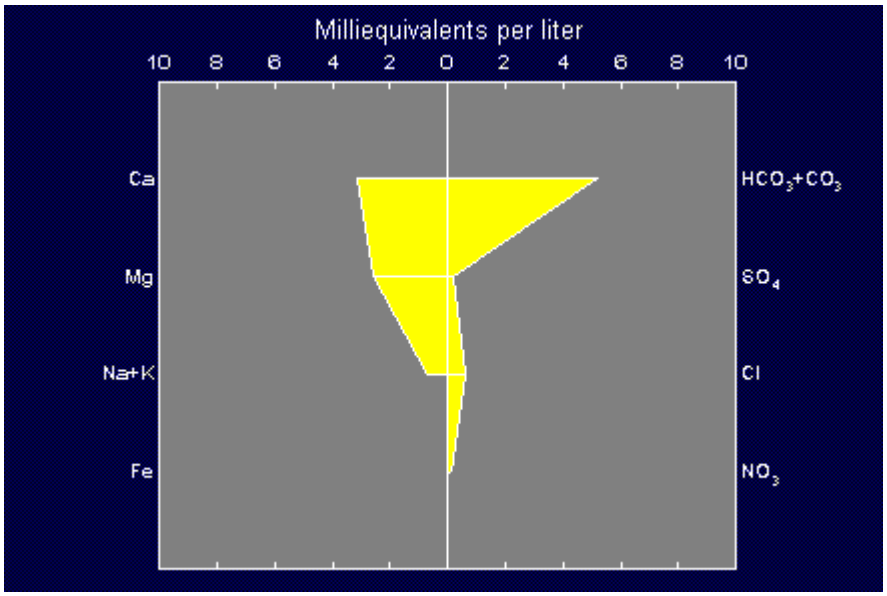
Figure 5.10 shows Stiff Diagram which classifies the water of E'in Samia wells No.1, No.3, and No.4 as calcium-bicarbonate, while that of E'in Samia well No.2 as sodium-bicarbonate.




Milliequivalents per liter
5 4 3 2 1 0 1 2 3 4 5
Ca
Mg
Na+K
Fe
HCO3+CO3
SO4
Cl
NO3


Milliequivalents per liter
5 4 3 2 1 0 1 2 3 4 5
Ca
Mg
Na+K
Fe
HCO3+CO3
SO4
Cl
NO3


Milliequivalents per liter
5 4 3 2 1 0 1 2 3 4 5
Ca
Mg
Na+K
Fe
HCO3+CO3
SO4
Cl
NO3


Milliequivalents per liter
10 8 6 4 2 0 2 4 6 8 10
Ca
Mg
Na+K
Fe
HCO3+CO3
SO4
Cl
NO3

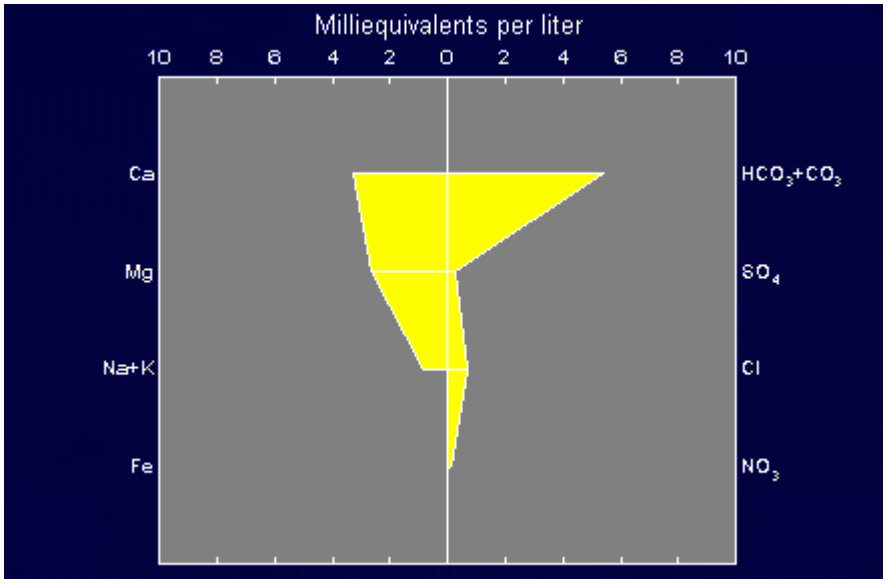


Fig (5.10): Stiff diagram

Contour maps of the chloride and nitrate levels in the Ramallah District are shown in Figures 5.11 and 5.12. Although the groundwater quality of E'in Samia Wells is better than that purchased from external sources (Mekorot & Jerusalem Municipality), the groundwater from all sources (E'in Samia domestic wells, that purchased from Mekorot, and the water from the major springs) in the Ramallah District meets the general standards for drinking water. This water does not need any treatment before being used.

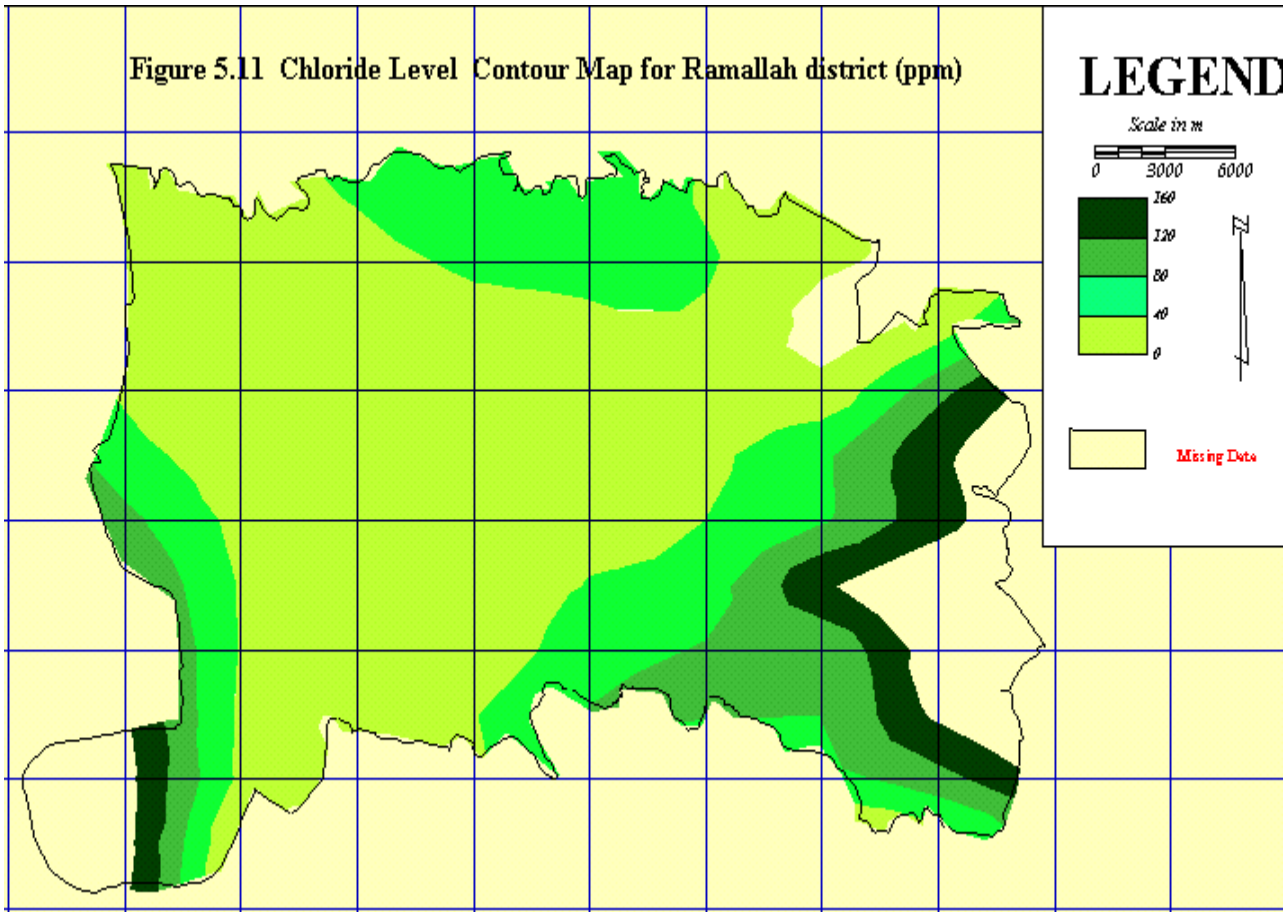


Figure 5.11 Chloride Level Contour Map for Ramallah district (ppm)
LEGEND
Scale in m
0
3000
6000
160
120
80
40
0
N
Missing Data

Figure (5.11)

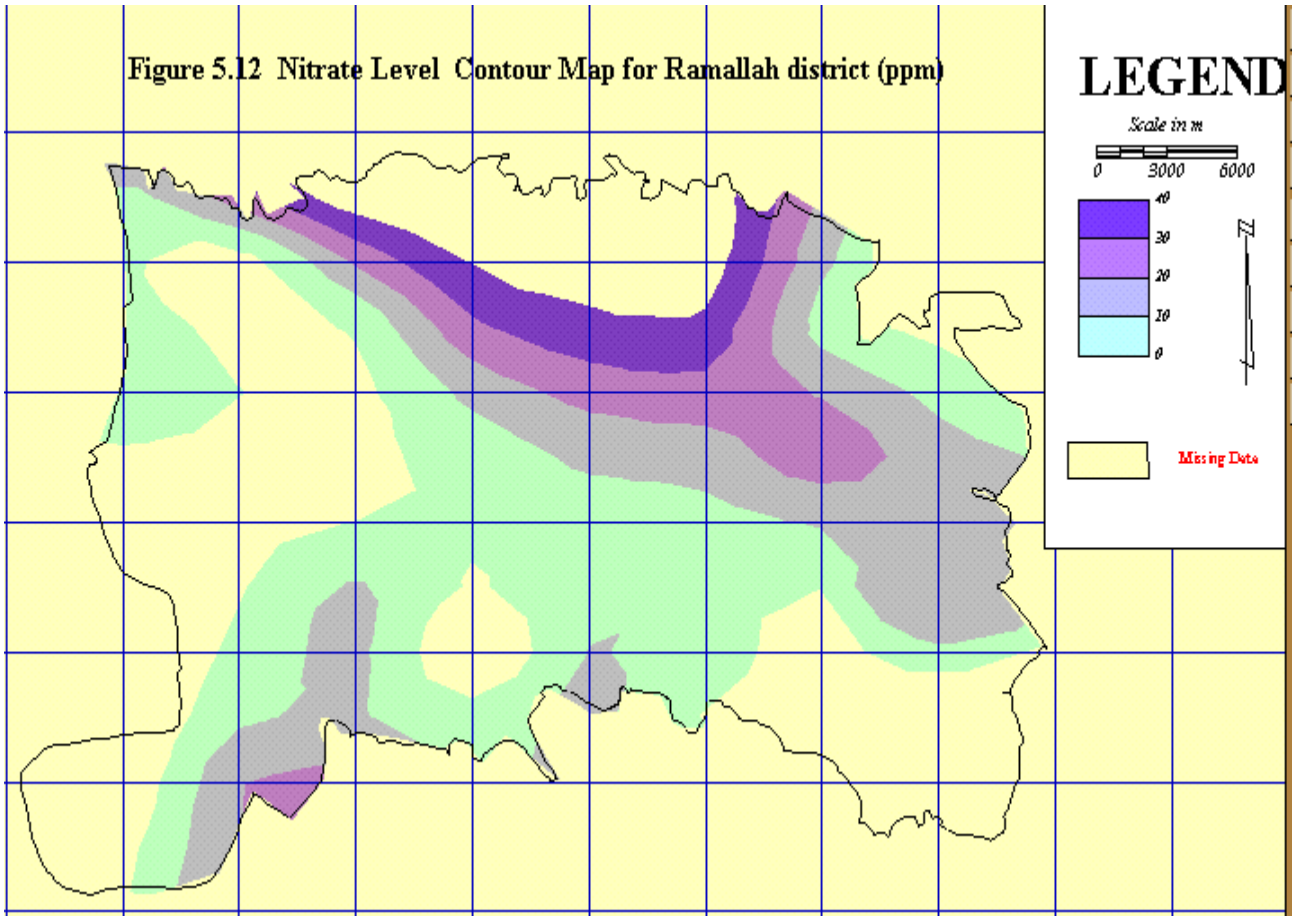
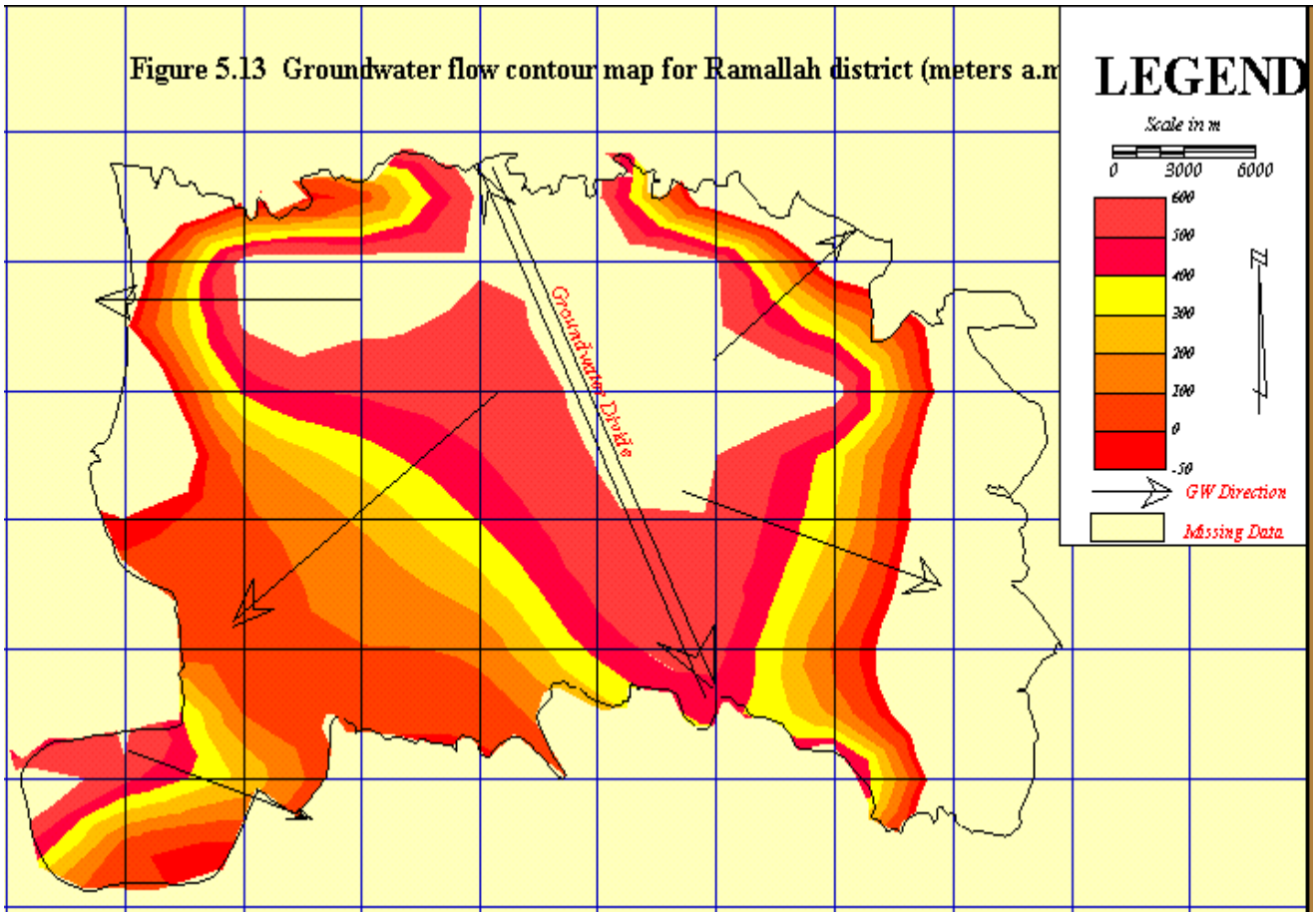


Figure (5.12): Contour map of nitrates

Groundwater Flow Pattern

Groundwater flows mainly in two directions in the Ramallah District, to the east in the areas underlain by the eastern groundwater basin such as E'in Samia wells field, and to the west in the areas underlain by the western groundwater basin (Mekorot wells).

The groundwater level contour map shows the groundwater flow and three zones of extensive pumping (Figure 5.13):



Fig(5.13): The groundwater level contour map

1. The E'in Samia wells field with groundwater flow direction to the east and the contours representing equipotential lines become closer as pumping occurred.
2. Shebtin wells and the two other Israeli wells located in the northwestern part of Ramallah District.
3. The Israeli wells located at the Latroun in the southwestern part of Ramallah District near the no-man land area. These wells tap the western aquifer system and their natural flow is to the west. The extensive pumping from these wells has caused the water to reverse its direction towards the southeast. Pumping in these wells should be reduced to avoid further damage of the groundwater system.

Water Supply & Demand

Water distribution in the Ramallah District is the responsibility of the Jerusalem Water Undertaking (JWU) and the West Bank Water Department (WBWD).

Jerusalem Water Undertaking (JWU)

The JWU distributes water to approximately 200,000 people including Ramallah and Al-Bireh cities, 44 villages in the Ramallah and Jerusalem Districts and 10,000 people from the Israeli military forces. Figure 5.14 shows the existing water distribution network controlled by the JWU. In 1994, approximately 66.3% (5.0 MCM) of the total water distributed (7.5 MCM) was purchased from Mekorot and the Jerusalem Municipality. The rest (2.5 MCM) of the distributed water was pumped from the E'in Samia wells.

West Bank Water Department (WBWD)

Shebtin Wells No. 4 and 5, controlled by Mekorot, are used to provide water for domestic purposes through the West Bank Water Department. These wells also serve 6 Israeli settlements and 22 Palestinian villages in the Ramallah District that are not connected to the water distribution network of the JWU.

The villages served by the WBWD constitutes 18% of the Ramallah District's population. Approximately 2.2 MCM of water are distributed by Mekorot through the WBWD. The total water quantity received from Mekorot either purchased and distributed by the JWU or directly distributed through the WBWD is 6.5 MCM (Mekorot, 1995). Table 5.4 shows the external water sources and the quantities of water purchased in the 1994.

Table 5.4: External water sources and the quantities of purchased water in 1994

Source	**Annual quantity (m3)**	**Connection Diameter**	**Connection Site**
Mekorot *	2,217,434	_	–
Mekorot **	4,282,566	16"	Ramallah
Jerusalem Municipality **	636,281	6"	Shua'fat
Jerusalem Municipality **	88,397	3"	Hizma
Total	7,224,678		

*Water distributed by WBWD
**Water distributed by JWU
Source: Jerusalem Water Undertaking and Mekorot

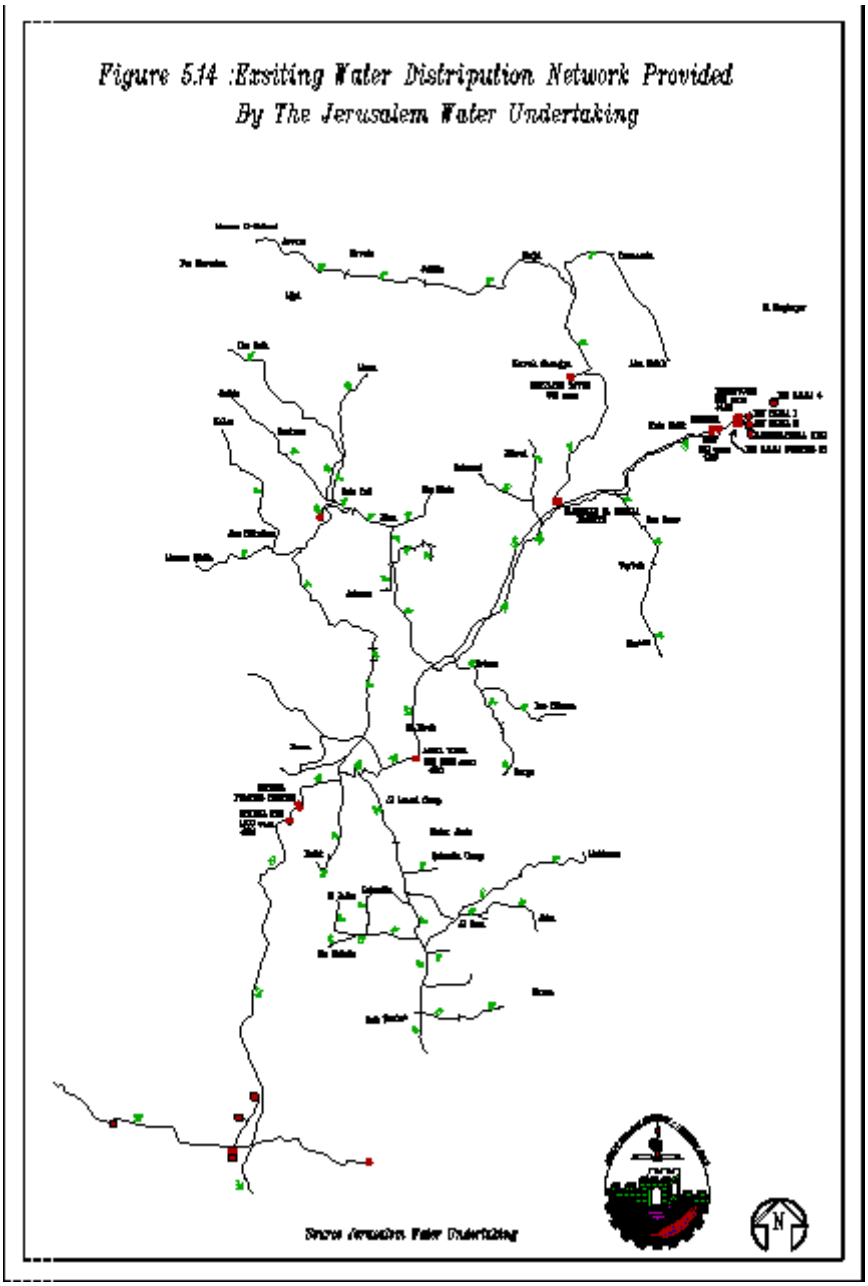


Figure 5.14 Water distribution network administered by the JWU

The water quantity consumed in 1994 can be summarized as follows:

- 7,244,678 m^3 were purchased from Israel sources and distributed by both JWU and WBWD.
- 2,548,567 m^3 were produced from E'in Samia wells.
- Additional unaccounted water quantities were consumed by some local communities of Ramallah District from cisterns and local springs.

In comparison, the Israelis pump 9,836,400 m^3 (Israeli Hydrological Services, 1995) from eight of their nine wells in the Ramallah area. This quantity equals the total water consumed by Palestinians in the Ramallah District in 1994, such over-pumping makes the water status very critical there.

Table 5.5 shows the water supply & demand projection for the years 2000, 2010, 2020 depending on 1990 baseline data consumption taking into consideration that the growth rate of population in the years 2000, 2010, and 2020 are 3.1%, 2.4%, and 1.5%, respectively.

Table 5.5: Water supply & demand projections for the years 2000, 2010, and 2020 using 1990 baseline data consumption in MCM.

Purpose	**1990 Baseline Consumption**	**2000**	**2010**	**2020**
Household	8.4	13.31	24.21	39.41
Agriculture	0.5	2.2	9.6	17.00
Industry	0.6	01.50	3.0	05.00
Total	9.5	17.01	36.81	61.41

In the "Oslo II" agreement and for the interim period, It is agreed that the Israelis should provide the Palestinians in Ramallah District with an additional amount of 0.5 MCM/yr. The Palestinian Authority will be responsible of developing the Eastern Aquifer System to provide the districts of Hebron, Bethlehem and Ramallah with 17 MCM/yr additional water supply.

Water Costs & Prices

The cost of water distributed by JWU is dependent upon the source.

1. Water purchased from Mekorot costs 0.64 $\$/m^3$.
2. Water purchased from the Jerusalem Municipality costs 0.69 $\$/m^3$.
3. Water produced from E'in Samia wells costs 0.47 $\$/m^3$.

JWU currently implements a tariff with a unit price increasing with the increase in consumption. Table 5.6 shows the tariff on solid water quantities.

Table 5.6: Tariff of sold water quantities	
consumption (m^3/2 months)	**Tariff applied ($/$m^3$)**
Min Charge up to 10	$ 12.66 per bill
10-20	1.0
21-40	1.05
>41	1.5

Distribution Network

The original network was laid by Ramallah/Al-Bireh water company in the early fifties. Unfortunately, the pipes used did not meet the standard specifications. Generally, second hand pipes of only two inches in diameter were used. The network mostly constructed for individual consumers and not for complete streets or areas. The result of this lack of standards for network construction, is a complicated network that is extremely difficult and costly to maintain.

The present network in the main cities and villages consists of pipes connected in rings as a circulation system. By the end of 1995, the total length of the distribution network including all the different size of pipes was 749,426 meters. Table 5.7 shows the lengths and pipe sizes of pipes used in the network at the end of 1994 and 1995 (JWU, 1995).

Table 5.7: Lengths of different size pipes in the distribution network at the end of 1994 and 1995.					
Size in inches	**Length in meters**		**Size in inches**	**Length in meters**	
	1994	**1995**		**1994**	**1995**
1/2	3876	3885	5	7368	7368
3/4	95327	99212	6	32713	3661 4

1	175389	184363	8	3998	3998
1 1/2	54536	55211	10	23426	23426
2	208894	218356	15	2652	2652
3	49853	51725	16	16370	16370
4	46246	46246	Total meters	720648	749426

Water losses

Water losses were estimated by the JWU in 1994 at approximately 25%. The total water distributed by JWU was about 7,555,811 m^3 whereas the sold water was 5,667,466 m^3 which means a loss of approximately 1,888,345 m^3 (JWU, 1995). The losses occurred through leaks in the main pipelines, the distribution network and the meters. It is also known that some water is taken illegally. No information is available from the WBWD about water losses in the network.

Reservoirs

There are 11 reservoirs in the Ramallah District under the jurisdiction of JWU. Taweel No.1 and Taweel No. 2 reservoirs are the main ones. Table 5.8 gives the information about each reservoir.

Table 5.8: Information on water reservoirs in the Ramallah District.

No	Reservoir	Capacity (m^3)	Elevation (m)	Shape	Construction year	Site
1	Taweel 1	6000	910	Rectangular	1965	Al-Bireh
2	Taweel 2	10000	900	_	1989	_
3	Ramallah Ground	492	885	_	1960	Ramallah
4	Ramallah Elevated	60	900	Square	1960	_
5	E'in Qinya	300	600	Rectangular	1955	E'in-Qinya

6	Kafr A'qab	150	765	_	1950	Kafr A'qab
7	Al-Mazra'a Esh-Sharqiya	300	963	Square	1981	Al-Mazra'a
8	Main Station	500	446	Circular	1989	E'in Samia
9	Booster Station 1	40	700	Square	1965	_
10	Booster Station 2	500	700	Circular	1985	_
11	Bitunia	1000	804	_	_	Bitunia

Photo 2: E'in Samia reservoir

Conclusions and Recommendations

- The water status in the Ramallah District is very critical as the demand for water is high and expected to increase rapidly in the future. Ramallah and Al-Bireh cities are

considered the commercial center for Palestinians, and therefore the demand on water will increase as investors choose to live and invest in Ramallah.

- Water shares between Israel and Palestine should be reexamined as Israel pumps a great deal of water from Ramallah District. Their discharge is equal to the water consumed by the whole population in the District. This water is needed for development of the Palestinian agriculture, industry, economy and society.
- Rehabilitating and building water collection and storage units to collect excess water, to regulate flow, facilitate spring use, and prevent waste of water.
- Pumping of the Israeli Wells located at the Latroun in the southwestern part of Ramallah District near the no-man's land area, should be reduced to avoid further damage of the ground water system.

Chapter Six
Agriculture

In terms of agriculture, Ramallah District is impressively diverse in the types of crops produced. This is due to the diversity in the climate and growing conditions within the district.

Agro-climatic Conditions

The district's total agricultural area is estimated at 2,3831.1 hectares during the 1993/94 growing season. This area encompasses three distinctive agro-ecological zones within the regions of the Eastern Slopes and the Central High Lands (Ramallah Agricultural Department, 1994). The altitude of the eastern region ranges from 0 to 200 m above sea level, and rainfall is minimal, only 200 to 400 mm, therefore, agricultural production is limited. The topography of the central region rises westerly from 200 m to more than 1000 m above sea level. Average rainfall in this area ranges between 400 and 700 mm per year, making it quite suitable for rainfed agricultural production. The western area descends gradually to almost 500 m above sea level at the western border of the district and receives 500 and 600 mm of rainfall annually, making it also suitable for rainfed agriculture (see Figure 6.1).

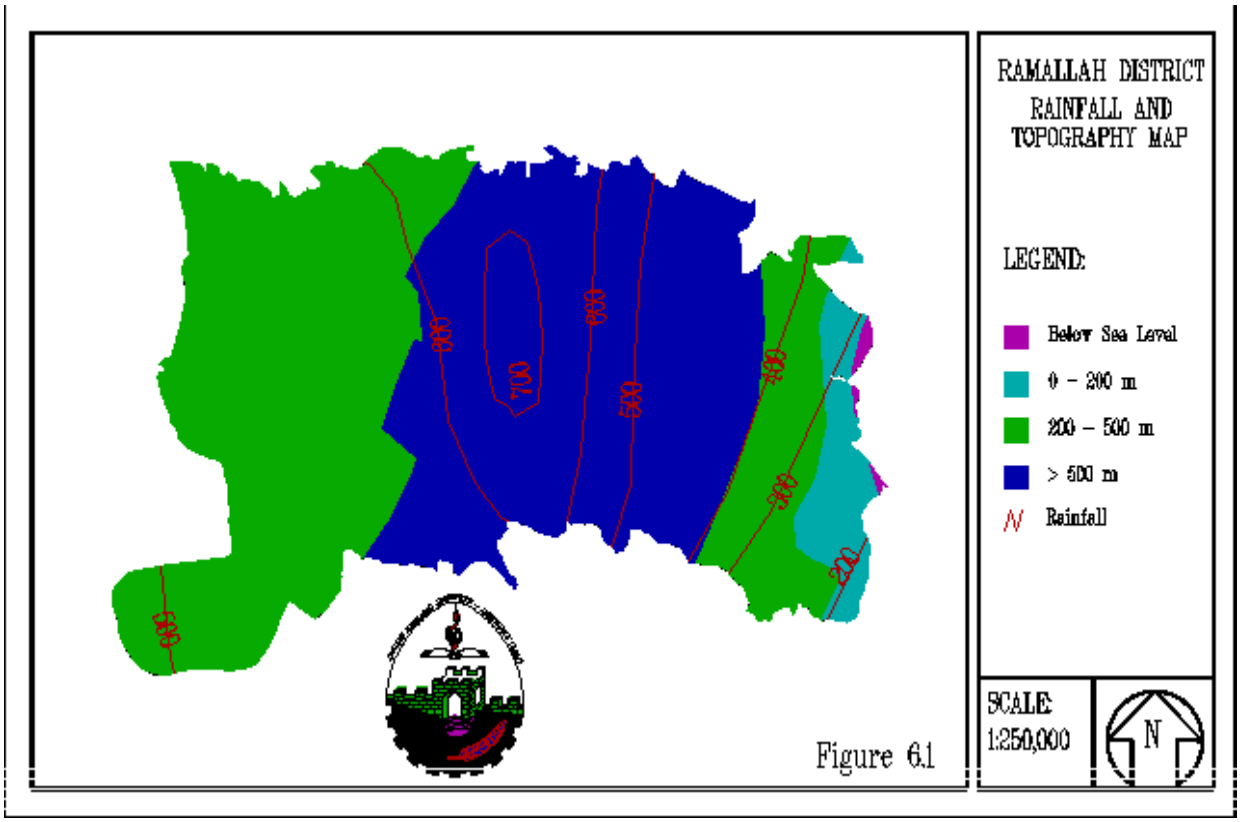


Figure 6.1

Plant Production

Rainfed agriculture is dominant throughout the district, comprising 99.6%, (23737.7 hectares) of the total cultivated area in the 1993/94 growing season. The size of the cultivated area varies yearly depending upon the climatic conditions, especially with the start of the rainy season, which has a dramatic effect on the success of field crops, forages and vegetables. Only 93.4 hectares of the total cultivated area were devoted to irrigated agriculture in 1993/94 (Ramallah Agricultural Department, 1994).

The total plant production in the 1993/94 growing season was approximately 34,954.2 tons. Fruit trees occupied the largest area and have the highest yield by weight. Fruit accounted for 79.7% of the total cultivated area and 78.3% of the agricultural production. Field crops and forages accounted for 17% of the total cultivated area and 12.4% of the agricultural production. The remaining area and production were devoted to vegetables (Figure 6.2).

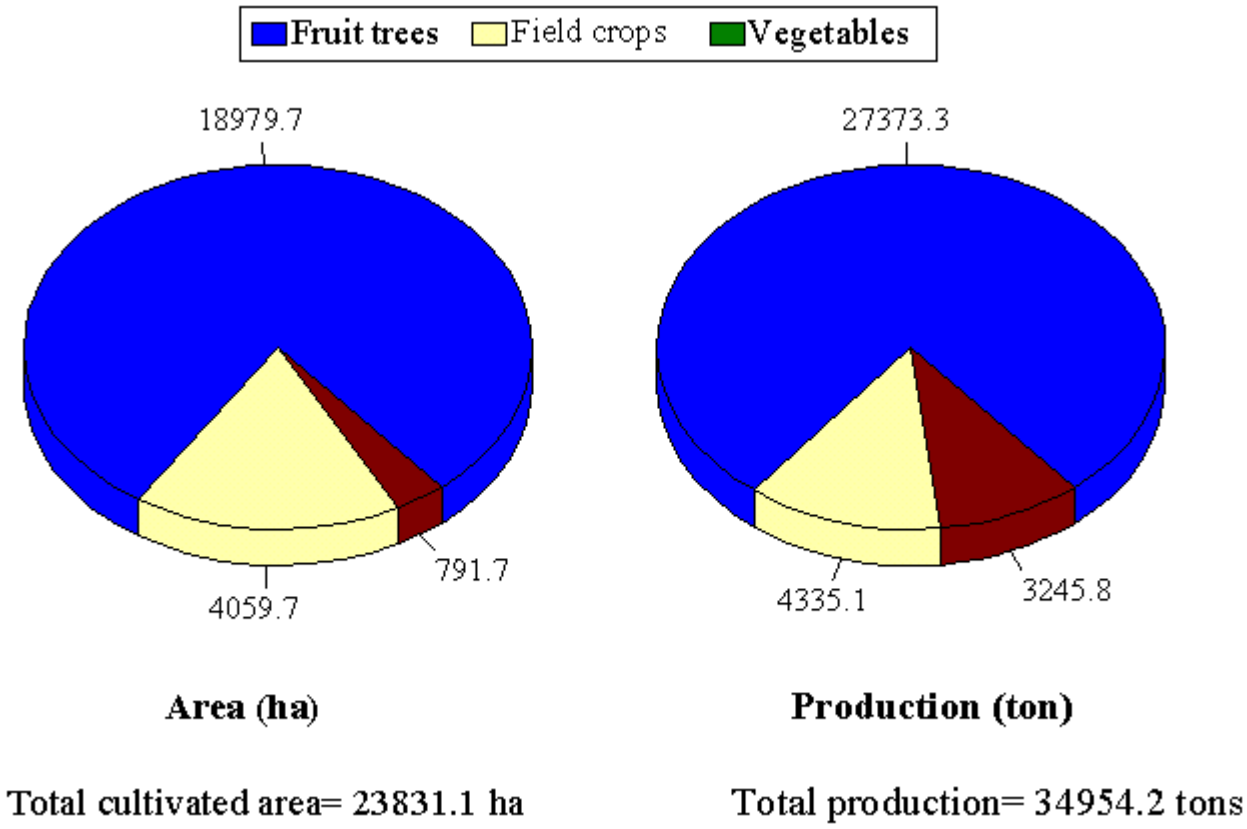


Figure 6.2: Total cultivated area and production of different cropping patterns in the Ramallah District for the 1993/94 growing season.

Fruit Trees

Almost all fruit trees are grown under rainfed conditions (18,959.6 hectares), only 20.1 hectares are used for irrigated fruit trees. Most of the cultivated fruit trees are located in the central mountains, though some are found in the western region, and very few in the eastern region of the district. The production during the 1993/94 growing season was 27,373.3 tons, rainfed cultivation contributed approximately 99.5% of the total production (Figure 6.3).

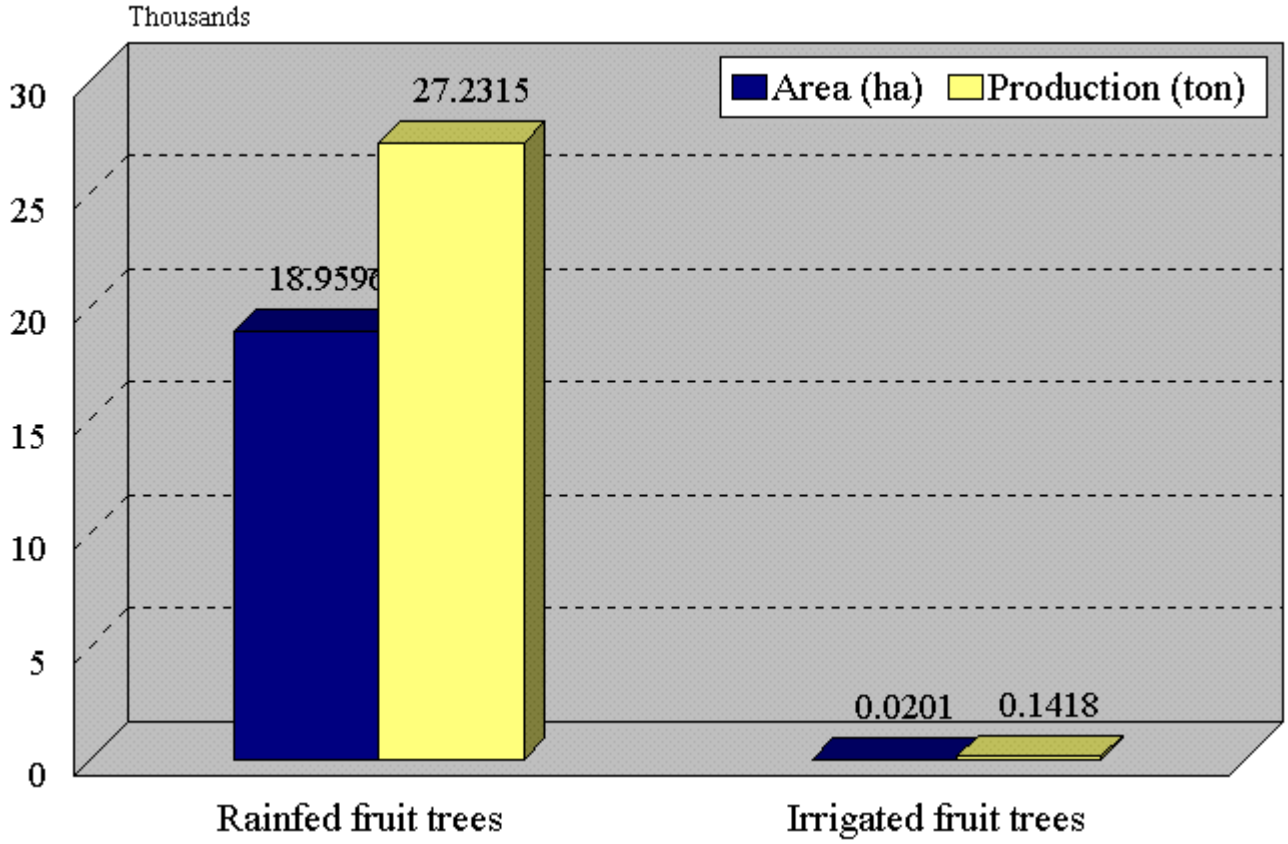


Figure 6.3 Total area and production of fruit trees under rainfed and irrigated cropping systems in the Ramallah District for the 1993/94 growing season.

Irrigated orchards of fruit trees are found on small areas of land in few villages. Lemons occupy the largest area with 12 hectares, followed by other varieties such as pomegranates, oranges, and guavas. The total production of irrigated trees was 142 tons with an average productivity of 5,500 kg per hectare for pomegranates and 9,000 kg per hectare for guavas.

Olives are the dominant fruit trees grown, occupying approximately 80.1% of the area devoted to fruit trees and 63.8% of the total cultivated area in the district. Olive trees are heavily cultivated in the central region, less in the western area, and sparsely planted in the east. The dominance of olives in the district can be explained by the following factors:

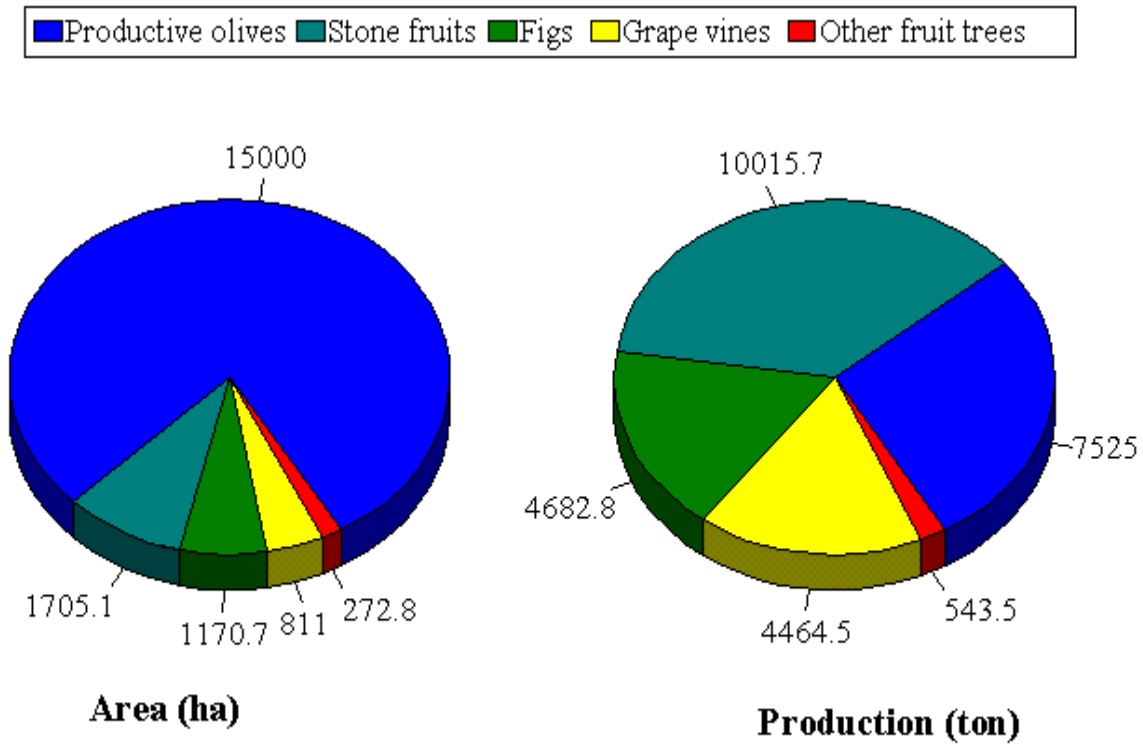
- The mountainous and rocky topography of the central and western regions make it difficult to plant and cultivate field crops, forages and vegetables;

- Since the most active roots of olive trees are concentrated in the first meter depth of the soil, they adapt well to the mountainous conditions of the West Bank, yielding well when rainfall is good;

- Palestinians have a historical attachment to olive trees. It is still possible to see trees which are hundreds years old and still producing;

- Due to the longevity and sentimental value of olive trees, it is often used as the tree of choice when land is being planted to prevent it from being confiscated by Israeli settlers or military authorities.

However, approximately 1.3% of the area planted with olives is covered with unproductive trees. Furthermore, in spite of their large area, olives contribute just 27.5% of the total production of fruit trees. This low production is, in large part, due to three factors: the alternative bearing phenomenon in the olive trees, where they bear heavily in one year and very little in the next; the old age of many trees in the district; low maintenance by farmers, especially in terms of soil cultivation, fertilization and the pruning of trees (Figure 6.4).



Total cultivated area = 18959.6 ha

Total production = 27231.5 tons

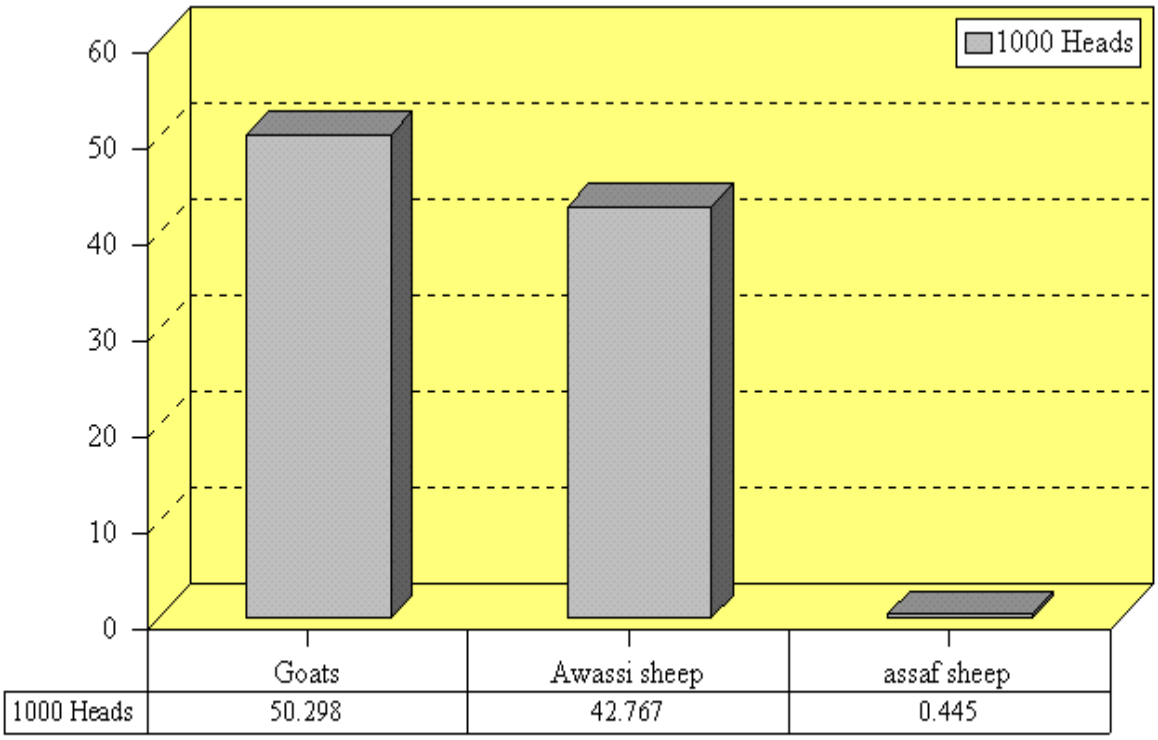
Figure 6.4: Total area and production of different rainfed fruit trees in the Ramallah District for the 1993/94 growing season.

Photo 3: Olive plantation in the Ramallah District.

Stone fruits, including plums, almonds (hard and soft), peaches, and apricots, are the next prominent with a total area of 1,705.1 hectares and a total production of 10,015.7 tons. Although, stone fruits covered only 9% of the total area of fruit trees, they produced approximately 36.6% of the total fruit production in the 1993/94 growing season. The productivity of stone fruits is generally high. Amongst stone fruits, plums are the most productive, averaging 9,700 kg/hectare, while soft almonds have the lowest productivity with just 900 kg/hectare (Ramallah Agricultural Department, 1994).

Fig trees covered an area of 1,170.7 hectares and produced 4,683 tons in the 1993/94 growing season. The average productivity of figs was relatively high, at 4,000 kg/hectare.

Grapes are not widely grown in the Ramallah District, covering only 811 hectares. Most of these vines simply run on the ground (810 hectares), only small area is planted with a trellis training system. Grape on trellis produces approximately 10,000 kg/hectare annually, compared to 5,000 kg/hectare for ground grapes. However, ground grapes have v130 liters of milk annually, and is capable of bearing twins in up to 80% of births. While Shami and hybrid goats can produce 270 liters of milk annually and produce twins in more than 90% of the births, the costs of feeding and management are much greater than for the local breeds. Thus the number of Shami and hybrid goats continues to be low, throughout the West Bank (Abo Omar, 1991).



Total number= 93,510 heads

Figure 6.8: Total number of sheep and goats in Ramallah District in 1994.

Poultry

There are approximately 545 farms of broilers in the Ramallah District, with an average capacity of 1,689 birds per round. Four rounds are reared during the year. The number of broiler chicken produced in the Ramallah District was around 3,681,500 in 1994.

There are approximately 160 layer farms, with an average capacity of 1,637 hens (Ramallah Agricultural Department, 1994). The total number of laying hens are estimated at 236,000 of which 72% are old enough to produce eggs (PARC & Arab Thought Forum, No.2, 1994).

Apiculture

There are approximately 4,565 beehives in the district, of which 4,129 are modern hives and the rest are traditional (old) hives (Ramallah Agricultural department, 1994). Of the total number of hives, 63% have local bees (Baladi), while the rest have the Italian

variety or hybrid varieties. On average, local bees produce 2.5 kg/year of honey, while Italian and Hybrid bees produce 11 kg/year. The total production of honey was 23,308 kg in 1994. Approximately 62% of the produced honey is sold in the West Bank and Gaza Strip, and the rest is sold at the site of production (PARC & Arab Thought Forum, No.3, 1994).

Agricultural Institutions

Ramallah Agricultural Department

The Ramallah Agricultural Department in Ramallah city, is a governmental department that provides extension services for farmers, especially in the areas of plant and livestock production. Occasionally, they are responsible for the distribution of free agricultural materials such as seeds, fertilizers, or vaccines to the farmers. There is also a veterinary section which provides all kinds of assistance for livestock production, such as, disease control and farmers training on new methods of livestock management.

Agricultural Cooperatives

A number of organized agricultural cooperatives specialized in particular products or activities (such as a beekeepers cooperative, or agricultural marketing cooperative) exist in the district. Their main target is to facilitate agricultural activities and marketing.

Other Agricultural Institutions

Non-governmental organizations (NGOs) such as PARC, MA'AN Center, the Bir Zeit Literacy Center and the Agricultural Services Center are also active in the area. They are especially focused on activities such as: the environmentally sustainable development of agriculture, especially through the adaptation of permaculture; improving the productivity of the land through more modern agricultural practices; improving farmer standards of living, and literacy; and the role of rural women in rural development and agriculture. Other centers such as the Birzeit Center for Occupational and Environmental Health and Science (COEHS) are involved in chemical analysis of water and soil and testing the pesticide toxicity levels in people.

Problems and Future Prospects

- The small size of land holdings, reaches to less than one hectare per farmer in the western region of the district, obviously, limits the potential productivity of farmers even under optimal conditions of the most intensive farming practices.

- The price of agricultural inputs is quite high, and almost all production and wholesale distribution are controlled by Israel. This explains why farmers tend to use limited amounts of inputs.

- Mechanization is not widely used to maximize production and improved seeds are not easily available to farmers in the market. Evidence to this is that the production of field crops and forages falls far below the market demand in the district, with the large majority of these products being imported from Israel and other countries.

- While fruit trees have good production potential, there have been problems in their marketing, especially during the closure of the Palestinian Territories to Israel. Markets to Jordan are also limited by Israeli authorities.

- Currently, there is no system to protect the farmers from agricultural losses. This system of protection is especially important in transitional periods when the access to surrounding markets is unpredictable. Without this protecti Environmental Profile for the West Bank (Vol4) - Chapter 7: Historical And Archeological Sites

Chapter Seven
Historical And Archeological Sites

Historical Background

Ramallah is a Palestinian city located 13 km to the north of Jerusalem. It extends over several hills with an altitude of 872 meter above sea level. More than one story explains the naming of Ramallah with its present name. One story attributes the derivation of the name to that Ramallah is built on a place "Ramtaem Sofeem" which is mentioned in the Old Testament where the Nabi Samuel born. Other story says that the name Ramallah is composed of Ram, an Aramaic word meaning hill or high place, and Allah, the Arabic word for God. Therefore, the name of Ramallah was originally either Ram or Rama, which lasted until the time of Muslim conquest in the seventh century. When the Arabs came to Rama, they seem to have added Allah to either Ram or Rama, and the site became known as Ramallah. Aramaic was the language of the people of Palestine from 400 B.C. up to the end of the Byzantine period in A.D. 640. Since the word Ram is Aramaic, the site of Ramallah was probably first settled by Aramaic speaking people prior to A.D. 640. So, it seems that prior to the Muslim conquest, Ramallah was temporarily settled from time to time throughout the centuries by inhabitants who lived there a while and then left. It may have became a permenant village in the sixteenth century, when the Haddad family who lived in the vicinty between Karak and Al-Shoubak came and settled in Ramallah (Shaheen, N. 1992)

Ramallah city served as an important crossroad in the ancient times and in the present between Jerusalem and Nablus, and from Ramallah to Jericho and the Jordan Valley. A number of prehistoric sites and Bronze Age tombs have been found in and around the city. Ras et Tahuna, within Ramallah city bounderies, is a hill which was inhabited in the Chalcolithic and in the Early and Middle Bronze Ages, in the Iron Age, Persian and Arab Periods.

Historical Sites

1. A'aboud:

A Palestinian village 17 km northwest of Ramallah. It has a Greek Orthodox church built on the foundations of a 5th century church, and has been renovated in the 11th century. Ancient masonary is reused in the village buildings. The confines of the village has other remains of Byzantine churches and monastries (Al-Dabbagh, M. 1991).

2. A'jjul:

A Palestinian village located 13 km north of Ramallah. The site contains rock-cut tombs and remains of buildings. The sherds found in the site indicate human settlements from the Iron Age to the Ottoman period

Within close proximity of Ajjul the following sites are found:

Khirbet Ein Meshraqa: It is located to the east of A'jjul, and has remains of an old building, a wine press, cisterns and rock-carved tombs (Al-Dabbagh, M. 1991).

Khirbet Jerwan: Located near Ajjul village and has remains of old buildings, oil press and a locality of Al-Sheikh Abed (Al-Dabbagh, M. 1991).

3. Beittin:

A Palestinian village located 4 km northeast Ramallah city. It is located on the site of the ancient city known as Beit-Eil which is thought to be the place where Yaqoub laid down to sleep and dreamed of a ladder ascending to heaven with angles going down and up. Upon awakening, Yaqoub built an altar and named the spot Beit-El " House of the God". The remains of Burj Beittin, an ancient settlement, are within the village boundaries. The found sherds indicate inhabitancy in the Roman, Byzantine, and Crusader periods. It is also has the remains of a partly preserved Crusader basalt-stone fort, monestary and church. (I.M.D. & Carta 1993).

4. Bitunia:

A Palestinian town 4 km southwest of Ramallah city. It may be the site of the biblical town of Beth-aven. Remains of buildings, pools and Medieval mosaic fragments are found (Al-Dabbagh, M. 1991; I.M.D. & Carta 1993).

The surrounding area has the following sites:

Khirbet Bir ed Dawali: A large Roman-Byzantine hamlet, 4 km southwest of Ramallah city. Remains of structures are scattered over the place, including a tower, a pool and water cisterns (I.M.D. & Carta 1993).

Khirbet Al-Mayta: Remains of a church, columns, ruins of several buildings, and rock-carved tombs are found (Al-Dabbagh, M. 1991).

Khirbet er Ras: Ruins from an early Arab period are found. It is Located 5 km southwest of Ramallah and west of Betunia village (I.M.D. & Carta 1993).

Rujm Abu Hashaba: Has remains of a square fort located 7 km southwest of Ramallah. There is a dressed stone structure with 6 rooms and a corner tower. The found sherds indicate inhabitation from the Persian, Roman and the Byzantine periods (I.M.D. & Carta 1993)

5. Bir Zeit:

A Palestinian town located 6 km north of Ramallah city, where Zeit means olive oil in Arabic. This hints that the town's name has been derived from an olive-oil well. On the hill within the town there are ruins from Mamluk and Ottoman periods with khan in the centre. Bir Zeit also has the remains of three long halls, with arched ceilings, encompassing a courtyard on three sides. The found sherds on the hill-slope indicate inhabitation of the site in the Iron Age and in the Hellenistic and Roman periods (Al-Dabbagh, M. 1991).

The following sites are in the surrounding area:

Khirbet er Ras: A ruin of Byzantine-Arab fortress 8 km north of Ramallah city. Remains of two courses of walls of an old structure are still found on the summit of the hill. The found sherds and other remains indicate earlier inhabitation during the Early Bronze and Iron Ages (I.M.D. & Carta 1993).

Khirbet Deir Al-I'qban: Located northwest the village of Bir Zeit. Remains of old building foundations, walls, and column bases are found there.

6. Budrus:

A Palestinian village to the west of Ramallah. Close to it is Khirbet Budrus which contains remains of Byzantine walls and agricultural installations. Between the village and the ruin there is a large sheikh's tomb (Al-Dabbagh, M. 1991).

7. Silwad:

A Palestinian village 10 km northeast of Ramallah, at the entrance of Wadi el Haramiyya. Ancient settlement ruins are scattered throughout the village. The found sherds indicate inhabitation in the Mamluk and Ottoman periods (I.M.D. & Carta 1993).

Within close proximity the following site is found:

Burj Bardawil: Remains of Crusader fort 10 km northeast of Ramallah city. Possibly, it was built by Crusader King Baldwin. It has remains of a fort and other contemporary fortifications. Found sherds indicate Iron Age occupation (Al-Dabbagh, M. 1991; I.M.D. & Carta 1993).

8. Deir Ghassana

A Palestinian village located 20 km northwest of Ramallah. It's name is related to a group of Al-Ghasasineh who settled there (Al-Dabbagh, M. 1991). Remains of an Iron Age settlement, apparently the site of Biblical Zeredah is found (I Kings 11:26). The site was also inhabited in the Byzantine period, Middle Ages and Ottoman times (I.M.D. & Carta 1993) .

Within close proximity of the village, the following sites are found

Khirbet Al-duweir: located to the west of Deir Ghassana and has remains of a church and a convent (Al-Dabbagh, M. 1991).

Khirbet Balata: Also called Khirbet Sarida, and has remains of a village and a well. A Canaanite village called Sarda was built on the same place (Al-Dabbagh, M. 1991).

9. Deir Jarir:

A Palestinian village located 12 km northeast of Ramallah city. It is built on the site of an ancient settlement containing building stones, wine presses, olive oil presses, crusader fortress and a church remnants (Al-Dabbagh, M. 1991; I.M.D. & Carta 1993).

Within close proximity of the village, the following sites are found:

Khirbet Ishqara: Located to the west of the village and contains old building foundations, oil presses and a wine press.

Khirbet Rodeen: Located northeast of the village and contains caves, walls and scattered old stones (Al-Dabbagh, M. 1991).

10.Dura el Qare':

A Palestinian village 8 km north of Ramallah city. It has ancient settlement remains. Remains of an underground room and some old buildings are found there. To the southeast direction of the village is located Khirbet Arnotia which contains remains of walls, foundations from big rocks and oil presses (Al-Dabbagh, M. 1991; I.M.D. & Carta 1993).

11.Ein Samia:

A large spring located 15 km northeast of Ramallah city. Its water flow into a small fertile valley. An archeological survey indicates the presence of an ancient settlement on this site. On the hill, to the north of the spring, is Khirbet el Murjana which contains remains of a Late Bronze Age settlement and 30 tombs containing pottery and weapons. The most important finding was a silver goblet decorated with scenes from Mesopotamian mythology. Also it has remains of Late Bronze and Iron Age settlements, including a tomb and a structure that is believed to be a ritual platform. It is believed that Ein Samia is the site of Baal-Shalishah mentioned in the description of one of Elisha's miracles (II Kings 4:42). Remains of a Roman and a Byzantine settlement were discovered there. Khirbet Samia also has dam walls, aqueducts, a church and cemetery (I.M.D. & Carta 1993).

12.El-Janiya:

A Palestinian village located 10 km northwest of Ramallah city. It is mentioned in the Byzantine textbooks as Ginta. The finds include Greek and Arabic inscriptions from the Byzantine and the Mamluk periods, mosaic floor, and a damaged mosque (I.M.D. & Carta 1993).

13.Jifna:

A Palestinian village 6 km to the north of Ramallah city. The village has remains of two ancient churches, a crusader fort, architectural pieces and oil press (Al-Dabbagh, M 1991; I.M.D. & Carta 1993).

14.Sinjil:

A Palestinian village 16 km northeast of Ramallah city, located on the site of a Crusader settlement named after Count de Toulouse Raymond de Saint Gilles, and then the Arabic name of the village was derived from this origin. The Crusader estate was built on the site of the previous Roman settlement. This village has remains of a Crusader fortress and a platform measuring 8 by 10 m. The present mosque is built on the ruins of an ancient church (Al-Dabbagh, M. 1991; I.M.D. & Carta 1993).

The following sites are found within close porximity:

Khirbet Ras ed Deir: Also known as Khirbet Deir Al-Fiqia, it is located northeast of Sinjil. Ruins of a monastery and a church, walls, column-fragments, cistern and a Roman road are found there. (Al-Dabbagh, M. 1991).

Khirbet 'Ammuria: A small Palestinian village 15 km northeast of Ramallah city, adjacent to Sinjil village. Two stone sarcophagi from the Roman period were discovered in a rock-cut tomb within the village. The found sherds indicate inhabitation in the Iron Age, Byzantine and Arab periods (Al-Dabbagh, M. 1991; I.M.D. & Carta 1993).

Khirbet Al-Burj: A ruined settlement located 16 km to the north of Ramallah city. Remains of a square tower preserved to a height of 6 m., apparently from Byzantine period, remains of structures, water cisterns and cave-tombs are found. The found sherds indicate inhabitation during the Iron Age and from the Roman period until the Middle Ages (I.M.D. & Carta 1993).

Khirbet et Tall: Located 4 km south of Al-Lubban Al-Sharqiyya, near Sinjil village. The site has caves, olive oil press, rock-cuttings, remains of building walls (apparently of a church from the Byzantine period). The found sherds indicate inhabitation from the Early Bronze Age until the Middle Ages (I.M.D. & Carta 1993).

15. Turmus A'yya:

A Palestinian village located 20 km northeast of Ramallah city. Remains of buildings, a wall and a mosaic floor, a Greek inscribed lintels and a Roman sarcophagi have been found there (Al-Dabbagh, M. 1991). The following site is found within close proximity:

Khirbet Abu Malloul: A ruined settlement located 4 km to the east of the village. After its damage, the people left the place and settled in Turmus Ayya. Remains of old buildings, tombs and caves are still found there (Al-Dabbagh, M. 1991).

16. Al-Mazra'a Esh-Sharqiya:

A Palestinian village located 13 km northeast of Ramallah city. The following sites are found within close proximity:

Khirbet el Burj: A ruined settlement located 12 km northeast of Ramallah, on summit of a hill. Remains of a large dressed stone structure, apparently Roman, rock-cut tombs and cisterns are found. The sherds indicate habitation during the Iron Age and from Hellenistic until the Arab periods (I.M.D. & Carta 1993).

Khirbet at-Tal: Located two km northwest of Al-Mazra'a Al-Sharqiyya. Remains of buildings, columns, wine-presses and a pool are found (Al-Dabbagh, M. 1991).

17. Al-Mazra'a Al-Qibliya:

A Palestinian village located 8 km northwest of Ramallah. The following site is found within close proximity:

Khirbet Deir Harrasha: Ruins of an ancient settlement located 6 km northwest of Ramallah. Remains such as structures, plastered pool and an olive oil press from the Roman, Byzantine and Arab periods, are scattered over a large area. (I.M.D. & Carta 1993).

18. Deir Nitham:

A Palestinian village located 23 km northwest of Ramallah. It contains caves carved in the rock and pigeons towers (Al-Dabbagh, M. 1991). Within close proximity the following sites are found:

Khirbet Tibna: A ruined settlement 15 km northwest of Ramallah, near Deir Nitham. The found sherds indicate habitation in the Middle Bronze and Iron Ages, Persian, Hellenistic, Roman and Byzantine periods, and in the Middle Ages (I.M.D. & Carta 1993).

Khirbet Hiblata: Located to the southeast of the village and contains remains of old buildings, oil presses carved in the rock with mosaic floor and many tombs (Al-Dabbagh, M. 1991).

19. Beit Sira:

A Palestinian village located 22 km west of Ramallah. Remains of old building foundations, caves and a round pool are found there. The following sites are found adjacent to the village:

Khirbet ed Dureish: A settlement remains from the Byzantine period, 14 km to the west of Ramallah. Ruins of a house walls with one meter height are found (I.M.D. & Carta 1993).

Khirbet Manna': North of Khirbet ed Dureish and contains remains of old buildings with columns, and tombs.

Khirbet Deirieh: East of Khirbet Manna', and contains remains of walls and building foundations (Al-Dabbagh, M. 1991).

20. Rantis:

A Palestinian village located 9 km southeast of Ramallah city. This village was built on the ruins of the Iron Age, Persian, Roman and Byzantine settlements. The Tomb of Sheikh Barhum is found there (I.M.D. & Carta 1993).

21. Al-Bireh:

A neighboring town of Ramallah city, located 15 km north of Jerusalem. It is an old city related to the Cana'anite period and beleived to be built on the remains of the Cana'anite city "be'rut". It is also the place where Joseph and Mary lost the child Jesus on the way back to Galilee. It was inhabited in the 12th century by the French Crusaders whom left the remains of a Crusader church (Al-Dabbagh, M. 1991).

22. Deir Dibwan:

A Palestinian village located 6 km east of Ramallah. The following sites are found within a close proximity:

Khirbet Qasr et Taziz: A remains of a settlement from the Ottoman period located 5 km east of Ramallah, near Deir Dibwan village. Ruins of a round tower, preserved to a height

of four meters, in addition to other structures and cisterns are found in the place (I.M.D. & Carta 1993).

Khirbet Al-Khudarieh: Located 2 km east of Deir Dibwan. Remains of old buildings, columns, oil press are found there (Al-Dabbagh, M. 1991).

Khirbet At-Tal: Located 19 km north of Jerusalem and about one and a half km northwest of Deir Dibwan. Remains of tombs, building walls and rock cuttings are found in the place. At-Tal was built on the remains of an old town ('Ai). Remains of a temple from 2600 B.C. was found in this place and considered one of the oldest temples in Palestine. Yosha', the Jewish leader, tried to occupy ('Ai) and succeded in the second time. With the swords, Yosha' and his army killed all the people and hanged their king at that time (Al-Dabbagh, M. 1991).

23. A'tara:

A Palestinian village 11 km north of Ramallah city. Its name was derived from the Canaanite name A'tarout which means the crowns. The village is built on the ruins of an ancient settlement. It has a number of springs with water conduits located north of the village. The found sherds indicate inhabitation in the Iron Age, Byzantine period and in the Middle Ages (Al-Dabbagh, M. 1991; I.M.D. & Carta 1993).

Within a close proximity the following site is found:

Tomb of Sheikh Qatrawani: Is located 10 km north of Ramallah and is built on the ruins of a Byzantine church of which its columns are still arranged in two rows. (I.M.D. & Carta 1993)

24. Al-Taybeh:

A Palestinian village located 10 km northeast of Ramallah. The Canaanite built this place and called it O'fra. According to Christian tradition, Jesus visited the village. Remains of a Crusader church, built on the ruins of a Byzantine church which is called el Khader whom famous as St. George are found. On the village slopes are the ruins of a 12th century Crusader castle, Baubariya, which was built on a 5th century Byzantine structure (Al-Dabbagh, M. 1991; I.M.D. & Carta 1993).

25. Um Safa:

A Palestinian village located 12 km north of Ramallah city. It is called also, Kafr Ishwa'. Several ancient structures are found there, and the found sherds indicate inhabitation in the Byzantine, Medieval and Ottoman periods (Al-Dabbagh, M. 1991; I.M.D. & Carta 1993)

26. Yabrud:

A Palestinian village located 9 km northeast of Ramallah off road leading to Nablus. It is built on a ruined settlement from the Iron Age, Persian period and from the Roman period. The discoveries contain wine presses, an ancient altar strewn with stone pieces obviously used as counters for a game, ancient building stones and other remains (I.M.D. & Carta 1993).

The following sites are located within a close proximity of the village.

- Khirbet Izaitebs: Located south of Yabroud village. Al-Sheikh Abullah locality is found there (Al-Dabbagh, M. 1991).

- Khirbet Al-Tantura: Located southeast of Yabroud village and sherds are found there (Al-Dabbagh, M. 1991).

- Khirbet Al-Batin: Building foundations and tombs are found in this place (Al-Dabbagh, M.1991).

Chapter Eight
Wastewater

Wastewater is the effluent water that has been used in various daily activities. It can be divided into domestic and industrial waste both of which are constantly increasing due to the increases in the population and the growth of human activities. Management of the wastewater for both types in the West Bank is the responsibility of the municipalities, village councils and UNRWA in the refugee camps.

Domestic wastewater

Domestic wastewater is the water produced from homes and small commercial establishments. It contains organic matter, complex minerals and many types of micro-organisms. The quantity of domestic wastewater generated by a community is equal to 80-90% of the average per capita water consumption and the total population. Based on a yearly per capita water consumption of 35 CM (Isaac, 1994), it is estimated that 5.0 MCM of domestic wastewater is generated in the Ramallah district every year.

The quality of wastewater depends on daily activities and the per capita consumption of the population. The BOD from Palestinian localities is very high compared to other countries. The domestic wastewater reaches to more than 500 mg/l in most of the West Bank while in other countries it ranges between 200-300 mg/l. This is because the per capita water consumption is very low compared to other countries. The characteristics of wastewater from Ramallah city is shown in Table 8.1. These values have been obtained through the analysis of composite samples from the collection network of Ramallah city (Nashashibi, M. & L.A.Van Duijl, 1995).

Table 8.1 Characteristics of raw wastewater for Ramallah city

Parameter mg/l	**BOD**	**COD**	**Kj-N**	**NH_4^+**	**NO_3^+**	**SO_4^{2-}**	**PO_4^{3-}**	**Cl^-**	**TSS**
Value	525	1390	79	51	0.6	132	13.1	350	1290

Source: Nashashibi, M. & L.A. Van Duijl, 1995.

Industrial Wastewater

Industrial wastewater contains both organic and inorganic waste. The organic waste is equal in polluting potential to the untreated domestic wastewater while inorganic industrial waste, which contains heavy metals and hazardous materials, is much more difficult to control and potentially more hazardous. As there are no regulations to control industrial effluents in the West Bank, most of the industrial waste is currently discharged into cesspits or sewage collection networks without any consideration for the potential to pollute. The problem with industrial discharges is the high biological oxygen demand (BOD) and suspended solids (SS) as well as the presence chemicals and toxic materials. Restrictions should be imposed on industries to reduce the level of pollutants to enter the environment.

Table 8.2: Estimated percentage of the various industrial wastewater disposal methods.

Method of Disposal	**%**
Cesspit	46
Sewage collection network	37
Reuse	12.3
Unofficial	4.7

Source: ARIJ survey

ARIJ surveyed approximately 70% of the industrial facilities in the Ramallah District and found that approximately 206,000 CM of industrial wastewater is generated by these facilities every year (does not include wastewater from olive mills and stone cutting facilities). This wastewater is disposed of into cesspits, the sewage collection network, reused, or it is disposed of in open areas or near the industrial facility (Table 8.2).

Chemical industries including the pharmaceutical industry are concentrated in the Ramallah District. The effluent from these facilities contains many toxic and biologically active constituents. It is estimated that approximately 18,000 CM/yr is generated from the pharmaceutical factories in the district. This effluent is usually collected through the sewage network without any pretreatment, for factories located in Ramallah And Al-Bireh cities or through cesspits for those located in Bir Zeit or Bitunia. Control measures should be taken to reduce discharge into the environment.

Olive Oil Mills

Olive production is very important to the economy of the West Bank. Olive trees in the Ramallah District are prominent and most of the yield is processed into olive oil. There are approximately 65 olive mills in the Ramallah District out of the 285 mills located in the West Bank. Most of these are either semi-automatic or "old-fashioned" model. Single and double line automatic processing constitute less than 30% of all mills.

The amount of olive produced differs greatly from year to another resulting in a great difference in the generated waste. Commonly, 90% of the total olive product is pressed to produce olive oil and the rest is pickled. During the 1993/94 growing season, the olive product in the Ramallah District amounted to 7,525 tons (Ramallah Agricultural Department, 1994).

The milling process generally utilizes water in the initial wash, again to crush the olives, and lastly to pulverize them. In addition to the olive oil, solid and liquid wastes are also generated. The liquid waste generated from the olive mills is a dark viscous substance and is usually released untreated into either the sewage network or onto uncultivated land without any consideration for its environmental impact on the groundwater or land. The quantity of this liquid waste changes from year to year depending upon the quantity of produced olives that year. Approximately 1.5 CM of wastewater is generated for every ton of processed olives. This effluent is extremely concentrated (42,000 mg/l BOD & 65,000 mg/l TSS) (Economopoulos, A., 1993) and is potentially injurious to the environment. The generated wastewater produced from oil mills in the district during the 1994 was approximately 10,160 m^3.

Focus should first be put on the disposal of liquid wastes because they currently warrant greater concern, as they contribute to ground and surface water pollution. A construction of treatment facilities based on new technologies for the disposed liquid waste is needed.

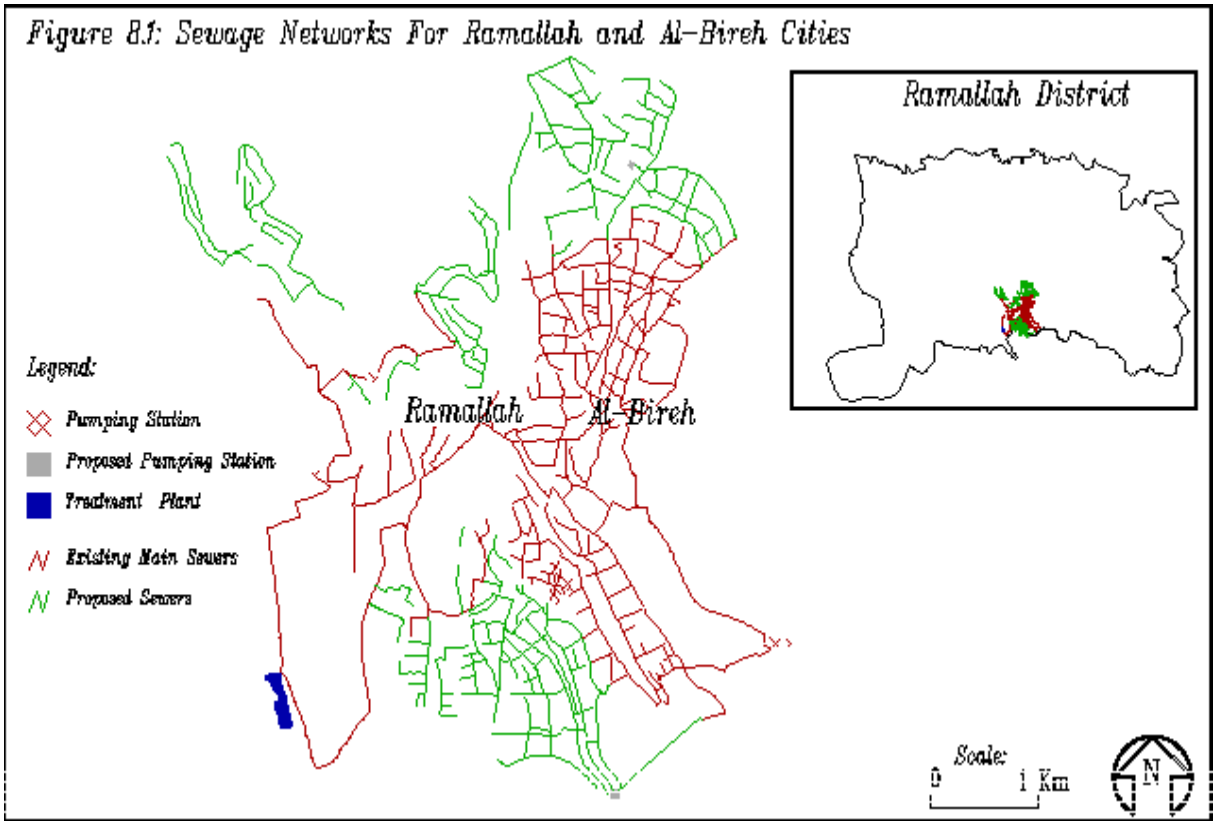
Wastewater Disposal

In general, wastewater collection and disposal in the Ramallah district, as is the case in the other districts in the West Bank, is inadequate. Wastewater in the Ramallah district is disposed either in the sewage collection network, cesspits or septic tanks.

Sewage Collection Network

According to ARIJ survey, approximately, 70% of the houses in Ramallah and Al-Bireh cities are connected to the sewage network. Of the four refugee camps in the district, only Al-Ama'ri R.C. is connected to the sewage network. The existing networks in the region cover approximately 21% of the houses in the Ramallah district.

The wastewater collected from Ramallah city flows to the existing treatment plant and then flows freely to wadi Bitunia. The wastewater collected from Al-Bireh city and Al-Ama'ri Camp presently flows untreated into wadi Al-Ein which empties into wadi Al-Qilt where many springs exist. The networks in Ramallah and Al-Bireh receive industrial and medical wastewater in addition to the municipal wastewater. Figure 8.1 shows the sewage collection networks of Ramallah and Al Bireh cities (Ramallah & Al Bireh municipalities, 1996)



Most of the Israeli settlements in the West Bank have sewage networks and most of these settlements discharge the wastewater into wadis without any treatment Accurate data about these settlements are not available.

Cesspits

All other localities are entirely dependent upon cesspits for wastewater collection. When these pits become full, they are emptied by sewage vacuum tankers and the contents are disposed of in the nearby open areas, wadis, cultivated areas or sewage network. This

situation is improper, unhealthy and causes several environmental hazards. The threat of groundwater pollution is the most probable. The spread of flies and insects and the contamination of fresh eaten vegetables are also possible.

The karstic structure of the aquifers in the West Bank facilitates the penetration of wastewater into the groundwater. Strict measures must be taken to prevent pollution of the groundwater.

Wastewater Treatment

Disposal of untreated wastewater into open areas and wadis is one of the major issues that Palestinian officials are worried about. But the high costs of constructing modern wastewater treatment plants and proper disposal systems, restrain the municipalities in the West Bank to meet the challenge of building such facilities on their own and thus they need an international assistance in this area.

Ramallah treatment plant

This plant is the only large scale wastewater treatment plant in the West Bank. It was designed by an Israeli company in 1973 and consists mainly of two mechanically aerated ponds and two stabilization ponds. The treated effluent is disposed of by an overflow pipeline that extends for almost two kilometers south of the treatment plant where it discharges freely to the soil surface in Wadi Bitunia (Ayalon). The design of the treatment plant allowed for the use of the effluent for irrigation of land south of the treatment plant but this was never implemented. Recently the Engineering Center for Planning and Design measured the efficiency of the treatment plant and it was found to be approximately 28% of its capacity. On average the daily flow entering the treatment plant is estimated at 2,000 CM/d (Ramallah Municipality, 1995). Additionally, a large number of industries also discharge their wastewater into the collection system.

When surveyed, the treatment plant was totally inoperative. The stabilization ponds were black and exhibiting septic conditions with gas bubbles and smells coming from the surface of the ponds. There is clearly a lack of proper maintenance of the facilities. The municipality is in the final stages for a plant upgrade using financial and technical support from ANERA/USAID. The new system will use aerated lagoons including surface aerators, stabilization ponds, a storage reservoir and disinfection. The plan includes reuse of effluent by farmers in the nearby villages of Bitunia, Judeira and Rafat.

Photo 4: Wastewater from Al-Jalazone Camp covering the agricultural land of Jifna village.

Al-Bireh Treatment Plant

AL-Bireh city is also in the final stages of planning for a new treatment plant. According to official in the municipality, the treatment plant will be located approximately at a distance of 1.5 km down stream the Wadi Al-Ein to the east of the Al-Bireh city. It is designed to serve an estimated 40,000 people in the first phase taking into consideration the feasibility to expand it to 80,000 people in the future. The treatment process to be used will be the high rate activated sludge and trickling filters. It is expected that this process will ensure an effluent with BOD/SS content of less than 20/30 (Al-Bireh Municipality, 1995).

The sludge treatment process will consist of anaerobic digestion and mechanical dewatering. Approximately 80% of the treated water and all the sewage sludge will be used in connection with land use amelioration. Estimated area of land to utilize the treated water is about 320 hectares. The new system proposes irrigation reuse of the effluent 10 km south of the existing wastewater treatment plant (Al-Bireh Municipality, 1995).

Bir Zeit University treatment Plant

Bir Zeit has an activated sludge wastewater treatment plant. The system treats a small flow from the daily use of the university. The flow is intermittent because of the university activity. The treated water is pumped to the top of a hill close to the university and is held in an open reservoir, approximately 10 CM in size. The effluent is then fed by gravity to the university where it is reused for landscape irrigation and for flushing the toilets. The treatment plant is considered the best in operation in the Ramallah District (Gearheart, R.et al, 1994).

Photo 5: Vacuum tanker empties the wastewater on cultivated land at Ramallah District.

Environmental Related Problems

Wastewater flood:

60% of the 65 localities surveyed by ARIJ in the Ramallah District suffer from wastewater flooding during the year, especially in the winter time. Jifna village is one of the villages in the West Bank whose population are suffering, since four years, from the

flooding of cesspits at Al-Jalazone camp. Wastewater in the camp, collected by open channels and cesspits, overflows to surface and discharges to nearby wadi on the agricultural land of Jifna village damaging the trees and creating nuisance. Flooding of wastewater is a major environmental and health problem, leading to odor problems, mosquito infestation and disease transmission. (Photo shows the wastewater from Al-Jalazone Camp covering the agricultural land of Jifna village).

Groundwater and springs pollution:

A major resource of water is lost through the contamination of the spring water. Percolation of wastewater from cesspits in the villages is the major cause of the contamination. Pollution has been discovered in the springs of the villages of Beittin, Al-Janiya, Silwad, Yabroud, Deir Jarir and Abu Shkheidem in the Ramallah District. It is believed that there are many undiscovered polluted springs which may be causing serious health problems in the people. Regular quality measurements, especially the E-coli test, are needed to ensure the safety of the springs. The cesspits are forming danger to the rest of the springs. Sewage from the villages must be properly managed so as to protect the limited drinking water resources of the area.

Irrigation with raw wastewater:

Treated wastewater can play an important role in water resource management as it can substitute for fresh water in irrigation. But the direct discharge of raw wastewater can create serious pollution problems. In the Ramallah district, the content of the cesspits in many villages is disposed of in areas cultivated with olive trees, barely and many other crops. This practice has been documented in the villages of Al-Taybeh, Khirbet Abu Falah, Al-Midya, Deir Abu Misha'l, Beit Rima, A'arura, Deir Dibwan and likely to be happening in other villages as well. (See photo: Vacuum tanker empties its contents of wastewater into area cultivated with olive)

Recommendations:

- The nature of the Palestinian localities in the Ramallah District as is the case of the West Bank is mainly rural. Constructing a central collection network is economically unfeasible. So different approaches have to be developed for the rural and urban areas. The localities of Ramallah, Al-Bireh, Bitunia, Al-Ama'ri Camp and Qaddura Camp are located close to each other. The connection of these localities with a comprehensive collection network is a priority.
- A wastewater treatment plant is needed to treat the sewage collected from the comprehensive collection network. Selection of the location of the treatment plant has to take into consideration the availability of land, the future expansion of the

built up areas, the topography of the area and the availability of agricultural land. The treatment process has to produce effluents that meet required standards to be used for irrigation purposes. The minimal purification level required for agricultural use, except that for vegetables that is eaten raw, is 20 mg/l for the BOD and 30 mg/l for the suspended solids (SS).

- For rural communities, septic tanks and other new technologies for rural areas, other than cesspits for the disposal of domestic wastewater is recommended.
- Restrictions and control measures should be imposed on industries to reduce the level of pollutants that enter the environment. Industrial waste has to be treated at source before disposal into collection networks.
- Stone cutting facilities are known to consume large quantities of water. Treatment and reuse of generated wastewater will save water and prevent environmental pollution. It is recommended that the Ramallah area use the same technology which is being implemented successfully in stone cutting facilities in Bethlehem District and is recovering 70% of the generated wastewater.
- Installation of a separate drainage system for rainwater is recommended, in order not to mix with the wastewater. The collected rainwater can be used for agricultural purposes.
- Irrigation with treated wastewater as an additional source of water should be encouraged among farmers.
- Programs for the environmental awareness have to be started among people especially farmers and owners of private vacuum tankers on the impact of irrigation with raw wastewater on the human health and the environment.

Chapter Nine
Solid Wastes

Introduction

Municipal solid waste includes nonhazardous waste generated in households, institutions, and commercial as well as agricultural wastes. The management of solid waste at all stages of handling is inadequate. Many obstacles are restricting the proper management of solid waste, among them are the political restrictions, financial and technical difficulties and the absence of environmental authorities.

Solid waste management is considered a major problem facing the residents and local authorities in the West bank. The poor or the absence of a collection system, in some areas of the West Bank had lead to open burning of garbage in inhabited areas as well as uncontrolled dumping sites. There is uncertainty with respect to the generated quantities in the Ramallah District, as most wastes are not weighed, especially for the industrial waste. As for the domestic waste, it is estimated that the daily generated solid waste is approximately 0.9-1 kg/person. With a population of 176,154 in the Ramallah District, it is estimated that 165.6 tons of household waste is generated daily.

The current management of solid waste has not yet created any severe environmental problems either to the groundwater, the soil or the air. But, the awareness of the rapidly increasing population and the expected development in the industrial and agricultural sectors calls for immediate attention to avoid the hazardous situation.

Municipal Solid Waste Management

Table 9.1: Distribution of responsibilities of domestic solid waste management

Responsible Party	**Collection & Disposal (% of population)**
Municipalities	37
Village Councils	6.5
UNRWA	9
Associations & clubs	5
No Party designated	42.5

Ramallah District is presently experiencing the same problems facing other districts in the West Bank. Solid waste collection and disposal generated from households and commercial centers are the most important among other problems. The solid waste management system, is inadequate throughout the district. It's responsibility is divided between either the municipalities in the urban areas, village councils, and associations in the rural area, or the UNRWA in the refugee camps. Table 9.1 shows the distribution of responsibilities for domestic waste collection and disposal. Table 9.2 shows the solid waste management in he Ramallah District

Table 9.2: Solid waste management in the Ramallah District

Zone	**Popula-tion Estim-ated**	**Quan-tity Tons/ day**	**Number of Vehicles**	**Labors**	**Suggested number of labors**	**Annual Fee**	**Disposal site**	**Distanc e Km**
A'arura	1586	1.5	1 Truck*	2	4	3	A'arura	1.5
Bani Zeid (Beit Rima+Dei r Ghassana)	5000	5.0	1 Truck	1	13	8	West Bani Zeid	0.5
Beit U'r Tihta	2259	2.2	Agricultural Tractor	3	6	30	Beit U'r Tihta	3.0
Beit Illu	1394	1.3	Agricultural Tractor	2	4	30	Beit Illu	2.0
Bitunia	3775	3.7	1 Truck	4	10	15	Ramallah	3.0
Bir Zeit	3542	3.5	1 Truck & 4 Carts	8	9	10	Bir Zeit	2.0
Deir A'mmar R.C.	1712	1.7	Tractor	3	4	0	Deir A'mmar R.C.	0.5
Al-Ama'ri R.C.	6623	6.6	1 Truck***	10	17	0	Ramallah	4.0
Al-Jalazone R.C.	7209	7.2	1 Truck***	11	18	0	Ramallah	9.0
Jifna	778	0.7	1 Truck*	2	2	3	Jifna	2.0
Kafr Ni'ma	2115	2.1	Agricultural Tractor	3	6	30	N/A	N/A
Ramallah	23314	130**	4 Trucks	30	58	12	Ramallah	1.0

Al-Bireh	21936	73**	5 Trucks	53	55	6.	North Al-Bireh	2.0
Saffa	2394	2.3	Agricultural Tractor	3	6	30	Saffa	3.0
Sinjil	4165	4.1	1 Truck*	N/A	11	N/A	N/A	N/A
Turmus A'yya	2949	2.9	1 Truck*	2	8	0	Turmus A'yya	1.5
Deir Dibwan	4646	4.6	1 Truck	4	12	15	East Deir Dibwan	2.0
Rammun	2051	2.0	1 Truck*	1	5	30	Rammun	2.0
El-Taybeh	1743	1.7	1 Truck*	2	5	0	El-Taybeh	2.0
Yabroud	2572	2.5	Agricultural Tractor	4	10	30	Wadi Yabroud	2.0
Silwad	4494	4.4	2 Trucks	4	10	6	West Silwad	1.0
Ni'lin	2357	2.3	Agricultural Tractor	3	6	30	N/A	N/A
Kafr Malik	2159	2.1	Agricultural Tractor	1	6	30	different locations	–

Key note:
*: A union of 6 village councils uses the same truck for collection
**: Quantity given by municipality officials.
***: A truck owned by UNRWA used for the Refugee Camps

Collection

Only 58 % of the population in the Ramallah District privileged with solid waste collection services. Among these are all the urban areas, the refugee camps and some villages. Table 9.2 shows the localities in the Ramallah district that have a managed solid waste collection system. Collection containers that are currently used in the municipalities, village councils, and refugee camps vary in number and size. There are approximately 800 containers of which close to 16% have a capacity of 0.4-0.9 CM, 53% are 1.0-4.9 CM and 31% hold 5.0-6.0 CM. Most of the present containers are old and no longer useful. The location and volume of these containers are chosen roughly without any considerations to the quantities produced and frequency of collection, resulting in solid waste accumulation near the containers. If not emptied soon, the piles will be burned where often the waste inside the containers also burned.

Many villages in the district lack any collection system and solid waste is left in nearby fields, abandoned plots and streets, creating bad smells and various types of insects, mosquitoes and rats especially in the summer time. Around forty villages and hamlets in the Ramallah District lack any solid waste collection services.

Photo 6:Solid waste piles beside a container in the Ramallah city.

The collection vehicles available at the different Palestinian built-up areas in the Ramallah District include hand carts, agricultural tractors and trucks of various types and capacities. Modern methods for collection have been adopted in the major cities where compacting vehicles and hydraulic lift containers have replaced open trucks. There are 4 hand carts, 8 agricultural tractors and 19 trucks throughout the district (Table 9.2) (ARIJ, 1995). It is worth mentioning that there is a union of village councils (Turmus A'yya, Sinjil, A'arura, A'tara, Jifna, Al-Taybeh and Rammun) who formed association for the purpose of joint garbage collection and are using the same vehicle for solid waste collection. These people are receiving collection services once a week. Table 9.3 shows the frequency of collection among the population.


Photo 7: Dumping site of Al-Bireh city.

Table 9.3: Collection frequency in the Ramallah District.	
Collection Frequency	**% of population**
Daily	47
Twice per week	4
Once per week	9
None	40

The number of available collection vehicles is far below what is required to handle the generated waste. Furthermore, many of these vehicles are old and frequently out of service resulting in an irregular and infrequent collection schedule in addition to the solid waste accumulation at the ground near the containers.

Disposal

Municipal solid waste in the West Bank is usually dumped in open and uncontrolled areas. They are usually located few kilometers away, either near another town or village or in an agreedupon open area. The choice of the landfill site is done arbitrary without any consideration to the soil characteristics, topography, climate, or future planning. Open dumping and uncontrolled landfills are the main disposal method. The dumping site of Ramallah city falls within the south western part of the city where the western wind carries the smell and the fumes toward the city. Moreover, the dumping site is located near the city forming environmental and hygienic problems to the inhabitants.

None of the dumping sites in Palestine are designed as sanitary landfills. None are internally isolated or have a leachate collection system, thereby allowing leachate to percolate through the soil and endanger the groundwater. Also, dumping sites are not fenced or guarded and scavengers, especially children, walk through the solid waste piles in search of usable items. They collect aluminum cans to be sold to Israel for recycling or glass bottles to be recycled in the glass factories. Recycling is preferable to reduce the generated waste, but it is a risky way to collect recycled materials. Figure 9.1 shows the location of the scattered solid waste dumping sites throughout the district.

Ramallah District is facing a serious problem with the disposal of old equipment such as old refrigerators, washing machines, vehicles...etc. These items can be found disposed in open areas and on road sides causing a serious danger to the environment and reducing the aesthetic quality of the area (Photo 8). Collection and recycling of these items would reduce the environmental risks and create badly needed job opportunities in the Ramallah area. Small scale metal industries could expanded and created, or crushed metals could be exported for recycling in other countries. Both of these would add to the economy of the West Bank.

Photo 8: Old vehicles dumped near the residential area in the Ramallah city.

Solid Waste Quantities and Composition

The quantity of the solid waste generated in the Ramallah District is estimated at more than 300 tons/day. Approximately 200 tons/day of this are generated in the cities of Ramallah and Al-Bireh. The large quantity of the solid waste is generated in the two cities as 25 % of the population lives in these areas and most of the commercial establishments and industrial activities are there.

There are no accurate figures regarding the composition of the generated solid waste. However, the municipality of Ramallah has conducted under the Peace Urbs Project a solid waste hand sorting in order to estimate the composition of the domestic, commercial and industrial waste. The preliminary results are given in Table 9.4.

Table 9.4: Composition of the Solid Waste at Ramallah city

Material	**Organic waste**	**Card-board**	**Textile**	**Plastic**	**Paper**	**Glass**	**Metal**	**Stone & Sand**	**Baby napkins**	**Unsorted <14 mm size**
%	41.1	7.6	7.5	10.1	3.4	3.9	2.3	5.4	6.4	11.7

source: Al-Hmaidi, S. et al, 1995.

Industrial Waste

Table 9.5: Distribution of industrial facilities within the district	
Location	**% of industrial facilities**
Industrial area	89.2
Residential	8.6
commercial	0.8
Agricultural	1.4

Ramallah District incorporate two industrial zones located close to Ramallah and Al-Bireh cities. Based on the analysis of approximately 70% of the industries in the district, industrial facilities in the Ramallah District are largely located in these two industrial zones. This is not the case in other districts in the West Bank. Table 9.5 shows the distribution of the surveyed industrial facilities within the district. Major industrial activities include food processing mainly sweets and snack industries, pharmaceutical industries and a range of manufacturing industries. These are located in the industrial areas of Ramallah and Al-Bireh. Outside the industrial areas are the stone cutting facilities located around Kafr Malik, Al-Bireh and Al-Mazra'a Ash-Sharqiya. Figure 9.1 shows the location of the industrial zones and quarries in the Ramallah District. Units for tile production, concrete blocks and other construction materials and the fabrication of many workshop products are found in several other locations of the district. Most of these industries are dependent on raw materials imported primarily from Israel except for stones which are available locally.

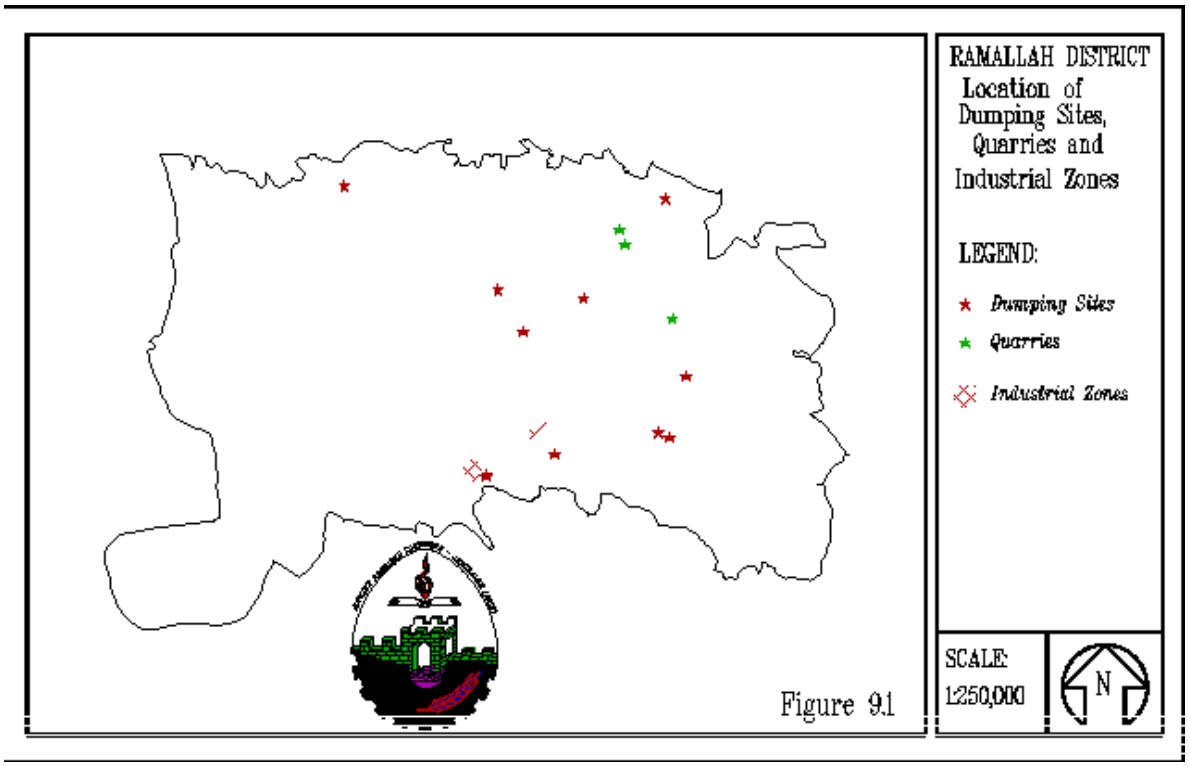


Figure 9.1 location of dumping sites at Ramallah district

The waste is usually generated when the materials are in production or at the packaging stages. Quarries, stone cutting facilities and olive oil mills are the major contributors to solid waste in the district. Excluding these industries, the total quantity of the generated

solid waste from the surveyed facilities is close to 1,200 tons/yr. It is estimated that the construction industries contribute approximately 400 tons/yr, the food and beverage industries contribute close to 275 tons/yr, metallic industries contribute close to 246 tons/yr and the wood industries contribute close to 110 tons/yr. Table 9.6 shows the distribution of quantities of industrial waste generated excluding the quarries, and olive oil mills. It is also worth mentioning that packaging materials, whether of raw or produced materials, constitute a considerable amount of the total generated waste. These packaging materials include paper and carton, metal, plastic, wood and jute.

Table 9.6: Quantities of industrial waste excluding quarries and olive oil mills

Industrial Branch	**No. of Factories visited**	**Solid waste Tons/yr**	**Liquid waste m^3/yr**
Food & Beverage	15	274.5	72,000

Construction	8	400	44,000
Textile	1	N	72,000
Plastic & Rubber	8	26.4	N
Pharmaceutical	8	24	18,000
Detergents	5	55	N/A
Wood & Bamboo	17	110	0
Metallic	29	246.5	0
Fiberglass	2	N	N
Paper & Cartons	3	0.6	0
Concentrates	4	N	0
Sponge	4	16	0

N: Negligible , N/A: not available
source: ARIJ survey

Quarries and stone cutting facilities produce the largest quantity of solid waste and are the major contributor to environmental degradation and pollution. According to the survey conducted by ARIJ which covered 35 stone cutting and quarries facilities in the district, these facilities generate approximately 24,000 tons of solid waste, 20 times the amount of solid waste generated by other industries. These amounts of solid waste is usually reused in the construction and sometimes left on road sides and open areas. The slurry generated is approximately 8,000 tons of solid waste mixed with large amounts of water. The slurry is always collected and settled in ponds, the clear water is reused for many times and the settled solid is always disposed of in nearby areas or wadis.

Olive oil mills also produce large amount of solid waste. Out of the 7,525 tons of olive produced in the 1993/94 growing season in the Ramallah district, approximately 4,700 tons of olive pulp was produced. This quantity is based on pressing 90% of olive and 70% of the pressed olive is discarded as olive pulp. The generated solid waste is usually used for soap manufacturing or as fuel and sometimes discarded adjacent to the press.

Table 9.7: Estimated percentage of the various industrial solid waste disposal methods.

Disposal Method	%
Municipal waste containers	39.6
Road-sides dumping	25.4
On-site burning	17.1
Reuse	12.6
All of the above methods	5.3

Based on the field survey of industries, the largest percentage of industrial solid waste is disposed of in municipal collection containers, the rest is dumped on the road-side, burned on site or reused. Disposal method of generated solid waste from different industries is shown in Table 9.7. Of the total generated solid waste, approximately 12.6 % is reused. Reuse practices can be observed in many of the metallic industries where the generated solid waste is melted and reused, also, at wood workshops where the generated solid waste is reused in poultry, or for heating purposes. Some of the used plastics in the plastic factories is also crushed and reused.

Medical Hazardous Waste

Medical waste is defined as all wastes generated from health care or health-related facilities. It is characteristically heterogeneous, consisting of objects of many different sizes and composed of many different materials. It can be classified into two categories: general waste and special waste. The general waste consists of all waste materials that are not defined as hazardous. It comprises a heterogeneous mixture of paper, cartons, plastics, food scraps, glass ware and metals. These wastes can be handled with the municipal solid waste streams. The special wastes, including the biological, contagious and sharp objects wastes, are hazardous and are generated either in solid or liquid forms. Special wastes require special handling, treatment and disposal methods to protect the people from potential health, safety or environmental hazards.

The generated hazardous medical wastes are considered a major threat to human health. ARIJ survey has covered three hospitals, three medical centers and nine laboratories in the Ramallah District. Findings from field investigations show that approximately 36% of the medical centers are located in residential areas and 64% were located in commercial areas. Lab technicians in laboratories, hospitals, clinics and medical centers do not use any kind of safety equipment such as gloves or masks.

Most of the medical waste in the district is disposed of in the municipal garbage containers. There are no special management policies for these wastes. Approximately all biological medical wastes are directly dumped and mixed with the municipal garbage with no previous treatment to guarantee the absence of any microbial or viral

contamination. Most of the blood samples, urine samples, stool samples and operational wastes are disposed of in the municipal garbage.

Sharp objects, including glass tubes, syringes needles and lancets, are not treated before being disposed of in the garbage. One of the protective method is to hold such sharp objects into special containers or to break the pointed edge of these objects so as not to harm people dealing with them.

Petri dishes, used for bacterial culture, is the only item which is properly treated in some of the health institutions. More than 20% of the surveyed medical centers autoclave the petri dishes, 15% burn them near the medical center and 8% use septic solution for sterilization while the rest dispose the petri dishes into the municipal waste. Limited treatment of petri dishes thrive from the increasing awareness about controlling disease from disposed petri dishes and protecting scavengers especially children who are attracted by the colorful dishes.

Proper disposal of hazardous waste is one of today's major environmental issues . Of all the available treatment technologies, properly designed incineration systems are capable of achieving the highest degree of destruction and control for the hazardous waste.

Recommendations

- Collection and disposal services should be provided to the villages and hamlets that do not have this service yet.
- Compacting vehicles and hydraulic lift containers have to replace the open trucks and agricultural tractors.
- A proper landfill should be constructed that can serve the Ramallah District. The landfill has to be lined and provided with a leachate monitoring to insure the protection of the groundwater.
- The use of transfer stations is recommended.
- The quantities of the generated domestic solid waste can be reduced through starting recycling and composting programs. The composition of the domestic solid waste in the Palestinian houses, is known to contain not less than 65 % of organic waste. Separation and composting at source are recommended.
- Proper elimination and disposal of hazardous waste generated by hospitals and clinics is needed. This can be accomplished through provision of an incinerator that could serve the whole medical institutions in the Ramallah District.
- Packaging of raw materials constitute a major source of solid waste in the industry. Using degradable and re-usable packaging materials should be encouraged.
- Collection and recycling of old vehicles and electrical appliances would reduce the environmental risks and create badly needed job opportunities in the Ramallah area. Small scale metal industries could expanded and created, or crushed metals could be exported for recycling in other countries. Both of these would add to the economy of the West Bank.

Chapter Ten
Air And Noise Pollution

Air Pollution

Pollutants are substances in the air other than normal constituents. These pollutants are formed and emitted through natural processes and human activities. Near cities and in populated areas, more than 90% of the volume of air pollutants is the result of human activity. The presence of air pollutants is of great concern because of their potential adverse effects on human health and environment. Potential adverse effects not directly related to human health include damage of vegetation and materials and visibility degradation.

Types of air pollutants

Air pollutants can be found in gaseous or particulate forms. Gaseous air pollutants are classified into inorganic pollutants such as carbon monoxide, sulfur dioxide, nitrogen dioxide and ozone, and organic pollutants. The particulate matter found in the air can be made up of many different substances including mineral, metallic, and organic compounds.

Sources of air pollution

Air pollution emission sources can be divided into two categories: mobile sources and stationary sources

Mobile sources

Emissions from mobile sources are those generated by the combustion of fuels in vehicles (cars, trucks, buses, motorcycles, etc.). Such pollutants include carbon monoxide, nitrogen oxides, hydrocarbons, particulate matter and sulfur compounds (depending on the fuel used). In general, land based transport is one of the major contributors to the deterioration of air quality.

The inhabitants of Ramallah District own approximately 17.6 % of the total number of vehicles in the West Bank. According to the transportation officer at the West Bank

Department for Vehicle Licensing in Beit El, in the year 1994, there were approximately 19,276 motor vehicle in the district of which about 13,562 (70%) were private. The motorization level (total number of vehicles per thousand of people) was about 73 for privately owned vehicles, which is very low compared to 191.5 in Israel at the end of 1994 (Statistical Abstract of Israel, 1995). These vehicles emit various types of pollutants such as carbon monoxide, sulfur oxides, nitrogen oxides and particulate matter. The number of transportation vehicles registered in the Ramallah District by type is shown in Table 10.1 (Transportation Officer, Beit El, 1995).

Table 10.1: Number of transportation vehicles in the Ramallah District by vehicle type.

Type	Private	Commercial	Bus	Taxi	Truck	Motorcycle	Other	Total
Number	13,562	3,038	169	358	471	170	1,508	19,276

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

Based on the WHO transportation air emission inventories (table 10.2), rough calculations estimate that the annual emission of air pollutants due to gasoline combustion is close to 0.6 tons per vehicle. Furthermore, an estimated 9,020 tons of CO, 650 tons of SOx, 740 tons of NOx, 1,100 tons of VOC and 42 tons of Pb are emitted each year in the district due to registered local driving only. These emission figures are believed to be the minimum because there are many unregistered old cars which is difficult to estimate.

Table 10.2: Transportation air emission inventories.

Year of production	**Engine capacity**	**Unit U**	**CO (kg/u)**	**SOx (kg/u)**	**NOx (kg/u)**	**VOC (kg/u)**	**Pb (kg/u)**
up to 1971	< 1400 1400-2000 > 2000	1000	45.6 45.6 45.6	1.9 2.22 2.74	1.64 1.87 2.25	3.86 3.86 3.86	0.13 0.15 0.19
1972-1977	< 1400 1400-2000 >2000	1000	33.42 33.42 33.42	1.66 1.92 2.2	1.64 1.87 2.25	3.07 3.07 3.07	0.11 0.13 0.15
1978-1980	< 1400	1000	28.44	1.39	1.5	2.84	0.09

	1400-2000 >2000		28.44 28.44	1.68 2.13	1.72 1.97	2.84 2.84	0.11 0.14
1981-1984	< 1400 1400-2000 >2000	1000	23.4 23.4 23.4	1.39 1.68 2.13	1.58 1.92 2.57	2.84 2.84 2.84	0.09 0.11 0.14
1985-1992	< 1400 1400-2000 >2000	1000	15.73 15.73	1.27 1.62 1.85	1.5 1.78 2.51	2.23 2.23	0.09 0.11 0.14
Source: World Health Organization, Geneva, 1993							

Although public transportation is available throughout the Ramallah District through buses and taxis and are relatively inexpensive, private transportation in the West Bank are gaining popularity causing continuous growing in their number. The annual increasing rate of private cars in the West Bank is about 12% (Statistical Abstract of Israel, 1995) which is faster than the population growth rate (approximately 3.5%). It is evident that public transportation systems are decreasingly competitive to the private ones which provides convenience and flexibility that seem to be highly valued by the inhabitants. Therefore, the problem of vehicle emissions is expected to grow in the coming years.

With the new political changes, it is expected that the city of Ramallah and Al-Bireh will be a growing commercial center and that the volume of traffic will increase there. Tourism is also expected to develop thereby increasing the use of rental vehicles, taxis and buses. An increase in the use of trucks (both gasoline and diesel based) is also expected. Vehicle emissions is expected to increase in the coming years demanding emission controls on vehicles. New programs in traffic management to reduce congestion will also help control emission of poisonous gases from mobile sources.

Stationary Sources

Air pollution emissions come from many stationary

sources in the Ramallah District such as:

- external and internal combustion of coal, fuel oil, natural gas and diesel-fired engine;
- solid waste disposal and open burning;
- chemical processing of paint and varnish, pharmaceuticals, soap and detergents;
- mineral products processing in quarries, brick and clay product, concrete batching, glass manufacturing and asphalt roofing.

The industrial sector in Ramallah District is relatively active compared to other districts in the West Bank. Industry is considered the second major source of gaseous emissions and air pollution after mobile sources. Although large industrial plants do not exist, there are clusters of small-scale plants operating obsolete equipment, with no emissions controls that are significant polluters.

Quarrying, stone cutting and crushing facilities contribute a great deal to air quality deterioration through the generation of particulate matter. The facilities lack air filtration systems to collect dust and particulate so it is released into the air. Such facilities have an adverse impact when located close to residential areas or areas of high natural and landscape value because it may impact the human health and plant development. In Ramallah District, there are several quarries and stone cutting facilities which release large quantities of particulate matter and dust into the atmosphere. Moreover, transportation of the rock from the quarry to the centers of demand is also a major problem.

Photo 9: Air pollution from quarries

Municipal solid waste dumping sites are potential sources of emissions as gases, mainly carbon dioxide and methane, generate from the natural decomposition of organic wastes. Methane can migrate through the soil and accumulate in closed areas, it is highly explosive and can be a significant source of danger. VOC, often toxic and sometimes carcinogenic, also are released in small quantities. Also very important, there is a

significant amount of the waste that is openly burned either at the dump site, along road sides or at the point of collection. This is often the case in densely populated areas where large amounts of garbage is generated and collection and disposal is inadequate. Emissions from burning may impact the human health and the environment.

An air monitoring system to measure the air pollutants is needed to provide the data to establish regulations and standards for air emissions.

Noise Pollution

Noise pollution has not been studied in the West bank, scientific measurements and data about noise levels are not available. Field observations provide information about noise sources commonly found in the district. Sources of noise include: low flying Israeli military aircraft, and sonic booms produced when the sound barrier is broken; traffic, especially in the center of Ramallah where frequent traffic jams occur; and stationary sources such as stone cutting facilities.

The need for well enforced regulation of noise pollution is justified by the fact that sustained loud noise may cause health problems and interfere with the work environment, communication, sleep and inter-room privacy. In addition, it has negative effects on wildlife

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