Environmental Profile for The West Bank Volume 3: Hebron District

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Table of Contents

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List of Tables

List of Figures

All maps used in this publication are produced by the Geographic Information System (GIS) Unit at the Applied Research Institute - Jerusalem (ARIJ)

Cover Photo Al-Haram Al-Ibrahimi. Taken by Imad Qafeesheh

- Photo 1 Spring water use for domestic purposes, Ein Arab Spring
- Photo 2 Deforestation between Hebron and Dura area
- Photo 3 Ibrahim Oak, Hebron City
- Photo 4 Livestock drinking raw wastewater, wadi es-Samn
- Photo 5 Cultivated areas irrigated with raw wastewater, wadi es-Samn
- Photo 6 Young people picking through solid waste at uncontrolled dumping site
- Photo 7 Stone quarry, Sa'ir
- Photo 8 Industrial waste, leather factory, Hebron City
- Photo 9 Dust on agricultural land adjacent to stone quarry, Beit Ummar

List of Acronyms and Abbreviations

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

Measuring Units	
^{o}C	degrees centigrade
CM	cubic meter
m	meter
km	kilometer
km^2	square kilometer
MCM	Million Cubic Meters
ppm	parts per million
Dunum	0.1 hectare
m^3	Cubic meter
1/c/day	liter per capita per day

Introduction

The environment in Palestine was not paid any attention in the past, especially during the years of occupation. The land, the water and the natural resources were exploited, the use of resources was not planned to preserve the environment.

The ultimate safeguard for Palestine's environment will be public knowledge, awareness, support and activism. These must be instilled or expanded in the minds of all Palestinians regardless of age, sex, education, income level, place of residence, or professional qualifications.

When the Applied Research Institute - Jerusalem (ARIJ) launched the environmental profile for the West Bank in July, 1994, the aim was to compile a document that accurately reflected the special characteristics of the total environment of the West Bank and the measures required to safeguard and preserve our environment for future generations. The project is supported and financed by the Federal Government of Austro - Arab Relations in Jerusalem (SAAR).

The Hebron District Environmental Profile addresses the issues related to the major component, of the environment in the district and provides data which are helpful for the initiation of projects to rehabilitate environmentally stressed areas and prevent future deterioration.

The profile emphasize on the primary environment safety, water resources, soil, landuse, agriculture, noise, solid wastes and wastewater. In addition, pollution sources the socio-economic aspects of the problems are reviewed. The profile also includes a section on the historical and archeological sites in the district. As the extension of the flora and fauna are unrestricted to the boundaries of the district, they will be addressed collectively with those of the other districts in the Comprehensive Environmental Profile for the whole West Bank.

Most of the information and data used in this report are based on primary field research, questionnaire, investigations, and personal interviews conducted by the project team. Maps and information related to land areas are all prepared by the Geographic Information System unit team ARIJ.

Chapter One
General Features of the Hebron District

Location

The Hebron District is located 36 km south of Jerusalem City, in the southern part of the West Bank. It is bounded by Bethlehem District from the north and by the 1948 cease-fire line from the other directions.

For technical reasons, the definition of the boundaries of the Hebron District used by ARIJ in this profile, as seen in figure 1.1, is a combination of the pre-1967 Jordanian and the Israeli designation of the boundaries. The district is located between +100 m and 1011 m above sea level.

The Hebron District, as the rest of the West Bank is controlled by the Israeli occupation since 1967. Under the "Taba Agreement" recently signed in Washington on September 28, 1995, limited autonomy for cities, villages, refugee camps and hamlets in the West Bank was agreed upon, providing for self-rule in these areas including the setting up of a Palestinian administration.

According to the above mentioned agreement, special arrangements will be applied to Hebron City because of the Jewish presence in the heart of the city and the sensitive historical and religious aspects involved. These arrangements will enable Palestinian police to exercise responsibilities vis-a-vis Palestinian residents while at the same time Israel will retain the powers and responsibilities necessary to protect Israeli residents living in the district and visiting the holy places. There will be a redeployment of Israeli military forces in Hebron, except for places and roads where arrangements are necessary for the security and protection of settlements and their movement. This redeployment will be completed no later than six months after the signing of this agreement. Israel will continue to carry the responsibility for overall security of the Israelis in Hebron. More details about the agreement can be seen in appendix 1 .

Landuse

Hebron District has a total area of 105,000 hectares with six major landuse classes distinguished. These are; Palestinian builtup areas, Israeli settlements, closed military areas and bases, nature reserves, forests, and cultivated areas.

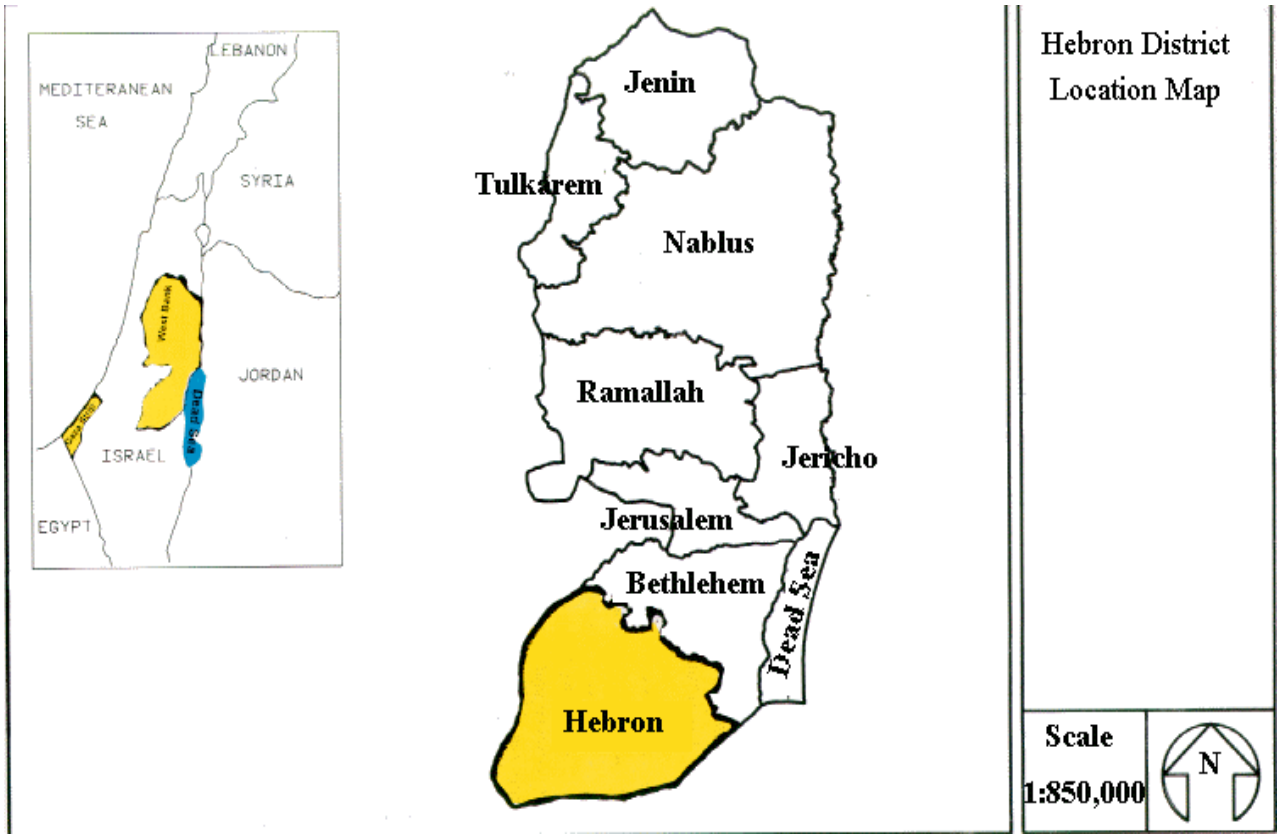

Figure 1.1: Hebron District Location Map

According to "Taba Agreement" the West Bank land is divided into three areas, namely Area A, Area B and Area C. Both Palestinians and Israelis agreed that the West Bank, except for issues that will be negotiated in the permanent status negotiations, will come under the jurisdiction of the Palestinian Council in a phased manner. In this respect the Hebron District is specified as follows:

- "Area A" means Hebron City,
- "Area B" means populated villages, camps and the built-up area of the hamlets listed in appendix 1 , and
- "Area C" means areas of the district outside Areas A and B.

The Hebron City is further divided into two areas, figure 1.2 , ";Area H-1" which is similar to those in other cities in the West Bank, and "Area H-2" in which Israeli military forces will not redeploy during the interim period.

Palestinian built-up areas

There are 153 Palestinian builtup areas in the district. Hebron, Halhul, Yatta, and Dura are the only municipalities in the district including the two refugee camps, Al-Fawwar

and Al-'Aroub camps. Other built-up areas are either village councils or village mukhtars. Palestinian built-up areas comprise 3.6% of the total area. Figure 1.3 shows the distribution and names of the various built up areas in the district. These areas comprise approximately 3,750 hectares and are located on the Brown and Pale Rendzinas, and Terra Rossa soils. These soil types are the most suitable for agricultural purposes in the district.

Israeli settlements

There are 27 Israeli settlements in the Hebron District, occupying approximately 580 hectares (0.55% of the total district area). They are located on the same soil associations occupied by the Palestinian built-up areas. Figure 1.3 shows the distribution and names of these settlements.

Closed military areas and bases

The Israeli army controls approximately 20,200 hectares of the Hebron District, claiming that these areas are important both as security zones and for military training purposes. In addition, there are four military bases, with a total area of about 120 hectares. The closed military areas cover the entire eastern border while the military bases are distributed through the district. The closed military areas and bases are located on the following soil associations:

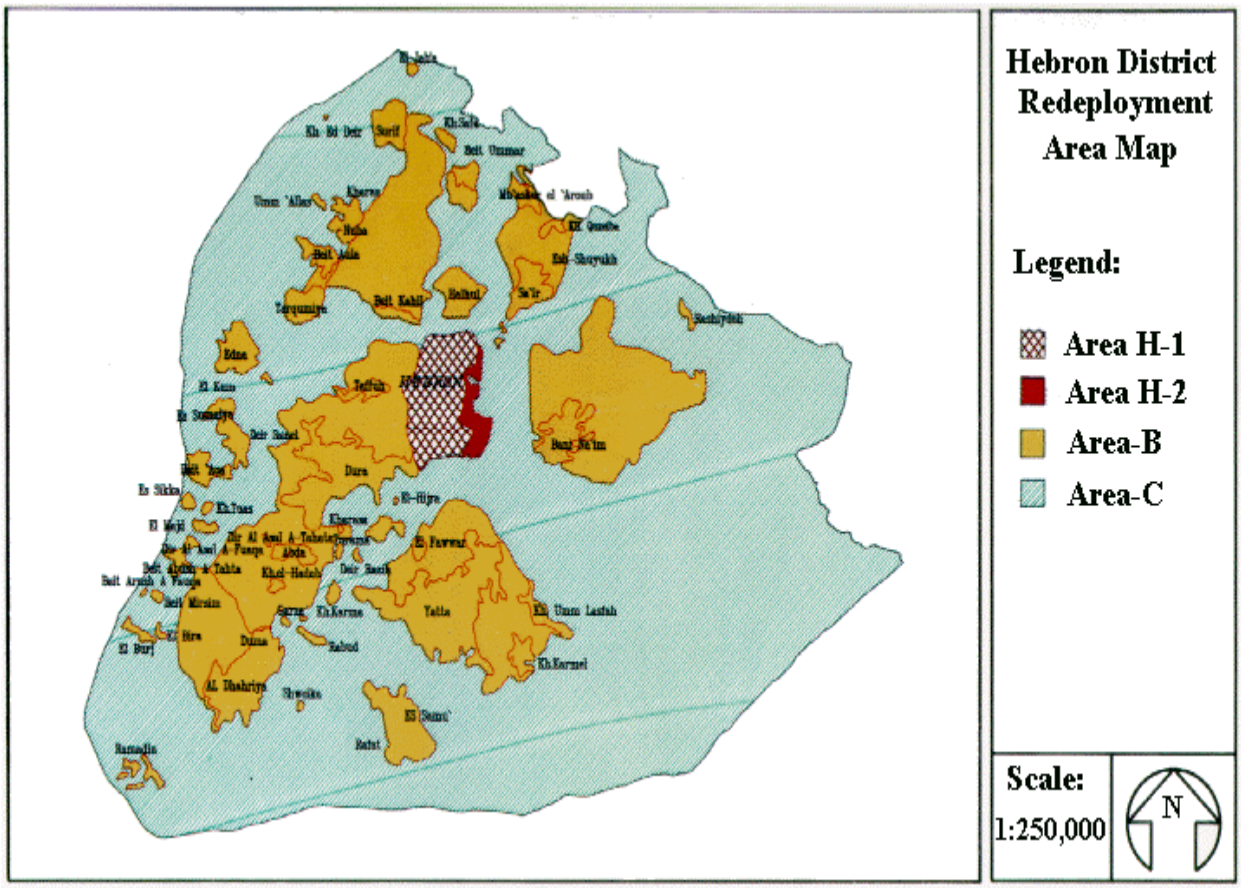

Figure 1.2: Hebron City Redeployment Areas

1. Brown lithosols and loessial Serozems, which are not suitable for agricultural purposes, but they are important in terms of natural biodiversity and as a potential source for managed grazing.
2. Brown lithosols and loessial arid brown soils, in which annual field crops, mainly wheat and barley, could be grown on these areas.
3. Terra Rossa, Brown Rendzinas and Pale Rendzinas, which are most suitable soils for agricultural purposes.

Nature reserves

Currently, there is only one declared nature reserve in the Hebron District with a total area of almost 700 hectares, most of which is located within the Israeli-declared closed military area. Because of the Israeli government's history of confiscating land by first declaring it as nature reserve, there is doubt about the true environmental significance of the currently declared nature reserve.

Forests

There are 18 forested areas in the district with a total area of about 1,200 hectares. 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

Approximately 34% (35,900 hectares) of the Hebron District are cultivated where 91 hectares are devoted to irrigated agriculture. The remaining agricultural area is cultivated with rainfed crops, such as fruit trees, field crops and vegetables, see figure 1.4 .

Table 1.1: Landuse classification.

Landuse	Area (ha)	% of Land
Palestinian Builtup Areas	3,750.7	3.6
Israeli Settlements	582.6	0.55
Closed Military Areas	20,215.8	19.3
Military Bases	119.2	0.11
Nature Reserves	688.9	0.66
Forests	1,200	1.14
Cultivated Areas	36,000	34.28
Others*	42,442.8	40.42
Total	105,000	100%

*** Unused land or land used for grazing.**

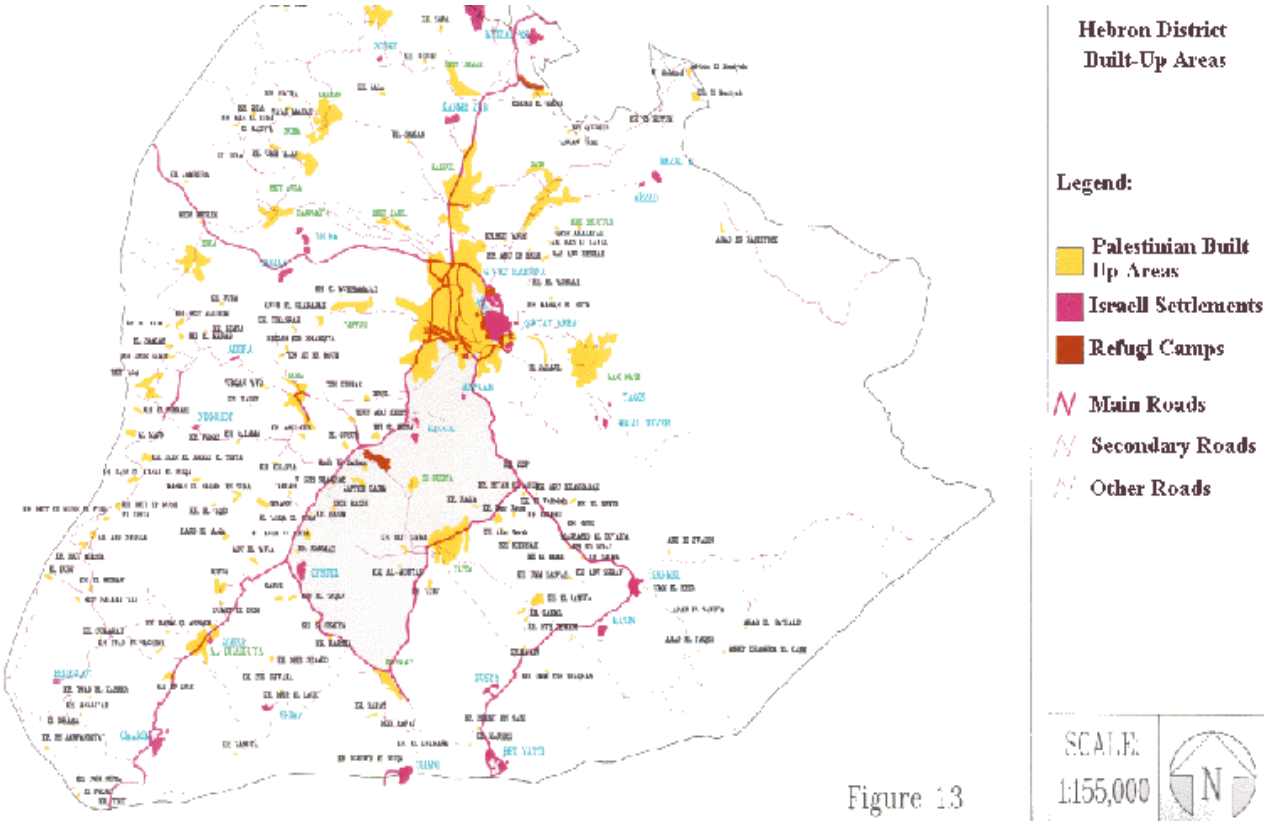

Figure 1.3: Hebron District Built-Up Areas

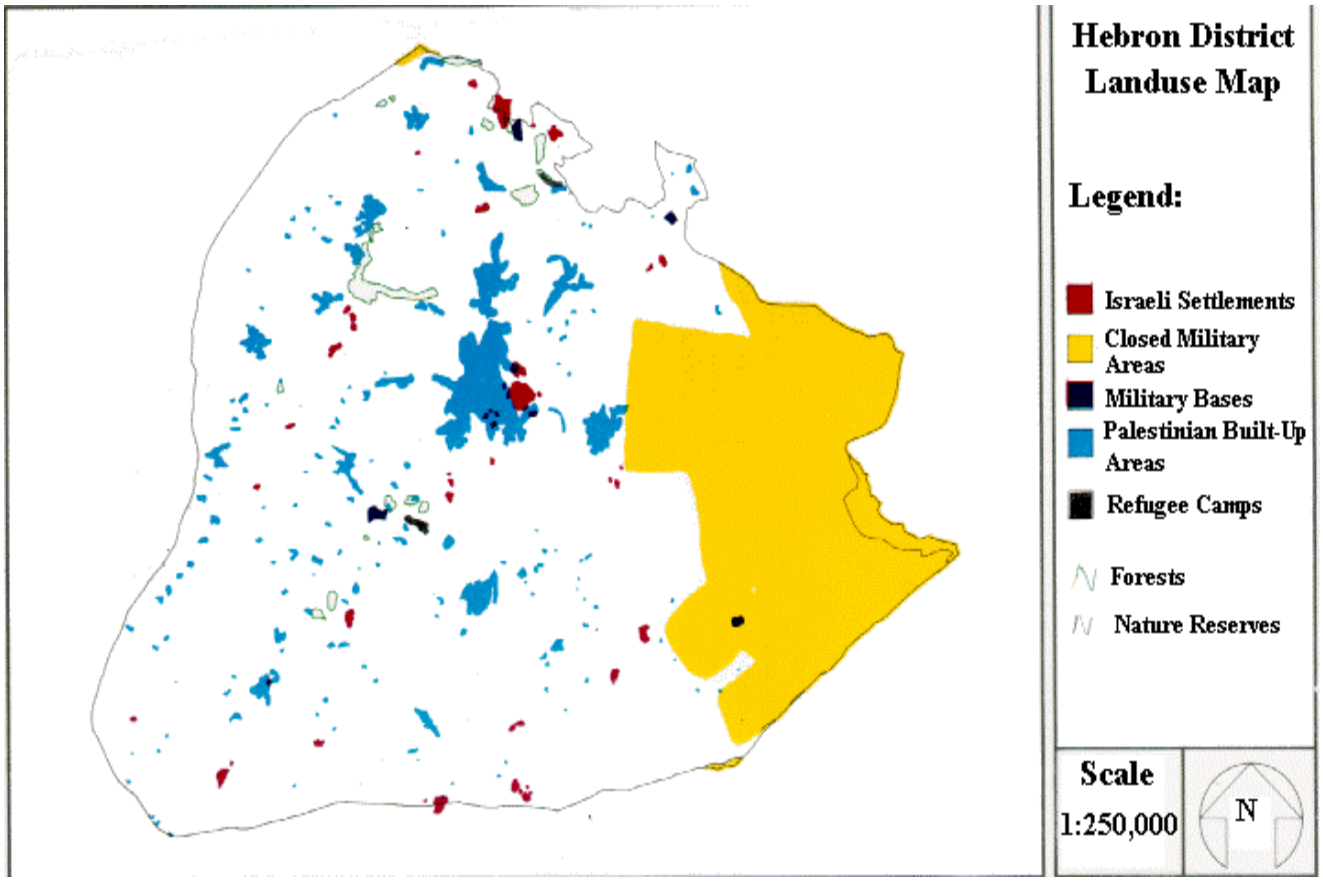

Figure 1.4: Hebron District Land Use

Chapter Two
Topography and Climate

Topography

The Hebron District is characterized by great variation in its topography and altitude. The highest elevation of approximately 1011 m above sea level is found in Halhul area. The eastern part of the district is charactrized by sharp slopes, called the Eastern Slopes, where elevation drops from 1011 to 100 m above sea level, see figure 2.1. Most of the Palestinian built up areas in the district are located at elevations between 600m and 1000m above mean sea level.

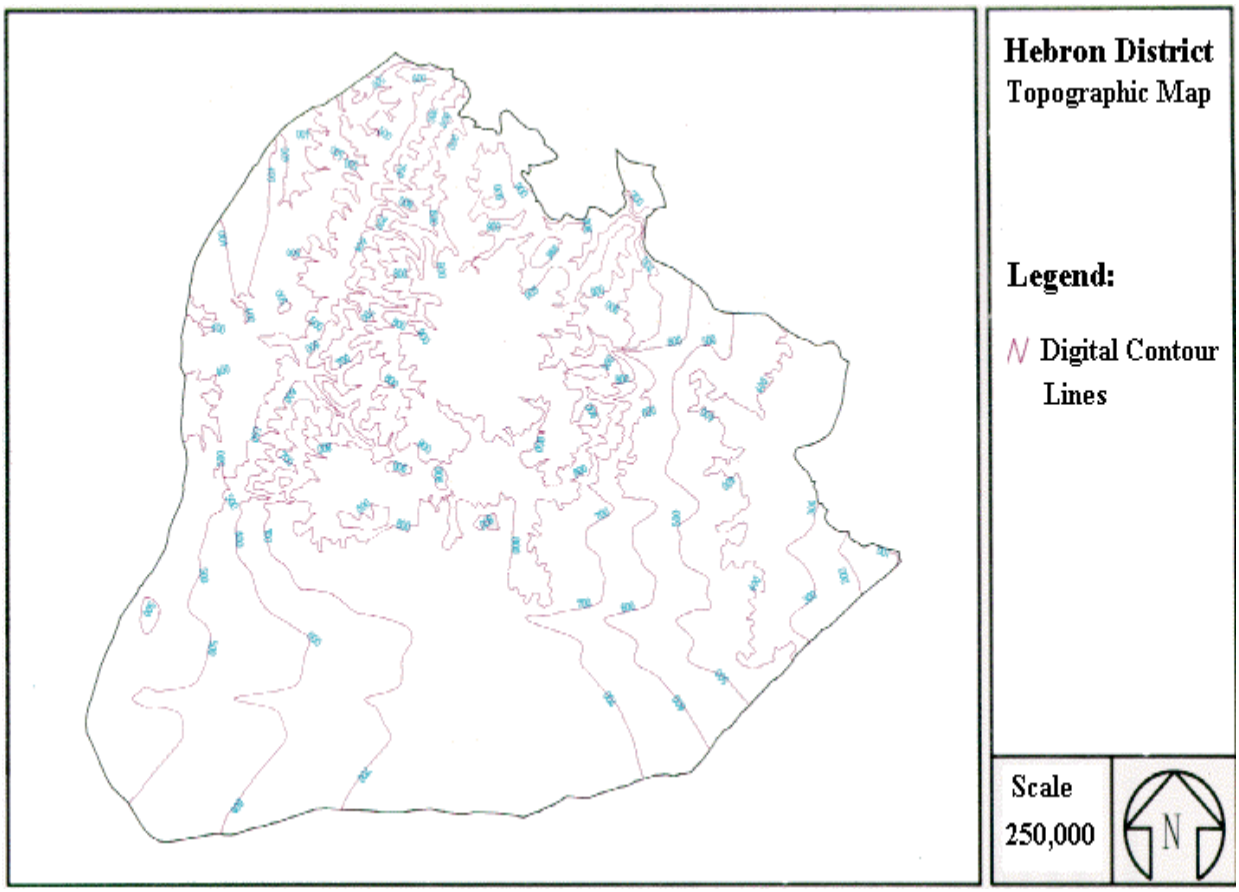

Figure 2.1: Hebron District Topographic Map

Two main drainage systems are distinguished in the Hebron District. The first system runs to the west or south-west such as wadi Al-'Aroub, wadi Haska, wadi Qura, wadi Nar, etc. While the second system runs to the east or south-east, such as wadi Umm el'Adees, wadi Abu el Haiat, wadi Ghar, etc.

A digital elevation model (DEM) containing Z-value with pixel size of 100m was created for the Hebron District. This model was constructed using the finite difference technique of the Topographer Model of the 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 three dimensional lines with varying elevation.

Figure 2.2 represents the produced DEM, which is themed using the threshold table with an interval of 100m. Themes are colored values that give a quick and effective method for identifying features and areas that meet specified criteria. The Threshold table simply tells the GIS software which color to use when displaying certain pixels.

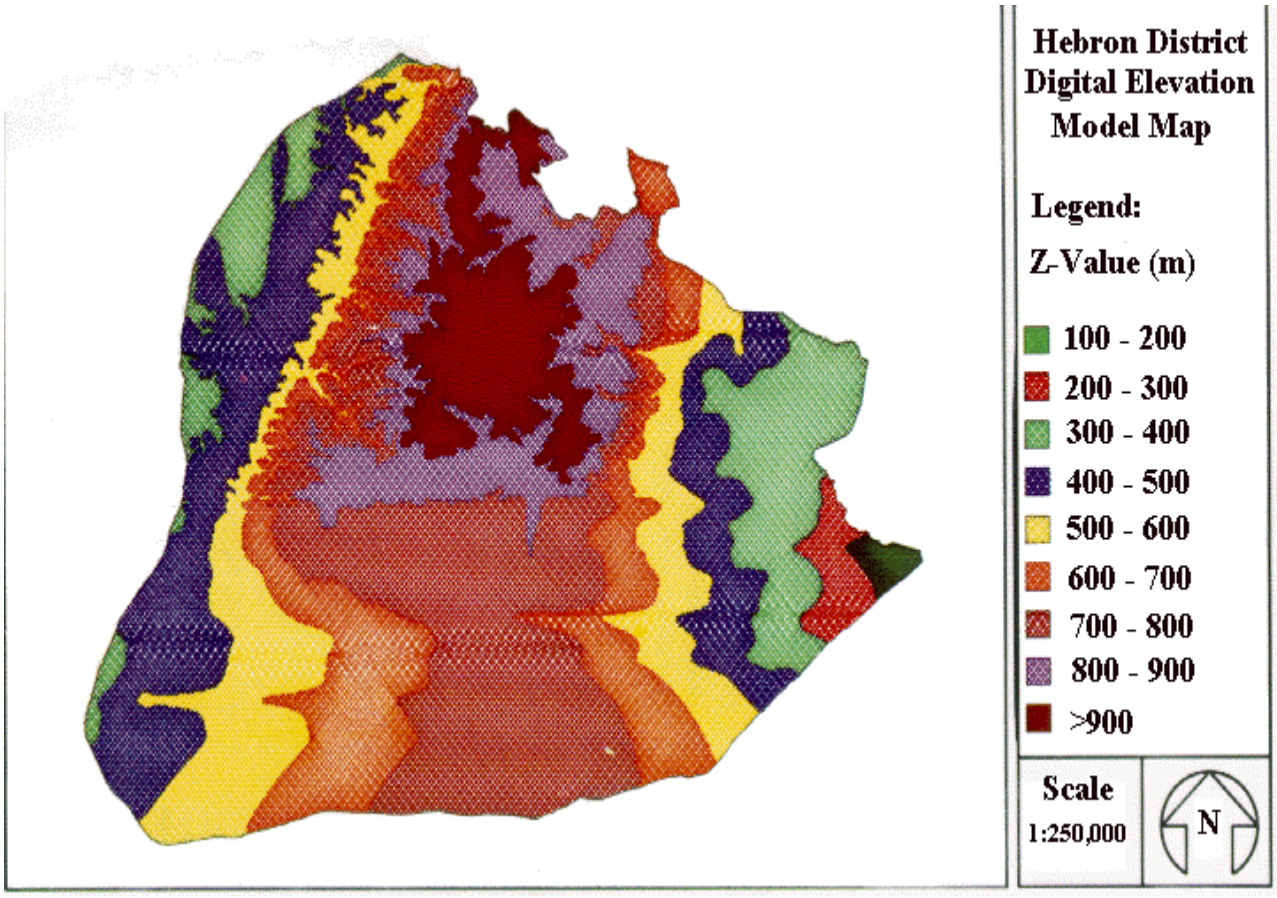

Figure 2.2: Hebron District Digital Elevation Model

Climate

The climate of the Hebron District ranges from arid to semi-arid with an increase in aridity towards the Negev desert in the south and the Jordan valley in the east.

Wind:

Usually Hebron District experiences western winds. During autumn and spring seasons, these western winds from the Mediterranean are humid. The incoming sea breeze is usually felt on the Mediterranean shore between 7-8 o'clock in the morning and reaches Hebron District around mid-day. During the summer, the prevailing winds come from north-west, at an average speed of 10 km/hour during the day, decreasing to 5 km/hour during the night and early morning hours. In the winter, the winds are most frequently from the south-west, with a wind velocity reaching 35 km/hour. Storms have been observed in winter with wind speed up to 40 km/hour (Kessler, Y. 1994).

From late April to mid-June, the Hebron District is often hit by storms known as the Khamaseen. The Khamaseen originates from the Arabian desert and brings very hot dry winds full of sand and dust to the district. These storms occur most frequently and severly at the beginning and end of the hot and dry summer period.

Temperature:

The monthly average temperature ranges from 7.5-10 oC in the winter to 22 oC in the summer. The minimum temperature is -3 oC in January and the maximum is 40 oC in August. The ground temperature ranges from a minimum of -5 oC in January, to a maximum of 42 oC in the summer season (Kessler, Y. 1994).

Relative Humidity:

The mean range of annual relative humidity is 60-75%. The relative humidity reaches 40% in mid-day and increases gradually to reach 80-100% as an average at night, as shown in figure 2.2(Kessler, Y. 1994).

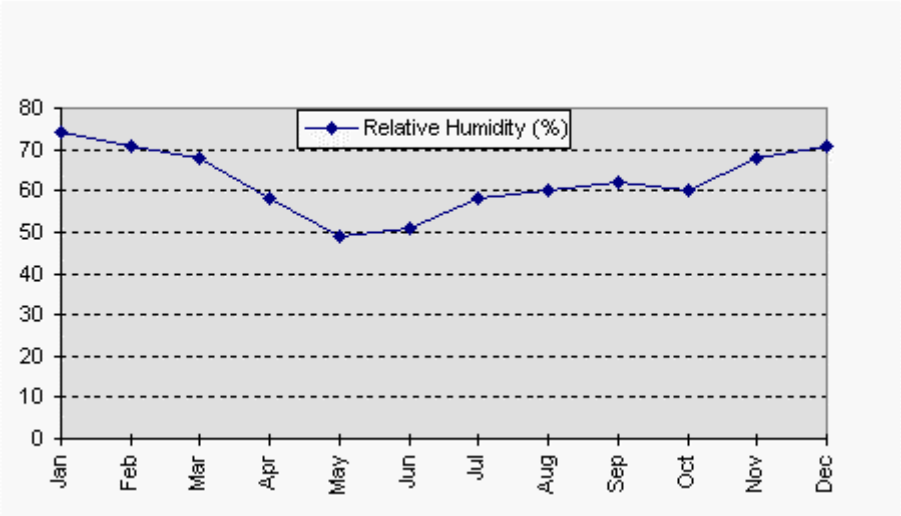

Figure 2.3: Annual mean relative humidity from 1970-1992.

Rainfall:

The mean annual rainfall, see figure 2.3 , for the period of 1970-1992 at the Hebron meteorological station was 588 mm/year. The quantity of mean annual rainfall in Hebron District varies from year to year, while the rainfall reaches 1027 mm in the wet years, it drops to 200 mm/year during the dry years (Hebron meteorological station). The amount of rainfall decreases from 638.4 mm at Al-'Aroub in the north to reach 383 mm at Al-Dhahriya in the south of the district and 200 mm at the eastern boundaries, see figure 2.7. During the wet year 1979/80, rainfall reached up to 876 mm and in 1991/92 reached 1027 mm (Kessler, Y. 1994).

Most of the rain falls during December through February, although there may be rain from mid-October to the end of April.

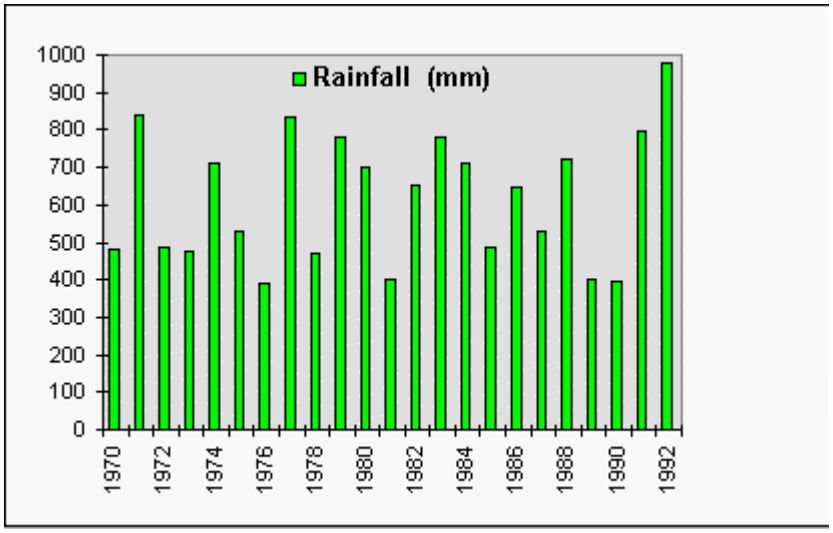

Figure 2.4: Annual mean rainfall in mm from 1970-1992

Evaporation:

Mean daily evaporation varies from 2 mm/day in December to 8.5 mm/day in August. The average monthly evaporation of Al-'Aroub weather station is 230 mm/month in the summer and 80 mm/month in the winter. As shown in figure 2.4 , there are only three months of the year where rainfall exceeds evaporation (Kessler, Y. 1994).

Sun Shine Radiation:

The district has a sunny climate with an average of 5-6 hours/day of sun shine during the winter and 10-11 hours/day during the summer (figure 2.5). Inhabitants of the district largely depend on this renewable source of solar energy for heating of domestic water. The annual mean solar radiation incident on horizontal surface for Hebron is approximately 2.1 k.Joules/cm2/day (Atlas of Israel 1995).

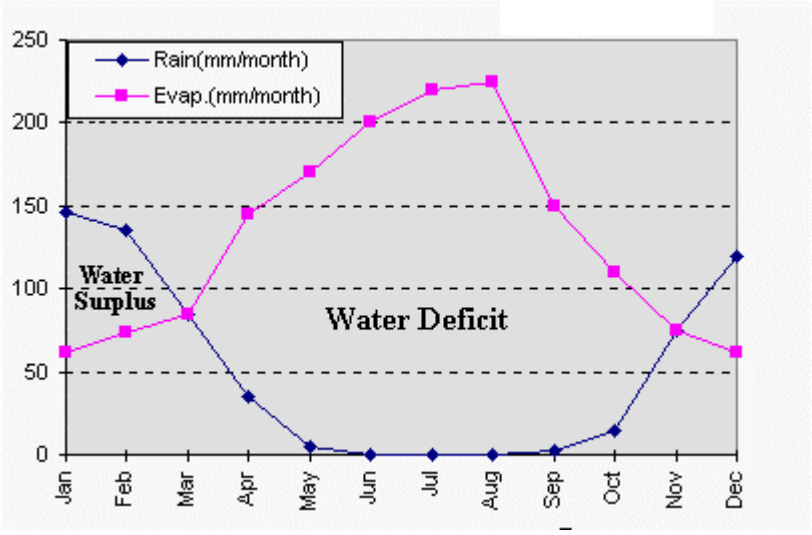

Figure 2.5: Monthly rainfall and evaporation for 1970-1992

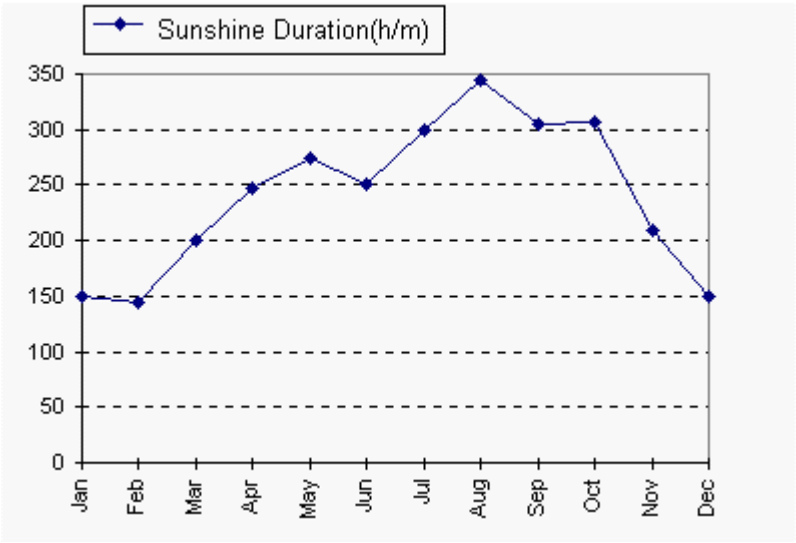

Figure 2.6: Monthly mean radiation for 1970-1992

Table 2.1: Meteorological conditions at the Hebron Weather Station for 1970-1992

Month	Rainfall (mm)	Max.Tem (oC)	Min.Tem (oC)	R.H. (%)	W.speed (Km/day)	Evap. mm/mon.	Sun.Dur. h/mon.
Jan.	145.15	10.25	3.96	74.19	298.2	65.1	145.7
Feb.	131.31	11.50	4.70	72.22	306.7	81.2	133.0
March	89.60	14.57	6.46	65.96	303.5	93.0	198.4
April	36.98	19.59	9.93	54.62	275.7	138.6	243.0
May	4.12	23.63	13.23	48.25	223.5	165.8	277.7
June	0.46	25.90	15.77	51.03	221.9	199.5	249.0
July	0.00	27.16	17.04	56.77	220.3	220.7	297.6
August	0.00	27.23	16.96	59.88	208.8	225.0	337.9
Sep.	1.51	25.97	15.94	61.66	194.1	156.6	304.8
Oct.	13.59	23.18	14.02	58.89	193.5	111.6	304.7
Nov.	63.00	17.50	9.90	64.07	210.1	87.0	210.0
Dec.	116.10	12.09	5.62	72.69	242.3	62.0	145.7
Total	601.82	-	-	-	-	1606.1	-

Source: Israel meteorological service
Table Notes:
R.H: Relative Humidity,
Sun. Dur.: Sunshine Duration
W. : Wind
Max.: Maximum
Min. : Minimum

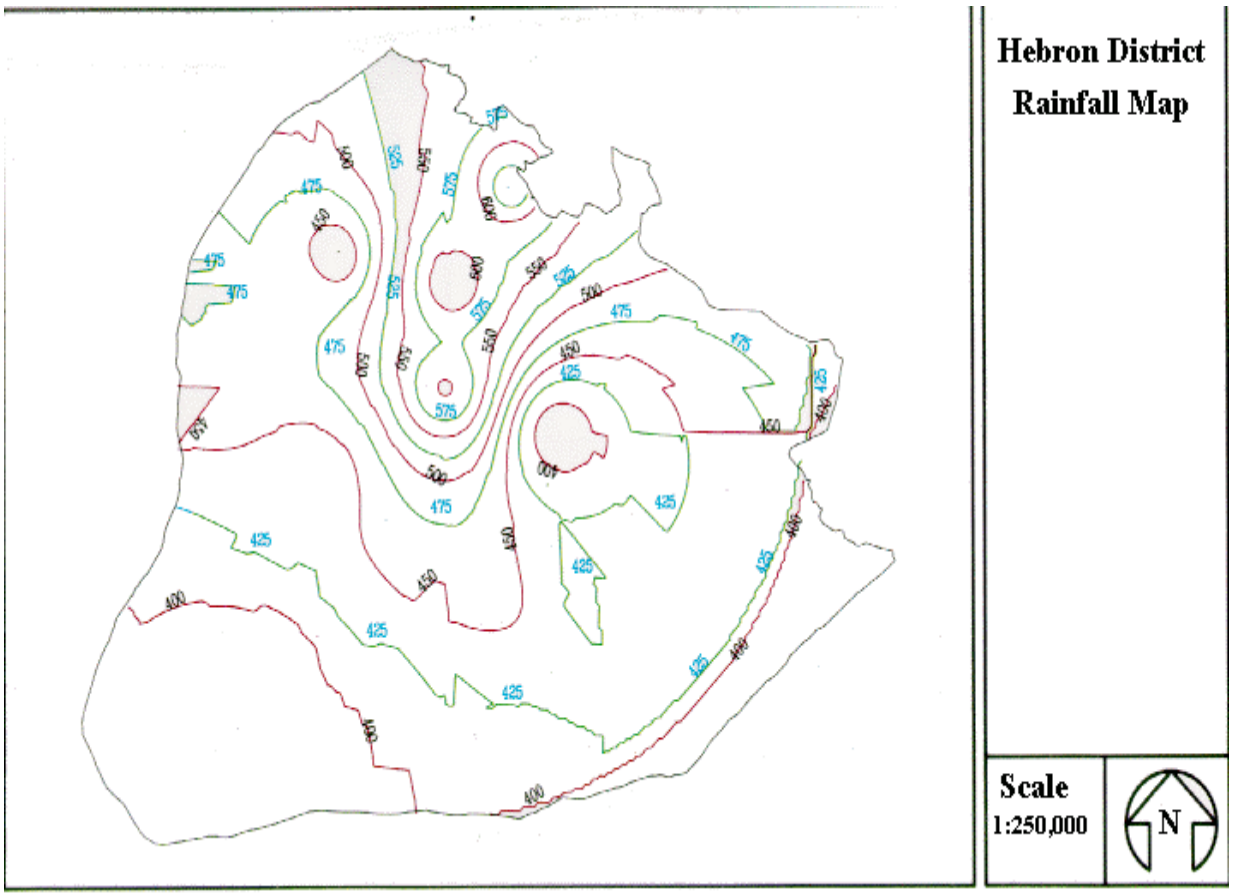

Figure 2.7: Hebron District Rainfall Map

Chapter Three
Socio-economic Characteristics

Demography and Population

The estimated total population of the Hebron District is 257,691 per the year 1994, representing 12% of the total population of Palestine. The district center, Hebron City, has a population of approximately 85,980, representing 33% of the total population of the district (PBS, 1994). According to the Hebron Municipality, the city has a population of around 123,000 people per the year 1994. Despite the PBS underestimation of the district population the PBS figures are used in this volume, because population statistics was not conducted Since 1967.

Approximately 42% of the population of the Hebron District (108,547 people) live in rural areas. 5% (approximately 11,675) lives in refugee camps and 53% (approximately 137,467) lives in communities under municipalities administration (PBS, 1994).

Hebron is an agricultural marketing and trade center, with glass and leather manufactures. Productive agricultural activities exist only in the western parts of the region where the climatic and soil conditions are favorable. The eastern part of the region has desert-like conditions with barren steep hills, sloping towards the Dead Sea shores. Except for grazing, there is a very limited potential for productive agricultural development.

Major industrial activities in the district include stone and aggregate quarrying, stone and marble cutting, tanning industry, manufactures a distinctive type of blue, hand-blown glass, shoes making and a wide range of manufacturing and processing industries.

There are no figures or studies concerning the per capita Gross National Product (GNP) or Gross Domestic Profit (GDP) for the district. According to the World Bank official statistics, the overall economy in Palestine is characterized by a per capita GNP of US$ 1,715 and a GDP of US$ 1,275 for 1991 (World Bank, 1993).

According to a 1994 study, Approximately 68% of the employed persons have permanent jobs, 17% have seasonal jobs and 15% have part-time jobs. The unemployment rate (aged 16 to 59) is around 30% which includes all persons who don't work at all for one reason or another (PARC & Arab Thought Forum, 1994).

Infrastructure Services

Provision of services for the district inhabitants is not limited to the governmental and civil administration institutions. The district contains a large number of charitable and non-governmental organizations that fill the gaps in services that the formal institutions

are not able to provide. Appendix 2 shows the most important associations and institutions.

Sewage Disposal Facilities:

According to the survey conducted by ARIJ in May 1995, around 55% of Hebron City is connected to the sewage disposal network. The remaining 45% depends on cesspits for sewage disposal. There is no sewage collection network in any of the villages in the district. The village inhabitants depend on cesspits for sewage disposal. In the refugee camps there is no access to a sewage system or collection in cesspits. The sewage waste is carried away in open channels.

Piped Water Supplies:

Although 82% of the population in the district has access to piped water, there are many problems with water quality and continuity of supply. During summer, people in the villages, camps and even in Hebron City, suffer from water shortages. Future plans to Rehabilitate the networks and to increase supply rates is prepared by municipalities and village councils.

Solid Waste Disposal Services:

Solid waste disposal and management is an increasing problem which local authorities must address. Solid waste can be seen on road sides, backyards and in open space. The waste collected by municipal or village councils is deposited in open, uncontrolled dumps. Nearly 78% of the solid waste is collected in the Hebron District, while the remaining 22% of the garbage is dumped randomly (ARIJ 1995).

Electricity Services:

The Israeli Electric Company (IEC) supplies the Hebron District with electricity. On average about 63% of households receive electricity on 24 hours basis. In rural areas, electric supply is erratic with less than 50% of rural households receiving a 24 hours/day. One of the major problems faces the rural areas is the disconnection of electricity supply because of poor maintenance, or as a result of commulative bills which are not paid by the municipalities or village councils. Rural communities which do not have access to electricity supplies are dependent on either local community generators or on home

generators which are used by some or all households in the communities (Heiberg, M. and Ovensen, G. 1993).

Transportation and Communication:

The level of infrastructure in the Hebron District varies between urban and rural areas. Many of the rural communities are accessible only through unpaved narrow roads. Access roads to most villages suffer from rapid deterioration, and internal road networks in some of these villages are rated as very poor. Furthermore, the small and scattered village communities have poineering or road infrastructure (Center for Engand Planning, 1993).

Not only the roads in the district lacks proper pavement and design, but also poor organization and management of the traffic system; for example, traffic lights are not allowed by the occupation military laws and traffic police is not available. Three types of transportation services are available in the district: buses, taxis, and private cars.

In the urban areas approximately 24% of households have access to telephone network, while 7% of villages and rural areas are connected (Heiberg, M. and Ovensen, G. 1993). In rural areas, most of the time, telephones are non-functioning due to network problems or cables theft.

Health Sector

Since the onset of Israeli occupation, the Israeli military authorities have implemented policies that neglected the existing governmental health services and led to the disintegration of health-care infrastructure in the territory. The natural development of this sector was impeded by tight restrictions, including the denial of funds, the blocking of further development and the linkage of health-care institutions to their Israeli counterparts.

There are four main branches supporting the health sector: the government, the private Palestinian sector, charitable and non-government organizations (NGO's), and UNRWA which is directed primarily towards refugees. In August 1994, the Israelis gave back responsibility for the health care sector to the Palestinian Authority as part of the agreements made in the Oslo Accords.

Health Services

Primary Health Care clinics: Sixty-three primary health clinics serve the Hebron District and are distributed as follows: Twentyfive clinics are operated by NGOs; thirty-one

clinics are run by the public sector, and UNRWA operates seven clinics for the refugees (PCH, 1994).

Hospitals: There are five hospitals in the Hebron District; two are public hospitals, one is operated by the government and the remaining one by NGO. There is also a pediatric hospital operated by NGO's sector and two private maternity hospitals. Six rehabilitation centers serve Hebron District (PCH, 1994).

There are 14 ambulances in the Hebron District, out of which 8 belong to the Red Crescent, 3 are owned by the Patient's Friends Society, one belongs to the government hospital and two are owned by the Hebron Municipality (PCH, 1994).

Medical and Health-Care Personnel: The total number of human health resources in the Hebron District is:

- 159 physicians, representing 12% of the total physicians in Palestine.
- 125 nurses, representing 5.5% of the total number of nurses in Palestine.
- 52 dentists representing 15% of the total dentists in Palestine.
- 140 technicians representing 11% of the total number of technicians in Palestine (Abu Libdeh, 1993).

Education Sector

Since 1967 the education sector was controlled by the Israelis military law. Recently, in August 1994, after the "Cairo Agreement" between Israel and Palestinian Authority, the education sector has been the responsibility of the Palestinians.

In 1942/43, there were only two schools in the district, they were classified as elementary schools, one for boys and one for girls. By 1966/67 the number of schools had grown to 25 this included governmental, UNRWA, and privately operated schools (Encyclopedia Palaestina, 1994).

According to the official Palestinian statistics for the year 1994/95, the total number of schools in the district was close to 312, of which 203 are primary schools (elementary and intermediate), 44 are secondary schools and 65 are either kindergartens or community colleges. These schools host close to 103,271 pupils (excluding universities) (PBS, 1995). The following table shows the total number of pupils in the district and the distribution by education level and sex.

Table 3.1: Distribution of pupils by educational level and sex for the year 1994/95.

	Kindergartens	Primary	Secondary	Colleges
Male	3,470	46,596	3,548	396
Female	3,008	43,650	2,999	546
Total	6,478	90,246	6,547	942

Although governmental schools which were established after 1967 comprise the largest sector of the school system in Hebron District, (there are 215 government schools, 79 private schools and 18 UNRWA schools), the educational system is in great need for attention and review. Overcrowding in classrooms greatly affects the levels of both education and literacy among pupils, as shown in figure 3.1 .

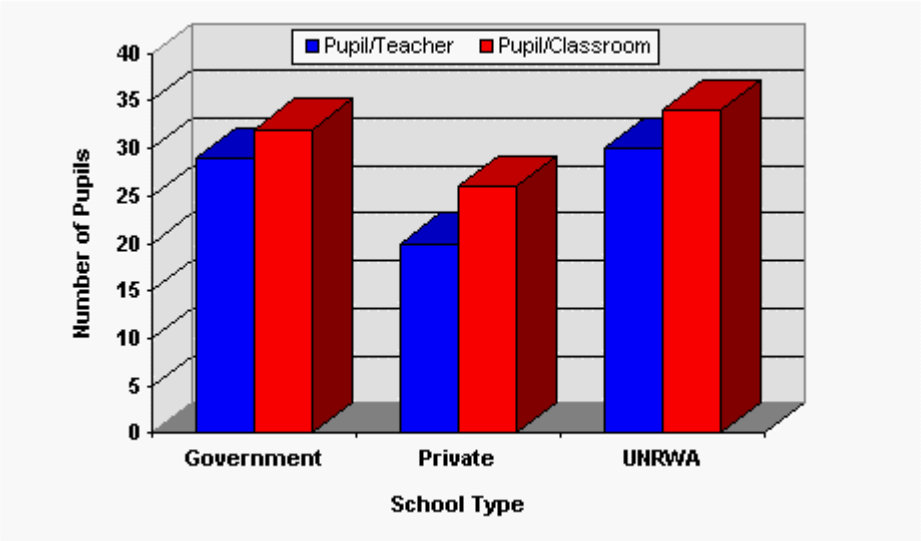

Figure 3.1: Average number of pupils in the various school types.

Chapter Four
Water Resources

Water shortage is a serious problem facing the Hebron District, not only due to the arid and semi-arid climatic conditions and rainfall variability in the area, but also due to the Israeli strict control over the Palestinian water resources. The &Taba Agreement & which signed on September 28, 1995, contains an undertaking on the part of Israel to increase the amount of water allocated to Palestinians by 28.6 mcm/year. Any further addition to either side will be based on an increase in the available water resources to be developed through international funding and channels. The agreement provides for the establishment of a Joint Water Committee that will manage water resources and enforce water policies, protecting the interests of both parties by the prevention of uncontrolled drilling by enforcing standards. The agreement provides Hebron and Bethlehem Districts with one million cm/year from the above mentioned quantity (Documents of Taba Agreement 1995).

Hydrogeological Status

Groundwater Aquifers

Hebron is located on the crest of the anticline structure extending from Beer Sheva' area in the south to Jerusalem area in the north forming the Hebron mountain series. There are two main aquifer systems in the district:

1. Lower Cenomanian Aquifer System

This system feeds the Herodion and Jerusalem boreholes and the springs in the Dead Sea area. The geologic formations of this aquifer system are Lower & Upper Beit Kahil (Rofe & Raffety, 1963) and are mainly composed of Dolomite, Limestone, Marly and Chalky Limestone.

2. Upper Cenomanian Aquifer System

This system feeds Al-'Aroub, Sa'ir and Dirwa springs, as well as other springs in the area. It also feeds Al-Fawwar, Beit Fajjar, Samu', and Rihiya well fields. This aquifer system is mainly composed of Limestone, Chalky Limestone, and Dolomite.

Groundwater Basins

Figure 4.1 shows the groundwater basins and exposed aquifers in the Hebron District. The majority of the district is underlained by the Jerusalem desert groundwater sub-basin

which is itself underlained by the Auga-Tamaseeh and the Hebron-Beer Sheva' Sub-basins of the western and eastern flank of the West Bank Mountain Aquifer.

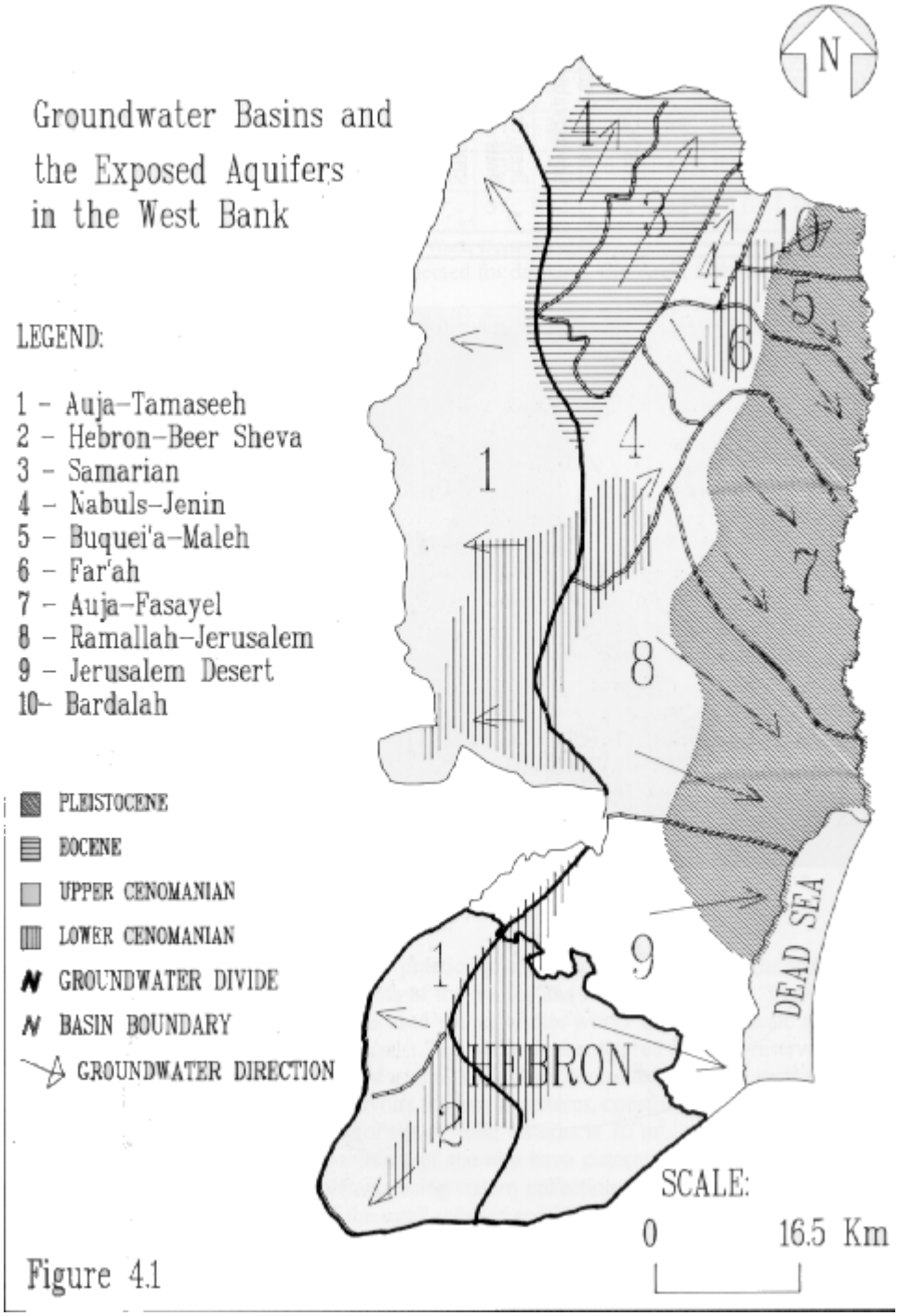

Figure 4.1: Groundwater Basins And The Exposed Aquifers In The West Bank

Sources of Water

Groundwater Wells

There are four licensed groundwater wells in the Hebron District which are used for domestic purposes. As mentioned previously, these wells are controlled by the following:

- The Hebron Municipality and West Bank Water Department which includes Fawwar wells No.1 and No.2 and whose total discharge to the network is approximately 105 m3 /hr.
- The Mekorot (Israeli Water Company) uses Samu' and Rihiya wells and the total discharge is undeclared to the Palestinians.

There are also 64 traditional shallow groundwater wells which are un-licensed and used for irrigation purposes.

Proposed Deep Groundwater Well in Sa'ir Area

To increase water supply to the Hebron District and reduce water shortage, Hebron Municipality requested permission from the Israeli military authority to construct a deep groundwater well to tap the Lower Beit Kahil formation (Lower Cenomanian Aquifer) in the Herodion area (Wadi Sa'ir). The Municipality has succeeded in 1995 in obtaining the necessary permission to drill this new well in Wadi Sa'ir close to Taquo' Area (13 km north of the city). The project will enhance the Municipality's own water recourses to meet the minimum demand currently estimated at about 70 l/c/day.

The well is planned to be 700 meters deep and 18 inches in diameter, and will have all the necessary electro-mechanical accessories and a 13 km conveyance pipeline (16 inch diameter) which will carry the water to the central reservoir in Hebron. The site is selected by the West Bank Water Department (WBWD) near the two operating wells at Herodion (Batn El-Ghoul 4 & 5). The estimated well's yield will be approximately 300-400 m3/hr, and will tap the Lower Beit Kahil geologic formation. Tahal (1979) had recommended to drill two wells at the same site, one in the upper and one in the lower Cenomanian aquifer.

Springs

There are approximately 57 springs, see figure 4.2, in the Hebron District which are freely used by the surrounding population without restrictions for small scale domestic and irrigation purposes. Table 4.1 shows the main springs of the Hebron District and their discharge rate. The springs and their discharge rate can be seen in table 4.2 of appendix 3.

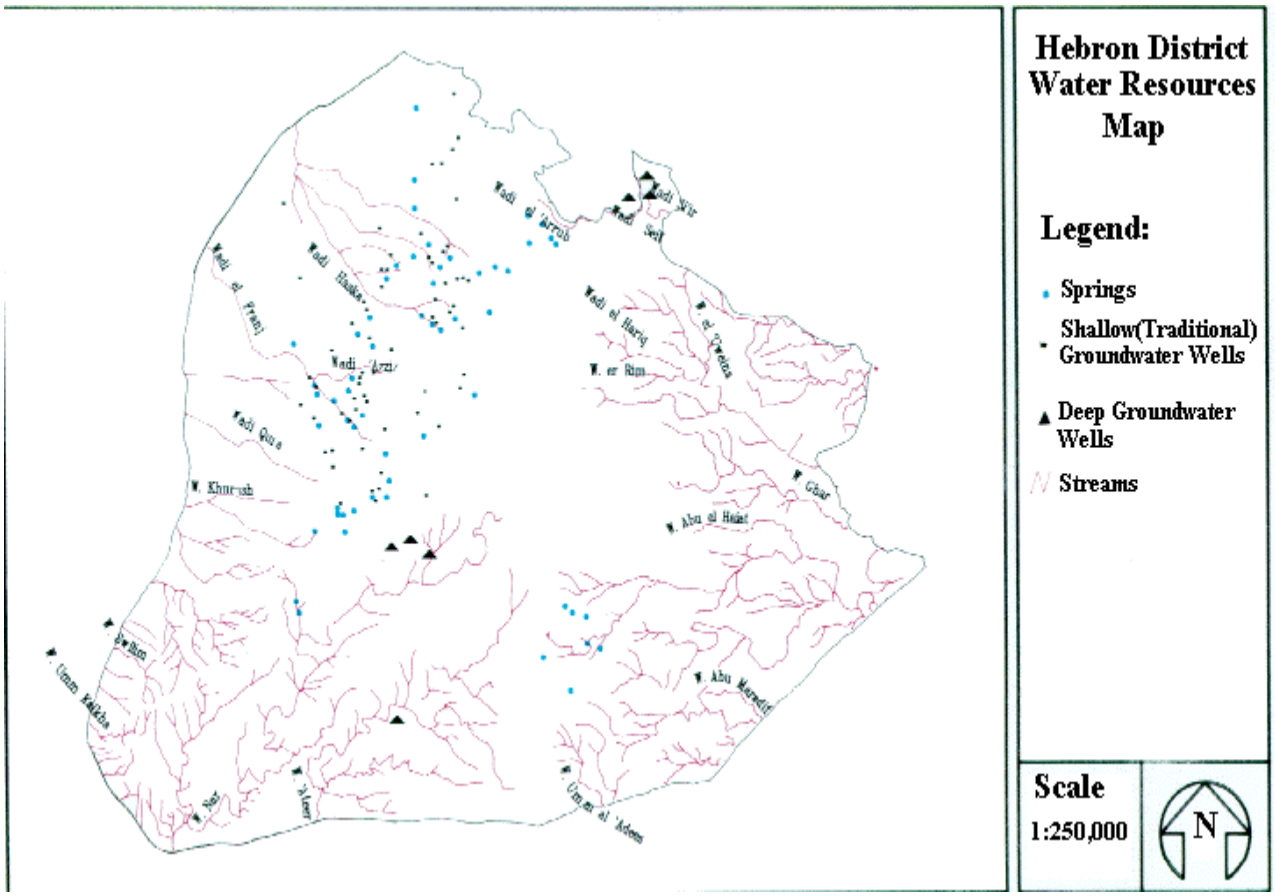

Figure 4.2: Hebron District Water Resources Map

Table 4.1: Variation in discharge of 4 main springs in the district from 1982/83 - 1993/94.

Spring Name	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94
Sa'ir	211	37	42	26	80	82	37	14	28	294	163	39
Dilba	84	32	32	20	23	37	32	32	38	108	50	32
Kanar -west	89	37	32	32	37	83	53	39	47	129	87	34
Ungor	105	44	26	32	37	37	42	37	32	110	76	66

*** Discharge in 1000 cubic meters (West Bank Water Department files).**

Photo 1: Site where spring water is collected for drinking, Ein Arab, Hebron City

Rainwater harvesting

Rainwater harvesting is a common practice in the West Bank. During the winter, the rainwater is collected from the roofs of the houses and stored in cisterns. Two types of rain water catchment systems are used. One system works on a large scale to collect storm water runoff from the ground. This water is then stored in large reservoirs. The other system collects rain water on a small scale from controlled surfaces, such as a roof. This water is stored in small reservoirs, known as cisterns, constructed underneath or next to house. The average capacity of the existing cisterns is 70 m3. According to Hebron Municipality, 60% of the inhabitants of the city have cisterns in their houses. In rural areas, the percentage of inhabitants using cistern collection systems is higher than in the city. This is because some of the small villages and khirabes are not connected to water distribution networks, thus experiencing a shortage of water. Also, if connected, rural areas suffer from frequent shortage in water supply.

Current Water Situation

The responsible authorities for water supply in the Hebron District are:

- The Hebron Municipality which is responsible for supplying water to the Hebron City as well as the nearly 50,000 inhabitants of Dura, Raboud, Abu Azja, Der Razeh, Tarrameh, Karmeh, Al-Fawwar and Al-'Aroub Refugee camps. The water

is abstracted from two wells located 7 km south of Hebron City (Fawwar wells No.1&2).

- The West Bank Water Department & Mekorot (The Israeli Water Company) which are responsible for supplying water for few municipalities and villages in addition to the Israeli settlements in the district. The water is extracted from two wells located in the Hebron District, Al-Samu' and Al-Rihiya.
- Those not served by any of the above mentioned water authorities rely on rainfall water collection in cisterns for domestic and agricultural use.

Groundwater quality

Table 4.3 below shows the results of routine chemical analysis for major cations and anions of Al-Fawwar wells which are operated by Hebron Municipality. Water sampling and physical water quality measurements, pH, Temperature (Temp) and Electrical Conductivity (EC) where conducted by the Applied Research Institute of Jerusalem (ARIJ) and analyzed at the laboratories of Abu Dies University in December, 1994. ARIJ was not given access to the Mekorot wells to analyze the water quality. The results of the water testing shows that all of the measurements fall within the international standards for drinking water.

Table 4.3: Groundwater quality in Al-Fawwar well field.

Well Name	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	HCO_3^{-}	NO_3^{-}	F^{-}	TDS
Fawwar1	65	58	28	6	182	12.22	0.15	452
Fawwar2	61	54	21	1	223	12.23	0.10	472
Well Name	Date		Temp(^{o}C)			EC(uS/cm)		pH
Fawwar1	7/12/94		14.7 13.0			389 412		7.3
Fawwar2	7/12/94							7.1

Water distribution network

The current network was constructed early in the 1960's. The network is made of steel pipe-lines, with a diameter ranging from 2-16 inches. Approximately 55% of the water is lost due to leakage, illegal use of water and accuracy of water meters. Along with the two wells from which water is drawn, the Hebron Municipality has five storage reservoirs which are also connected to the municipality distribution network (see table 4.4).

Table 4.4: Capacities of reservoirs of the Hebron Municipality	
Reservoir	**Capacity(m^3)**
Central	3,785
No.2	2,000
No.3	600
No.4	600
No.5	400
Total	7,385

The municipality has recently completed the construction of 12 km of new distribution lines and has rehabilitated 4 km of the existing pipelines under the support of the Palestinian Economic Council for Development and Reconstruction (PECDAR). The network currently covers 90% of the population of the city. Rehabilitation of the existing networks is in progress in some villages of the district such as, Yatta, Halhoul and Al-Dhahriya under the support of PECDAR.

Water Supply and Demand

Hebron Municipality consumes approximately 105 m3/hr from Al-Fawwar wells No.1 & No.2 which is equivalent to 2500 m3/day, and Mekorot supplies the municipality with approximately 7000 m3/day at the best conditions, and decreases to reach zero during the summer months. The average water supply of about 9500 m3/day, distributed to the population of Hebron City and the population of the surrounding villages and refugee camps which is about 50,000 people. The daily per capita supply rate varies from 20 l/c/day during the summer months to 50 l/c/day during the best conditions of supply, (including water losses). The daily consumption is considerably low compared with the Israeli per capita consumption, that is currently estimated at about 250 l/c/day. The villages of the district which are supplied by Mekorot have a shortage in water supply around the year and have almost no water supply during summer months.

Water provided by Mekorot is conveyed from Herodion wells into the supplied areas through a 16-inch diameter pipeline. Hebron Municipality buys water from Mekorot at a price of 2 NIS/m3 and sells it for consumers at the following tariff:

Monthly Consumption (m^3)	**Price (NIS)0-10**
0-10	2.45
11-15	2.55
>15	2.65

Two other wells of Rihiya and Samu' are used by Mekorot to provide the settlements and villages of Yatta, Dhahriya, Samu' and Rihiya with water.

Most of Hebron District population are using cisterns as an alternative source for domestic and agricultural purposes. Table 4.5 below shows water supply and demand projections up to the year 2020.

Table 4.5: Water supply and demand based on 1990 baseline data and projections for the years 2000, 2010 and 2020 (Isaac et al, 1994).

Year	Household (mcm)	Industry (mcm)	Agriculture (mcm)	Total (mcm)
1990	9.5	1.6	0.5	11.6
2000	20.77	4.3	1.8	26.87
2010	37.58	8.8	23.6	69.98
2020	58.56	14.3	45.5	128.36

The figures in table 4.5 take into consideration the population growth, returnees, increment of per capita demand and development of the a agricultural and industrial sectors.

Recommendations

- Distributed drinking water should be potable and should meet the international standards.
- Periodic quality control of water in abstraction wells, cisterns and distribution networks is needed.
- Drinking water distribution networks should be rehabilitated, and installation of new networks is very necessary in small and rural communities.
- Development of springs protection and management programs on both state and local levels, as well as the creation of an organizational structure to implement these programs and coordinate activities of the various agencies and levels is needed to cover the district water shortage.
- Allocation of the district water supply should be increased to cover the severe shortage in the district, bearing in mind that the proposed quantity from "Taba Agreement" will not solve the problem.

Chapter Five
Geology and Soil

Geology

The general geology of the Hebron District is displayed in figure 5.1 . The following lithologic units (from the oldest to the youngest) cover the area:

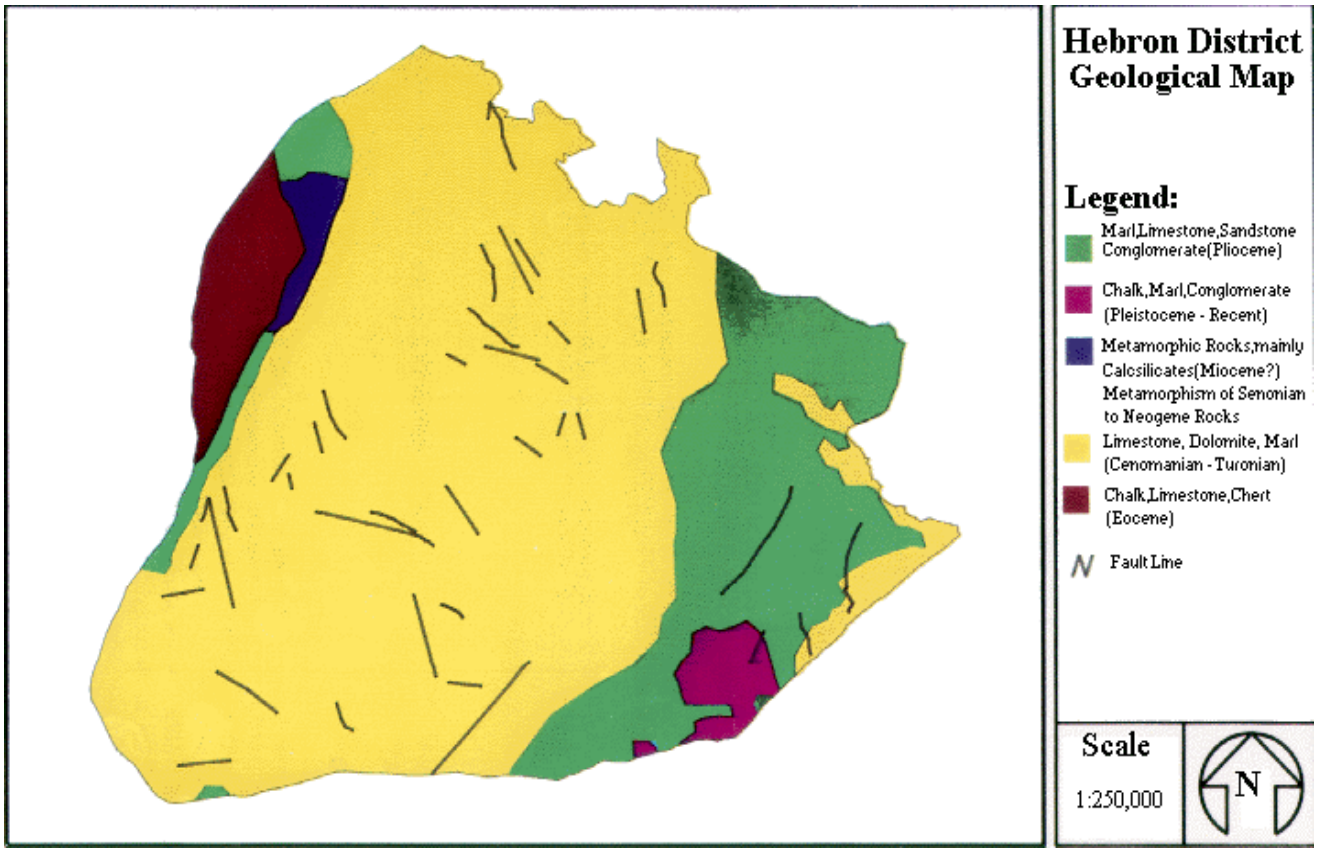

Figure 5.1: Hebron District Geological Map

- Limestone with Dolomite and Marl of the Cenomanian-Turonian age cover about 80% of the district. Figure 5.1 shows the distribution of low and large-scale faults of different types in the study area.
- Chalk and Limestone with Chert of the Eocene age, covers the north-western part of the district and overlies the layer mentioned above.
- Metamorphic Rocks composed mainly of Calcsilicates of the Miocene age occupies the north-western section of the district.
- Marl Limestone with sandstone and conglomerates of the Pliocene age (Tertiary), cover the eastern part of the district in addition to a small area in the western part.

- Chalk- Marl with conglomerates (Pleistocene-Recent) covers a small area of the south-eastern section of the district.

Soil

The major soil associations found in the Hebron District, see figure 5.2 are classified as following:

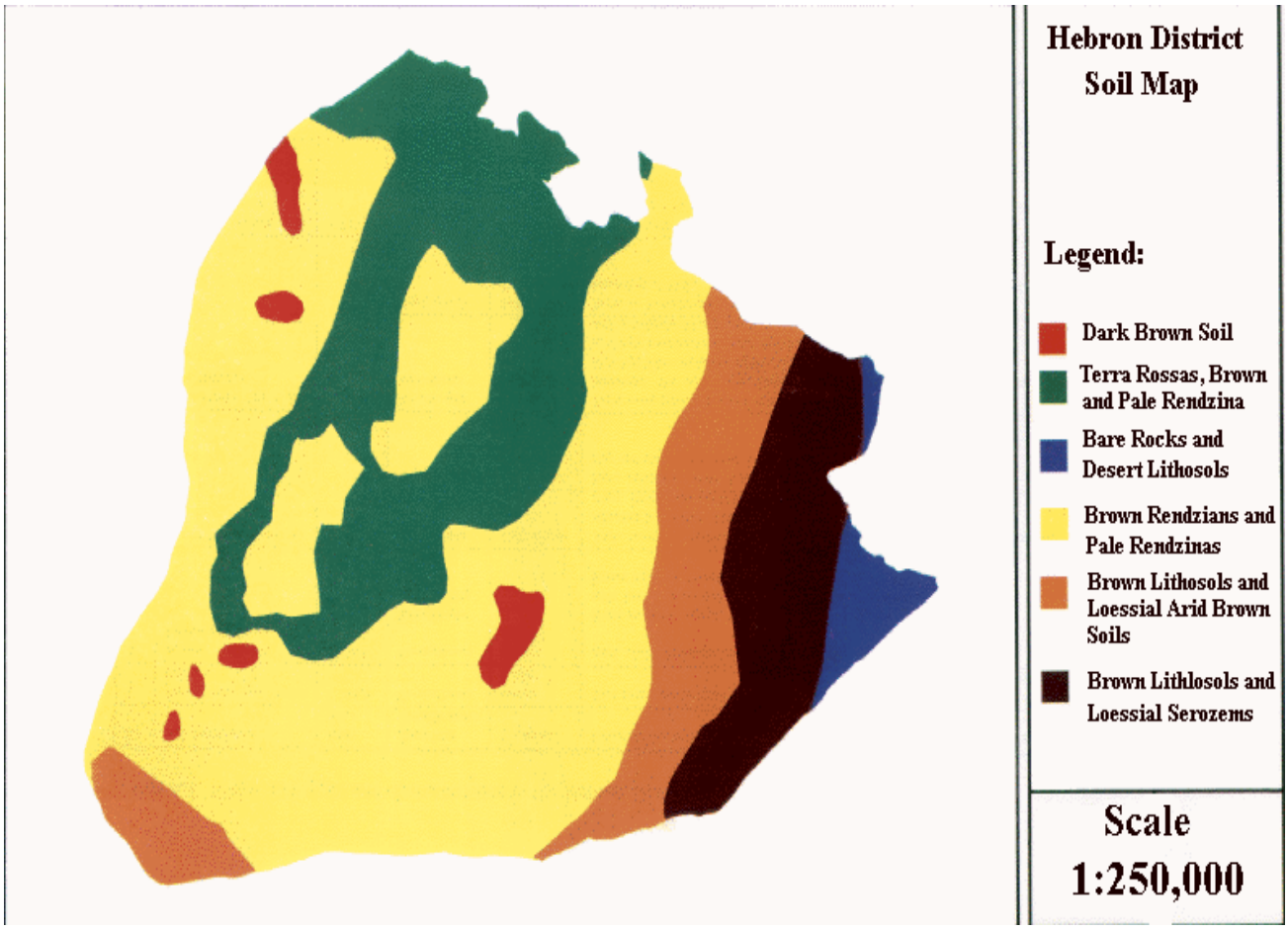

Figure 5.2: Hebron District Soil Map

1. Bare Rocks and Desert Lithosols

These types of soil associations cover about 2,300 hectares of the eastern border of the Hebron District. They are generally characterized by bare rocks and slight soil depths especially at plateau and moderately sloping areas. The soil is originally formed from hard limestone, dolomite and chalks mother rocks. The principal vegetation is shrubs, mainly *Retama roetam, Anabasis articulata, and Zygophyllum dumosum*. Use of this soil

type for is currently limited to grazing, especially, where natural valleys and depressions occur allowing for increased vegetation growth. The American great classification that represents these soils is *Terriorthents*.

2. Brown lithosols and loessial arid brown soils

These types of soil associations cover an area of about 12,200 hectares of the Hebron District, mainly the steep to moderate rocky and eroded eastern slopes of the district. Brown lithosols are found in pockets among the rocks. Loessial arid brown soils are found on flat hilltops, plateau and footslopes. The parent rocks of this soil association are chalk, marl, limestone and conglomerates. Major vegetation growing on these soils is *Aretemisietea herbaealbae*. The American great classification that represents these soils are *Haploxeralfs, Xerochrepts and Terriorthents.*.

3. Brown Rendzinas and Pale Rendzinas

These types of soil associations dominates the area of Hebron, Halhul, Dura, Yatta, Idna, El Samu' and El Dahriya, covering an area of 55,900 hectares. Around 3050% of these soils are outcropped with rocks. On such areas, cultivation of grapes and olives, field crops (wheat and barley), and grazing are the main land uses, especially in shallow and steep slopes. According to the American great group classification, these soils represent the associations of *Xerorthents and Haploxerolls*.

4. Terra Rossa, Brown Rendzinas and Pale Rendzinas

These types of soil associations occupy a total area of approximately 23,300 hectares, mainly in the central part of Hebron District. Similar to the previous soil types, rock outcrops in these soils are almost 3050%. The major native vegetation cover is *Ceratoni siliqua pistacia lentiscus.* Land with these soil types is used to cultivate field crops, mainly wheat and barley, vineyards, olive and fruit trees. The American great group classification that represents these soil associations are *Xerorthents, and Haploxerolls*.

5. Brown lithosols and loessial Serozems

These types of soil associations characterize the eastern slope of the district, covering an area of about 9,700 hectares. These soils are originally formed from limestone, chalk, dolomite and flint. Major vegetation types found in these regions are *Anavasetea articulatae* and *Zygophyllum*. Such soils suffer from extensive erosion due to runoff, especially in steep slopes. These soil associations also suffer from salt accumulation due to limited salt leaching capabilities. The current land use is restricted to winter crops that are grown by Bedouins in some wadis. The American great group classification that represents these soil associations are *Haplargids and Terriothents*.

6. Dark Brown Soils

Dark Brown Soils cover an area of approximately 1,800 hectares in the Hebron District. The soils are distributed as elongated polygons on the western and eastern slopes of the district. In the western slopes this soil association is characterized by coarse textured residual dark brown soils. The parent rocks of this soil association are aeolian sediments, calcareous sandstone (Kurkar), and medium to fine textured alluvial deposits. Primary natural vegetation on this soil was destroyed. Today there is segetal vegetation of the *Prosopis farcata scolymus maculatus.* The American great group classification that represent this soil association are *Xerorthents, and Haploxerolls*.

Table 5.1: Major soil types and characteristics in the Hebron District

No	Soil Assoc-iation	Area (ha.)	American Classi-fication	Location	General Charac-teristics	Natural Vegetation	Rainfal (mm/y)
1	Bare rocks and desert lithosols	2,295.6	Torriorthents	eastern border	Bare rocks, rarely small depth of soil	*Retama raetam, Anabasis articulata, and Zygophyllum dumosum*	80-100
2	Brown lithosols & loessial arid brown soils	12,207.7	Torriorthents Xerochrepts Haploxeralfs	eastern slopes	marl, chalk, limestone and conglomerates parent rocks. Xeric moisture regime, the soil has ochric surface epipedon with low organic matter < 0.6% and massive structure. Parent material is loessial sediments.	*Ballotetelia undulatae, Artemisietea herbae.*	200-350
3	Brown & pale rendzinas	55,895.7	Xerochrepts	Hilly slopes	Xeric moisture regime, it has a reddish brown color. Soil structure is crumby. Texture is loamy or clay, about 30% is stony. Parent material is soft chalk and marl.	Pinus haleness and Pistachio palaestina.	600-700

			Haploxerolls	Valleys and depressions	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.*	300-700
4	Terra rossas, brown and pale rendzinas	23,269.1	Xerochrepts Xerorthents	central 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.	*Quercus calliprinos, Pistacia palaestina and Pistacia lentiscus.*	400-700
			Haploxerolls Small	Same plateau of the mountains	Same as Xerochrepts with the exception that it has a base saturation of 75%.	*Pistachio atlantica, Amygdalus korschinskiiand Pistacia palaestina.*	400-700
5	Brown lithosols & loessial Serozems	9,755.9	Haplargids Terriothents	moderate to steep hill	Shallow depth where concentrated on steep hill slops. Parent rocks are limestone, dolomite, chalk and flint.	*Anabasis articulata, Zygophllum dumosum and Suaeda asphaltica.*	80-200
6	Dark Brown soils	1,825.9	*Xerorthents and Haploxerol*	sloppy areas	It is characterized by coarse textured residual dark brown soils. The parent rocks are aeolian sediments, calcareous sandstone and medium to fine textured alluvial deposits.	*Prosopis farcata-Scolymus maculatus*	350-500

Chapter Six
Agriculture

Hebron District has varying climatic zones, ranging from arid wilderness in the east as low as 100 m in altitude, to a mountainous zone in the middle, with an altitude as high as 1,020 m, separated by a transitional zone. There are variations in the climatelogical conditions. The average annual rainfall increasing and average maximum and minimum temperatures for both winter and summer seasons decreasing as one moves from south to the north of the distinct and from both east and west towards the middle mountainous zone. The highest averages of annual precipitation are recorded in the mountainous zone, varying from 200 mm in the southern part to 650 mm in the northern parts. In the transitional area, the amount of annual rainfall varies from south to north and from east to west (Department of agriculture in Hebron, 1995).

Approximately 36,000 ha are currently under cultivation which is 34% of the total land area. There are 19,031 ha which are considered cultivable but currently not used. In the district approximately 1,200 hectares are forested and 41,423 ha are classified as range lands and bare rocky areas. Land classified as arable, forestry or range land makes up 62% of the total district area, thus clearly presenting the importance of studying the status and needs of the agricultural sector (Al-Hawamdeh and Al-Rijoub, 1992).

Plant Production

Due to low average annual rainfall and Israeli restrictions, ground and surface water resources (wells and springs) accessible to Palestinians in the Hebron District are limited.

According to the statistics of the Hebron Agricultural Department for the year 1994, the areas of the rainfed cultivation reached 31,788 ha, while only 91 ha were under irrigation, see figure 6.1 . The total of these two areas comprises 88.3% of the total cultivated land in the district. Thus, approximately 4,121 ha of the agriculture land left un-cultivated.

The cultivated crops for the year 1994 varied between field crops and rainfed vegetables, depending on the rainfall and its distribution across the district. The 1994 season was characterized by low rainfall of irregular distribution compared to other seasons. Figure 6.1 shows percentage of various cultivation and their annual production.

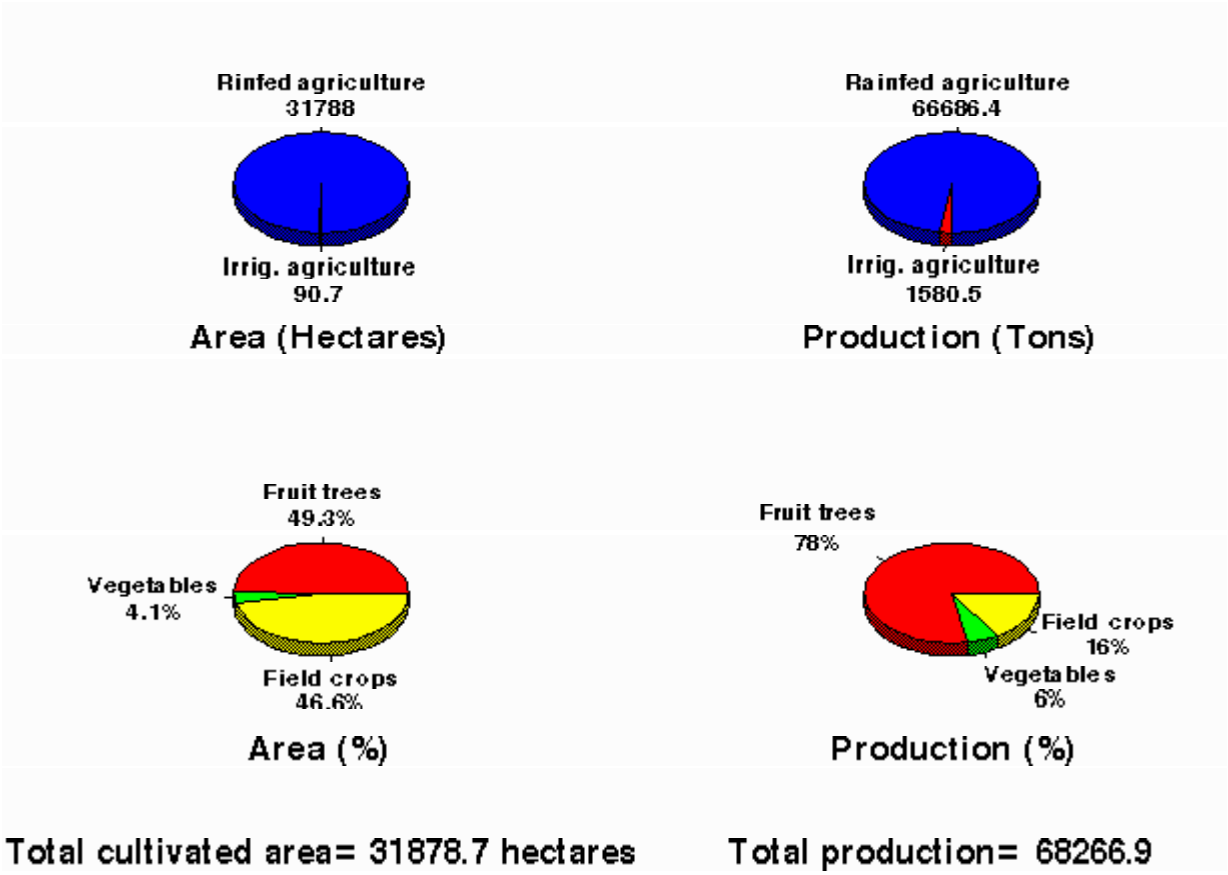

Figure 6.1: Total area and production of different crops in the Hebron District for the 1994 growing season.

Fruit Trees

Fruit orchards cover a total area of approximately 15,700 ha, with a total production of 53,150 tons/year as shown in Figure 6.2 . The mountainous zone and northern parts of the district are mainly cultivated with fruit crops including grape vines, stone fruits, apples, and olives. Olive and almond orchards also extend to the southern parts of the district.

Almost all fruit trees in the district are grown rainfed, with the exception of 10 hectares of lemon trees which are irrigated. For the last 10 years the largest percentage of fruit trees grown were olives, grapes, plums, and figs. The following pages describe the status of the fruit trees grown in the district.

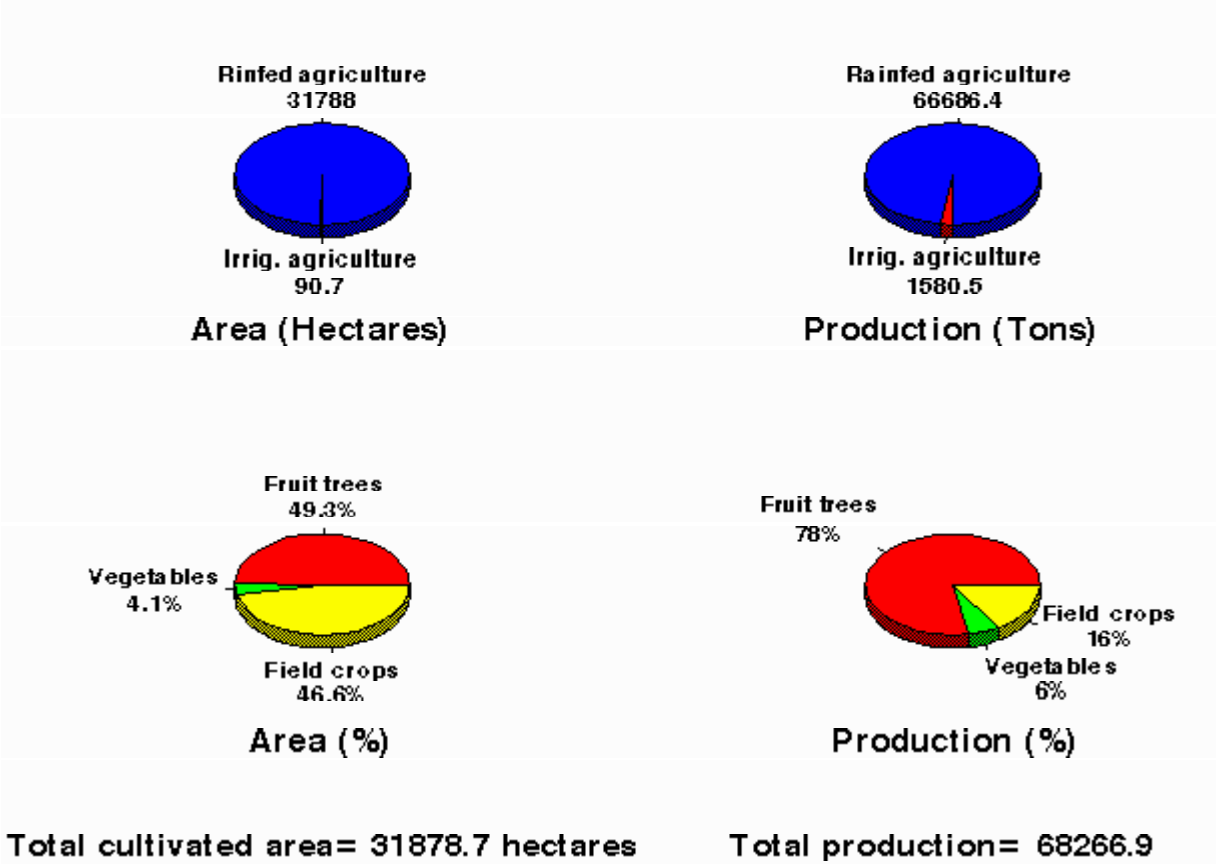

Figure 6.2: Total area and production of fruit trees in the Hebron District for the 1994 growing season.

Olive trees

Olive orchards cover more area than the other fruit trees (53%). This includes 2,300 hectares of unproductive olive trees and 5,961 hectares of productive olive trees. They contribute only about 24% to total production of fruit trees by weight, see figure 6.2 .

Olive trees, while not significantly high in productivity, played an important role in preventing land confiscation by the Israelis. An Israeli military law states that land which has been uncultivated for 3 years is considered abandoned and can be confiscated. Because of this matter, farmers frequently plant olives on land they fear it is in danger of confiscation, since the precedent has been set that productive land may not be taken. However, Israeli government and settlers have been known to try to counter such measures by cutting down, uprooting, or chemical spraying. This pattern of struggle has in large part led to the expansion of the areas devoted to olive trees.

Olive production is very important to the economy in the Hebron District. The phenomena of alternative bearing, where trees produce poorly in a given year and excessively well in the following year. For instance, in 1993, olive production was only

120 kg/ha while in the following year it reached 2,150 kg/ha. The unstable production has resulted in reduced profit compared to stone fruit or grapes. However, proper land cultivation, fertilization and pruning of olive orchards may reduce the effect of alternative bearing and improve the productivity and quality of the olive fruits and oil.

A bout 85% of olive production in the West Bank is processed into olive oil while the rest amount goes to pickling. There are about 15 olive presses distributed throughout the city of Hebron and the villages of the district.

Grapes

Grapes production occupies the second largest area of cultivated fruits (33%) and is considered the most important crop in the district. The Hebron soil and climatic conditions are suitable for growing several varieties of grapes which vary in taste, aroma, color, size, shape and ripening period. Grapes are the most important crop produced, as they are the main source of income for large number of the farmers. They are among the oldest cultivated fruits in the district, as demonstrated by the existence of ancient stone grape presses. Grapes contribute 54% by weight to the total fruit production (59% of the total cultivated area for grapes in the West Bank and Gaza Strip is within the Hebron District).

The potential for increasing grape production is very good and correlates positively with type of training system used from ground creeping and head training systems to a trellis training system. Trellis training system is used on about 21% (1064 ha) of the total area of grapes. The potential productivity of the trellis system (about 9,000 kg/ha) is double than that of the other training systems (see figure 6.3). Increasing the use of a trellis training system would greatly increase yield.

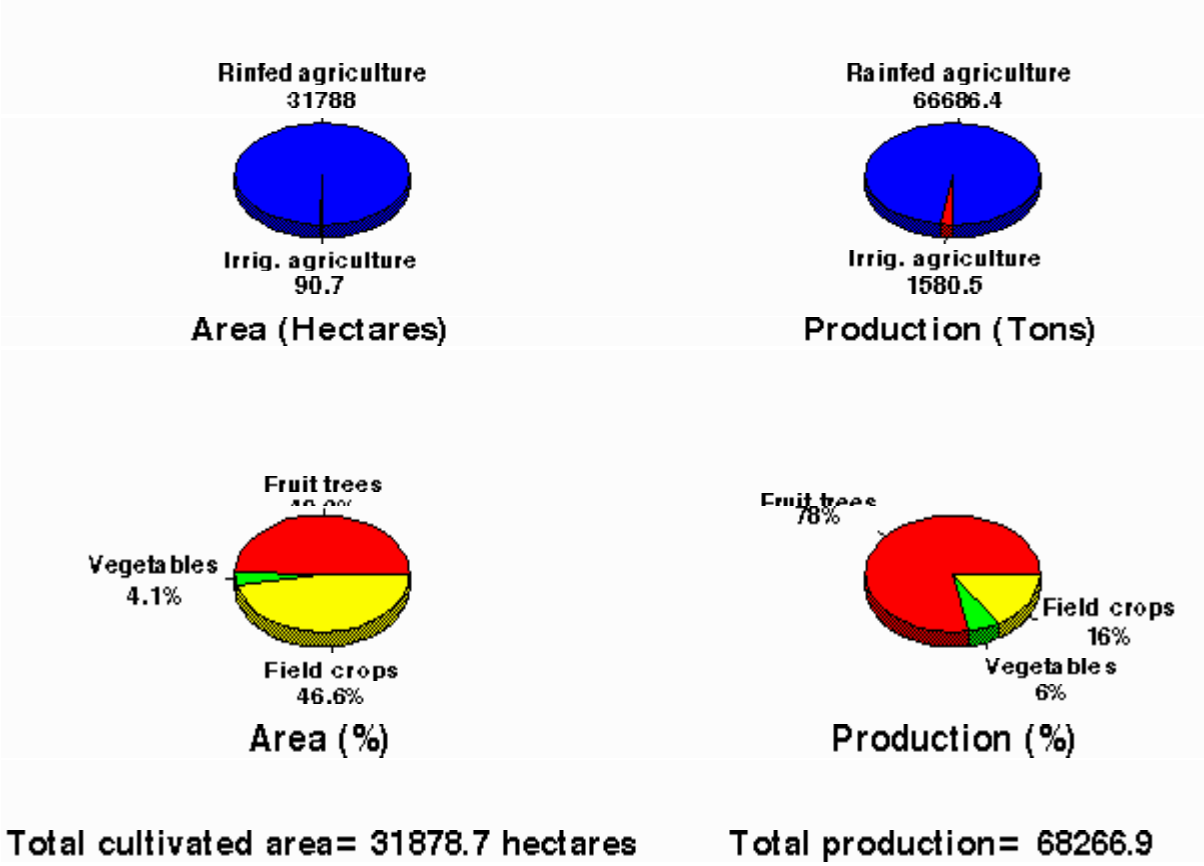

Figure 6.3: Total area and production of different cropping systems of grape vines for Hebron District in the 1994 growing season.

Most grape varieties in the district have seeded berries. The dominant varieties are classified as: white grapes include dabouki, zaini, marrawi, hamadani, beiruti, and jandali; red grapes include halawani and fuhaissi; black grapes include, shami, shoyoukhi, beituni, motartash; seedless grapes includes sultani.

The white grape variety of dabouki is most cultivated, (making up close to 50% of total area planted with grapes). However, in recent years farmers have started replacing dabouki, which is an early ripening variety, with late ripening varieties such as red grapes, halawani and fuhaissi; black grape, shami.

Most grapes are consumed fresh in the local markets of the West Bank and Gaza Strip. Small amounts are exported to Israel and Jordan. Small portion of grapes is processed and sold as, raisins, molasses (grape honey), malban, juice, vinegar and jam and marmalade (Al-Thaymoma, 1992).

To improve the quality, quantity, and marketability of grapes, the following measurements are recommended:

- Improve picking, grading, packaging and labeling methods.
- Activate local cooperatives to facilitate the harvesting and marketing processes.

- Construct cool storage stations.
- Construct grape juice factories.
- Plant and graft late ripening varieties to reduce marketing crisis.

Stone fruits

Stone fruit orchards comprises the third largest area of fruit trees in the district, covering an area of 1,850.7 ha (11.8% of the total area). For the growing season of 1994 they contribute 19.5% to the fruit tree production, see figure 6.2. Among the varieties of stone fruits, plums occupied the largest area with 1,315 ha and the highest productivity, with 7,350 kg/ha, about 93% of total stone fruit production. The remaining area cultivated with stone fruit is divided between peaches, apricots, and almonds.

Most plum production is marketed locally in the Hebron District, although is a significant part of production goes to Israeli markets as well. Developing markets outside the West Bank, Gaza, and Israel will be important in increasing net profits for farmers and protecting them from marketing crisis.

There are many high-yielding and disease resistant varieties of plums and almonds which could be introduced in the Hebron District, thereby increasing the potential for higher production and better fruit quality. As the markets are often flooded during the harvest season, some trees in the district could be replaced with later maturing varieties, this could increase the marketability and economic rate of return for farmers.

Other Fruits

The remaining area devoted to fruit trees production is generally planted with nuts, such as walnuts and pistachios, and pome fruit trees, such as apples, pears, quince, and pomegranate. These combined form about 1.3% of the total area of fruit trees, producing 507 tons of fruit.

Field crops

Field crops are totally cultivated under rainfed conditions, intensively in the eastern, western and southern parts of the district in areas receiving rainfall below 400 mm. Wheat, lentils, chickpeas and sorghum are mainly cultivated in areas receiving annual rainfall between 300 and 400 mm. Barley generally cultivated in areas receive rainfall below 300 mm.

Barley covers 53% of the total area of field crops, followed by wheat which covers 24.4%, and lentils covering 9.1%. The rest of the area is cultivated with bitter vetch, chickpea, sorghum, tobacco, and other field crops and forages, see figure 6.4 .

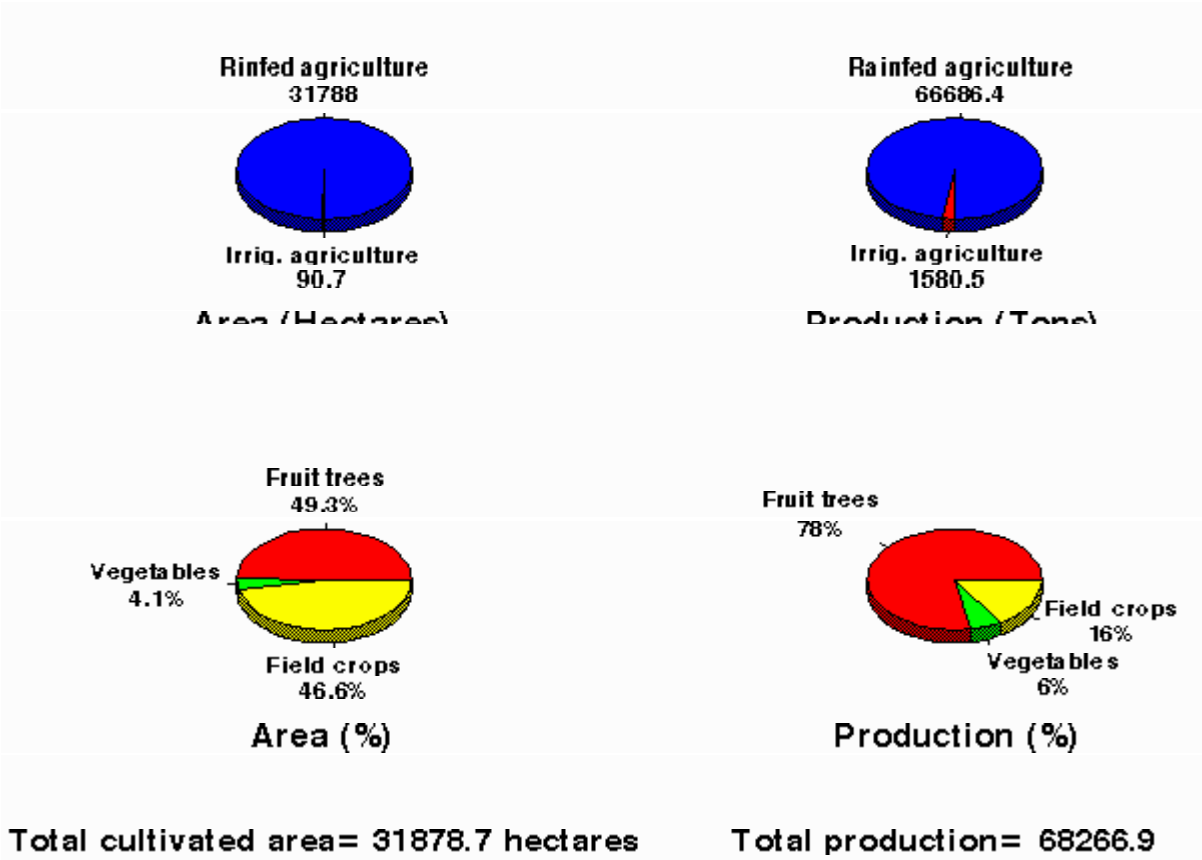

Figure 6.4: Total area and production of different field crops and forages for the Hebron District in the 1994 growing season.

On average, wheat and barley have the highest yield, reaching 900 kg/ha, followed by sorghum, 550 kg/ha. The average productivity of all cultivated field crops in the district is as high as 745 kg/ha. This rate of productivity is low and the net profit is very limited, encouraging farmers to leave their lands and work in the other sectors of production. However, farmer losses were often not as large as they could be due to extensive use of family labor. Attempts to increase efficiency, for example, by increasing mechanization, often end up with loss.

Because of neglect through the occupation of the last 27 years, this sector of plant production has shown very little progress. Farmers generally still planting only local (baladi) varieties, and have made only small adaptations to traditional planting techniques. As a result there is great fluctuation from year to year in both the area planted and the yield.

During the last ten years (1985-1994), the size of areas cultivated with barley, wheat, lentils, sorghum, and chickpeas in the Hebron District varied from 11,650 to 16,600 hectares per year. Research and agriculture extension services could greatly develop the agricultural sector.

Recent research done by the Applied Research Institute-Jerusalem (ARIJ) showed that yields and profitability of field crop production under rainfed farming could be improved significantly with the introduction of new higher yielding and resistant varieties, especially when combined with methodological changes such as crop rotations and the introduction of fertilizer. Such practices could minimize the fluctuation in areas planted and also encourage rural Palestinians to return to farming (Isaac, J. and Hirmat 1994).

Vegetable production

Vegetable production is very limited, it makes up only 4.1% of the total cultivated area in the district. Approximately 82% of the vegetables are grown under rainfed conditions (1,222 ha) and the remaining 18% is irrigated (80.6 ha), see figures 5 & 6 .

Because most vegetables are planted as summer crops, the size of the area devoted to rainfed vegetables is impacted by the amount and distribution of rain in that season. For example, the total area of rainfed vegetables in 1994 was less than in 1993 by 225 ha, as rain during 1994 was significantly lower.

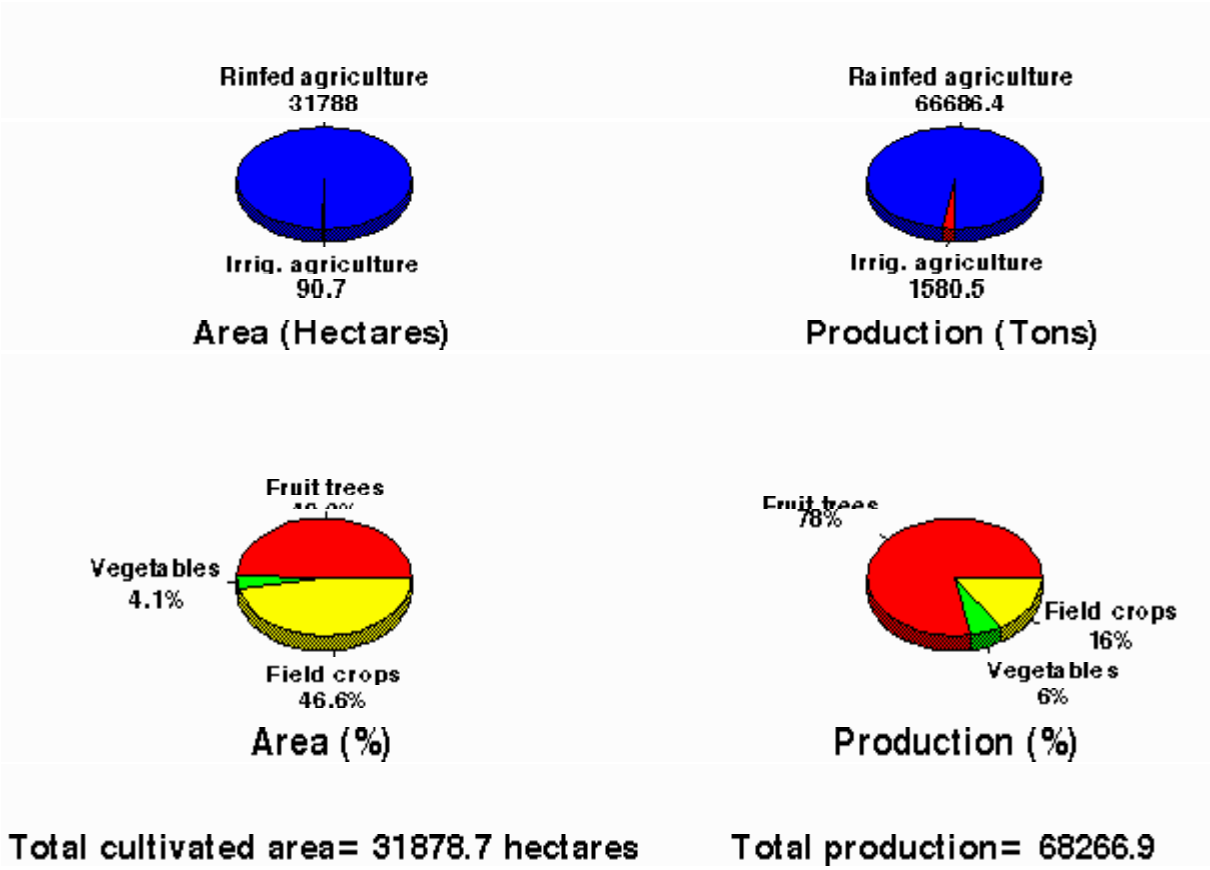

Figure 6.5: Total area and production of rainfed vegetable crops for the Hebron District in the 1994 growing season.

The productivity of mainly cultivated rainfed vegetables in 1994 ranged between 1,700 kg/ha for squash and 5,000 kg/ha for dry onions. The capacity of yield varies from year to

year and from one location to another. The main factors affecting the productivity are the amount and distribution of rainfall, altitude, temperature, and soil type. Obviously irrigated vegetables can produce significantly more than rainfed vegetables. For instance, in 1994 irrigated vegetables covered only 6.2% of the total areas devoted to vegetables, and produced 37.5% of the vegetables produced by weight. About 99% of irrigated vegetables are grown under open irrigation conditions, the remaining 1% is devoted to plastic houses, planted mostly with cucumber and tomatoes, see figure 6.6. The average productivity per one hectare of rainfed vegetables was 2.4 tons; 16 tons for open irrigated vegetables and 60 tons for vegetables grown under plastic houses.

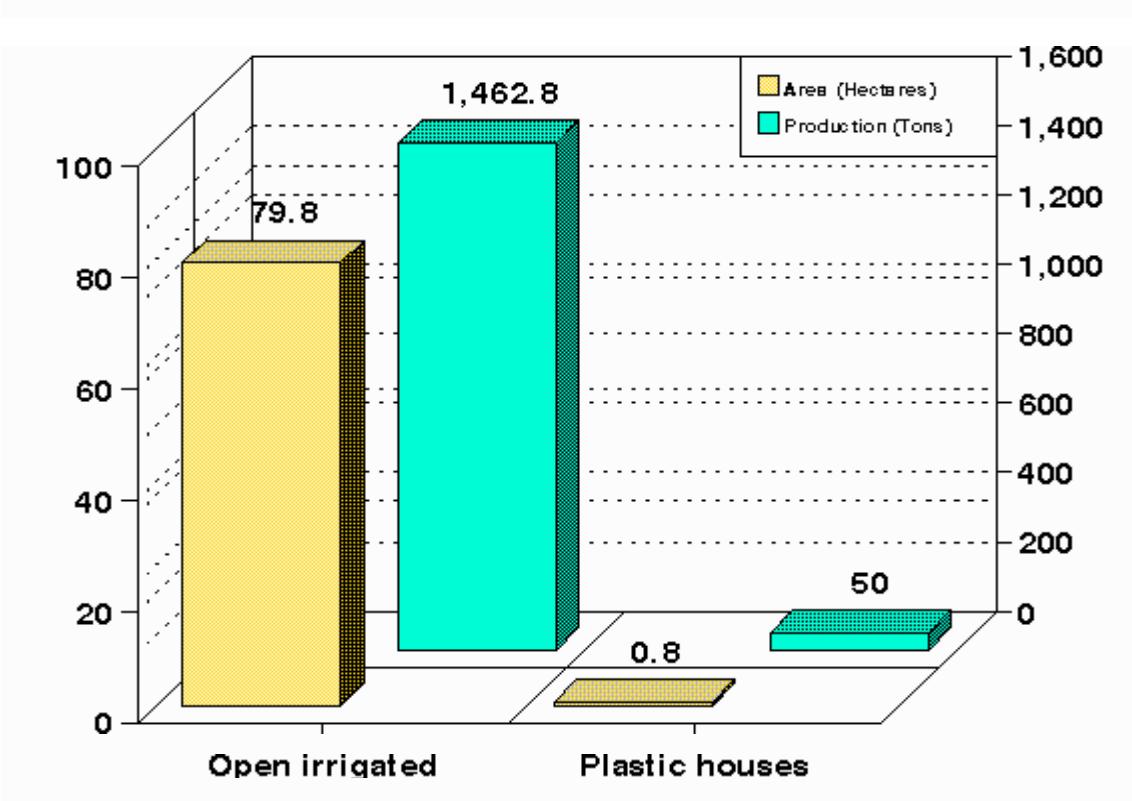

Figure 6.6: Total area and production for different cropping systems of vegetable crops for Hebron District in the 1994 growing season.

The main factor restricting the application of intensive cropping systems in areas cultivated with vegetables is the limited water supply, especially from groundwater sources.

Forests

Forests in the Hebron District make up 4.4% of the total forested area in the West Bank occupying an area of 1200 ha. Forested areas are mostly found in Tarqumia, Dura, Beit-Ummar, Al-Dhahriya, growing on hill tops and mountains. Man-made forests comprises 62.9% of the total forest area while private forests occupy 9.2% and natural forests about

7.9%. All forests, other than private ones, are located in areas classified as governmental lands.

Pinus halepensis is the most dominant forest tree, found on nearly 90% of the total forested area, followed by *Cupressus sempervirens, Quercus spp*. and caroub (*Ceratonia siliqua*). Several other species of different characteristics and genera also exist, such as acacia, which is considered an important plant for grazing animals.

Little improvement was made in the forested areas of the district during the Israeli occupation, in fact all Israeli forestry development programs in the district were stopped in 1970. Moreover, the land has been exposed to destructive factors such as overgrazing, poaching of trees by the surrounding residents for firewood, continued years of drought, lack of programs to rejuvenate the forest by planting seedlings, and uncontrolled expansion of cities and towns.

The governmental forests are administered by the Israeli civil administration, and have been restricted to Palestinians. They have thus been viewed negatively by the local population, rather than being viewed as positive agents against the effects of industrial and transportation pollution.

There is one governmental forestry nursery in the district called Wadi Al-Quf nursery. This nursery was established in 1927, with a production capacity of half million seedlings until the 1970's, after that time its production was reduced to 15,000 seedlings/year. Produced seedlings are usually sold to individuals, rather than planting new areas or replanting already forested lands. There are about 12 different types of trees in the nursery. The methods used in producing these seedlings are somewhat outdated, as a result, seedlings have low success rates. This is explained by the fact that only one person has been employed to operate the nursery and to guard the forest lands.

Intensive work is needed to improve the existing forests and to develop additional forested areas. This must be the work of not only the government, but also the local population. In order to increase the size of forests and to maintain the density of the trees per area, the surrounding communities should be encourage to protect the trees through activities such as national or community tree planting days. On the policy level, a specialized team in forestry should be pulled together with the goal of developing practical measures for the preserving and expanding of forested areas through public awareness, regulations, enforcement mechanisms, and use of existing and new institutions charged with management of forests.

Photo 2: Deforested area on the road between Hebron and Dura

Pesticide usage

The total annual use of pesticides in the district is as high as 69 tons (equivalent to 1.9 kg/ha). The rate of use varies according to cropping patterns, type of cultivated crops, size of cultivated areas.

According to 1994 statistics, about 45 tons (2.9 kg/ha) of different types of pesticides were used on fruit trees, and about 21 tons (17.2 kg/ha) of pesticides were used on rainfed vegetables. About 50 tons of sulfur are also consumed annually in the district for controlling insects and fungi (sulfur is not considered to have the negative environmental or health effects as other chemicals) (Saleh, A. and et al. 1995).

In general, the amount of pesticides used is higher in intensive irrigated cultivation than rainfed. Plastic houses, for example, use on average 40 kg/ha, while rainfed farming uses an average of 6 kg/ha. Because of the limited irrigated area, pesticide use is relatively low in the Hebron District, but some of the chemicals used are internationally banned because of their negative side effects. Some of these include Folidol (active ingredient is Parathion), a dangerous class Ia pesticide (LD 50=13 mg/kg) which is still used by farmers to control insects and spider pests.

Livestock, poultry, and apiculture production

The Hebron District has the largest number of livestock, making up about 40% of the total number of sheep and goats in the West Bank.

Most cattle in the district are dairy cows, about 80% of which are Friesian, while the rest are of local breeds. The average total daily milk production in the district is 17,815 liters. Friesian cows produces approximately 21 liters/day of milk, while the average daily milk production for local cows is generally below 8 liters. Serious work is needed with dairy farmers to increase their awareness about the importance of using modern techniques which will increase the efficiency of milk production, transport and storage and improve the sanitary level of the product (Department of Agriculture in Hebron 1995, ARC and Arab Thought Forum 1994, Vol.2, No.2).

Local breeds of sheep are the predominant in the district, forming 66.2% of all small ruminants. Local goats make up 33.6% of the total. Assaf sheep make up only 0.2% of the total. There are about 2,300 herd owners in the Hebron District, see table 6.1.

Table 6.1: Numbers of livestock and poultry in the Hebron District for 1994

Type	Number
Cattle (Local)	274
Cattle (Friesian)	2234
Sheep	122,620
Goats	62,125
Beehives	1528
Poultry	6,716,500
Layers	280,500
Broilers	6,436,000

The economies of the livestock production are affected by a number of factors, including the limited natural pastures, the number of Bedouins and farmers with large flocks of sheep and goats; and the number of livestock merchants operating in the district.

Many years of intensive, year-round grazing, especially in the wilderness area of the district (the Eastern Slopes), has resulted in the loss of many beneficial species of range plant, and the degradation of the vegetative biomass. The intensity of grazing has been especially high as only 15 percent of the area has been left open to herders after 1967. Species which are predominant in the eastern slopes are herbs plant species and spiny bushes such as *Sarcopoterium spinosum (thorny burnet),* which are generally of low

nutritional value and grazed only with difficulty by sheep. The remaining 85% of this wilderness is still off limits to Palestinians, either for reasons of security, settlement or natural reserves. Serious work is needed both in the open areas and in the closed zone to collect, conserve and categorize the existing natural resources, and to begin revitalizing the area through planting of well adapted beneficial species and the introduction of managed grazing schemes.

Poultry production

Poultry production in the Hebron District increased during the Palestinian *Intifada* (starting in 1988), as chicks were produced through local hatcheries or bought directly from Israeli hatcheries, and raised to produce eggs for local consumption. Food concentrates (poultry feed) were also introduced as many of the poultry batteries were in urban, rather than rural areas where other kinds of food would have been more readily available.

In the last two years, however, production has begun to diminish in reaction to significant increases in the prices of chicks, concentrates and equipment, and to a marketing crisis which lowered the profit margin, forcing many to abandon this area of production.

The 1994 statistics show that approximately 1,010 broiler farms and 200 layer farms with varying bird capacities exist in the district. There are approximately 7 million broilers in the district and three rounds in broiler farms per year, see table (6.1).

The main factor controlling the economical status of the poultry sector is the unstable supply and demand for chicken meat and eggs during different periods of the year. This has resulted in excesses in the market in certain periods of the year and shortages in others. It has been very difficult for farmers to predict these swings, especially in the absence of planning and controls on produced quantities and quality.

Apiculture

The 1994 statistics indicate an overall improvement in apiculture in the district over the last few years. About 98% of bee hives are new hives, while there are now only 45 old hives in the district. There are about 145 hive owners in the district. The estimated annual production of honey in the district is 20 tons, with an average production of 9 to 10 kg of honey per hive, see table 6.1 (ARC and Arab Thought Forum 1994, Vol.2, No.3).

Chapter Seven
Historical and Archeological Sites

Historical Background

Hebron, Al-Khalil, in full Al-Khalil Ar-Rahman (the beloved of God, a reference to Ibrahim), is one of the oldest continuously inhabited cities in the world. Canaanite Arabs came to this area around 3000 B.C. Their settlements are the foundations of many of the towns and villages in the Hebron District. The villages of Arba-Al-Khalil, Halhoul and Carmel are some of the Palestinian cities whose origins are traceable to Canaanite settlements.

Originally, Hebron was known by the name of Karyat Arba. It was named after a leader of an Arab tribe whose name was Arba. He was of the Anakite Tribe which lived in the hills that stretch from Hebron to Jerusalem. The Anakites were described by those who knew them as "mighty ones".

The Canaaites were visited by the Prophet Ibrahim about 1900 B.C., when he came to dwell in the city. The city was destined to contain his remains, and those of his family; Sara, Isaac, Rebkah, Jacob and Leah. Legend has it that Adam and Eve are also buried here. The location of their tombs was the reason that Hebron became the second holiest place in Palestine for Muslims.

Al Haram Al Ibrahimi (where the Tomb of Ibrahim El Khalil is located) was built in the days of Herod and expanded during the Crusader period. During the Mamluk period it was divided into several mosques, embellished with slabs of marble, colored plaster and inscriptions (I.M.D.& Carta 1993; Encyclopedia Palestina 1994).

Historical Sites:

1. Halhul:

It is located on the Bethlehem-Hebron road at a distance of 5 km north of Hebron. It contains ruins of a building, a mosaic floor, and rock-cut tombs (Al-Dabbagh, M. 1991). The surrounding area of Halhul has the following sites:

Beit Zur (Khirbet et Tubeiqa): tel located 6 km north of Hebron. It is on the site of the ancient city of Beth-Zur that the Hebron-Jerusalem road was controlled and was consequently a battlefield in various periods. Beit Zur is mentioned during the Persian period as an important city whose inhabitants participated in rebuilding Jerusalem. Excavations at Khirbat Tubeiqa shows uncovered Iron Age remains (Al-Dabbagh, M. 1991).

Khirbet Burj es Sur: There is found the remains of Crusader defense tower built on the ruins of a Byzantine fortress. Other finds indicate inhabitation from post-Babylonian Exile until the Ottoman period (I.M.D.& Carta 1993).

Issha: A small village to the north-west of Halhul, where the remnants of a building, mosaic floor, fragments of columns, wine press and rock-cut tombs (Al-Dabbagh, M. 1991).

Baqqar: Located near the village of Issha, has the remnants of a building, cisterns and many caves (Al-Dabbagh, M. 1991).

Al-Hasaka: Located in the south-west of Halhul, this site contains many springs, the remnants of a tower, the remains of a mosque and a wine press (Al-Dabbagh, M. 1991).

Ein Ed Dirwa: It is a spring located 6 km north of Hebron, near the ruins of Bet Zur. The name means spring of the peak (the spring originates 960 m. above sea level). According to Christian tradition it is believed to be St. Philip's fountain. It also has the ruins of a Roman way-station, burial caves and a Byzantine Church (I.M.D.& Carta 1993).

Khirbet el Qatt: It is a ruined town located 3 km north of Halhul. It has the remains of a square fortress, (30 x 30 m), built of undressed stones and containing rows of rooms enclosing a central courtyard. The shards indicate inhabitancy during the Iron Age, the Persian and Byzantine periods (I.M.D.& Carta 1993).

Khirbet en Nasara: A settlement ruin on a hill, 3 km north-west of Hebron, close to Beit Kahil. It has remains of structures, cisterns and caves. The name hints that it had been a Christian settlement (Nasara=Christians). The shards found indicate habitation in the Iron Age, and in the Byzantine and the Middle Ages (I.M.D.& Carta 1993).

2. Eshuyukh:

An Arab village located 7 km north-east of Hebron. The surrounding area has the following sites:

Khirbet Abu (er) Reesh: A small village south-east of Eshuyukh, where ruins of a church, two columns and a cistern are located (Al-Dabbagh, M. 1991).

Khirbet Beit Anon: A ruin located 2 km south-east of Halhul. It has the remains of a church with a mosaic floor. Many shards indicate inhabitancy in the Iron Age, Hellenistic, Roman, Byzantine and in the Medieval periods (Al-Dabbagh, M. 1991).

3. Beit Ummar:

A village located 11 km north of Hebron. It is built on the same site as a Canaanite town and has the following sites in the surrounding area:

Khirbet Jadur: A village located 12 km north of Hebron. Adjacent to the village is a tel with remains from the Bronze Age through the Mamluk period. Cave-tombs and a secret tunnel system are still found here (I.M.D.& Carta 1993; Al-Dabbagh, M. 1991).

Khirbet Kufin: Settlement ruins 10 km north of Hebron, where the remains of a two large dressed stone structures, apparently from the Roman period, are found along with an underground vaulted structure from the Byzantine period. Finds also contain many shards which indicate habitation in the Middle Bronze Age and from the Hellenistic period until the early Arab periods (I.M.D.& Carta 1993; Al-Dabbagh, M. 1991).

Deir (Ash) Sha'ar: Located at the northern-east of Beit Ummar, here is found the remnants of a Byzantine church, a mosaic floor, and an olive press (Al-Dabbagh, M. 1991).

4. Dura:

A village 8 km south-west of Hebron. John Hyrcanus captured the city and forced its Canaanite inhabitants to convert to Judaism. Today's village has the remains of ancient buildings and many cave-tombs. The Shards indicate inhabitation in the Iron Age II, in the Roman and Byzantine periods and in the Middle Ages. Local tradition says that Noah was buried here (I.M.D.& Carta 1993). The surrounding area has the following sites:

Rujm Abu Hilal: Ruin in the Hebron Hills 8 km south-west of Hebron. It has hewn stone walls of square structure perhaps a fortified tower, and shards from Roman and Byzantine periods (I.M.D.& Carta 1993).

Beit Awwa: A village located 15 km south-west of Hebron. It is built on the ruins of an ancient settlement and contains shards from end of Babylonian Exile to Byzantine era. A baptismal font in the shape of a cross was found among remains of the ancient buildings (I.M.D.& Carta 1993; Al-Dabbagh, M. 1991).

Khirbet Karmah: A village in located 12 km south-west of Hebron, which is built on the ruins of an ancient settlement from the Byzantine period and from the Middle Ages. The remains contain buildings, wine presses and caves (I.M.D.& Carta 1993; Al-Dabbagh, M. 1991).

Khirbet el Burj:Settlement ruins located 11 km north-west of Hebron. In the middle of the ruins are the remains of a square structure, apparently a khan; its walls have been preserved to a considerable height. Many remains of other structures and an olive oil press in addition to shards which indicate habitation during the Byzantine period and in the Middle Ages (I.M.D.& Carta 1993).

Beit Marsam: A small village which is very close to Khirbat el Burj, 20 km south-west of Hebron. There are found remnants of a church and a mosaic floor. Tel Beit Marsam, which is very close, contains the remains of an old city and its external wall (Al-Dabbagh, M. 1991).

Raboud (Debir: Canaanite name): A village located 12 km south-west of Hebron. Adjacent to it, there is a tel with remains of a double wall, built of hewn stones, in addition to other structures. The tel and its surrounding area also contain shards that indicate inhabitation from Early Bronze Age to Iron Age and during the Hellenistic period (I.M.D.& Carta 1993; Al-Dabbagh, M. 1991).

Khirbet Deir El-Asal: Located in the south-west of Dura. It has the remains of a church, buildings, cisterns, wine press and tombs (Al-Dabbagh, M. 1991).

Abda:A small village located 10 km south-west of Hebron. The tel in the village has caves and cisterns. It is also has many shards which indicate Byzantine and Medieval settlement (I.D. & Carta 1993).

(Al) Majd: A small village in the Hebron Hills, 13 km south-west of Hebron, which is built on the ruins of an ancient settlement. The ruins contain burial caves, cisterns and shards that indicate Byzantine, Medieval and Ottoman habitation (I.M.D.& Carta 1993; Al-Dabbagh, M. 1991).

Kirza: A village located 15 km from Hebron, which is built on the ruins of the Byzantine settlement. Apparently was also inhabited in the Middle Ages. It has the remains of walls and columns (I.D.& Carta 1993).

Kharsa: An Arab village located 10 km south-west of Hebron. Its name means the small wood. It has the remains of a two-roomed structure built of dressed stones with decorated columns and lintels. Many shards which indicate occupation in the Byzantine period and in the Middle Ages were found (I.M.D.& Carta 1993).

Khirbet el Muraq: An Arab village located 13 km west of Hebron, which is built on the ruins of an ancient settlement. Remains of magnificent columns and a frescoed structure from the reign of Herod was found. Nearby are the remains of a tower built of undressed stones. The found shards and other remains indicate habitation in the Byzantine and Arab periods (I.M.D.& Carta 1993).

Turrama: Located at the southern part of Dura. Here are found the remnants of a fortress, a pool, and large number of caves (Al-Dabbagh, M. 1991).

Khirbet Fir'a: A settlement ruin located 9 km west of Hebron. It was inhabited during the Iron Ages, Byzantine period and in the Middle Ages. Remains of a number of structures, columns and mosaic floor are found (I.M.D.& Carta 1993; Al-Dabbagh, M. 1991).

Khirbet Shadrawan: Located in the southern part of Beit Awwa, this site holds the remains of a church, fragments of columns, caves and cisterns (Al-Dabbagh, M. 1991).

Khirbet Majadel: A small village located at the south-west of Dura, where the remains of buildings, columns, caves and cisterns are found (Al-Dabbagh, M. 1991).

Khirbet Efqaqees: Remains of an ancient structure (perhaps a fortress), 13 km south-west of Hebron. One corner has remained to a height of several stone courses. The finds of cisterns, caves and shards indicate an Iron Age settlement (I.M.D.& Carta 1993).

(Al) Hadab: An Arab village in Hebron Hills, 8 km south-west of Hebron. To the north of the village is the tel of an ancient settlement with remains of a city wall, fragments of Mesolithic flint implements and columbarium at the summit. The found shards indicate inhabitancy during the Early Bronze and Iron Ages, the Hellenistic and the Byzantine periods (I.M.D.& Carta 1993).

Khirbet el Kum: An Arab village located 14 km west of Hebron, which is built on a partly excavated ancient tel. It has the remains of a wall and many tombs from the Middle Bronze and the Iron Ages. The found shards indicate habitation in the Early Bronze Age (I.M.D.& Carta 1993).

(Al) Burj: An Arab village on the border of Hebron Desert, 20 km south-west of Hebron. The site has ruins scattered over a large area. Some of the ancient ruins and caves still serve as dwelling places. In the center of the village, there are remains of a crusader fortress identified as Castellum Ficuum (Fortress of Figs). The found shards indicate occupation from the Byzantine period to the Middle Ages (I.M.D.& Carta 1993).

(Al) Qusur: Remains of square Byzantine fort, 9 km south-west of Hebron. Probably built to guard the meeting point of the 2 streams below it, and also the way to Khirbat el Fari'a (I.M.D.& Carta 1993).

Khirbet (el) Lauza: A village located 5 km west of Hebron, which is built on the ruins of the Roman and the Byzantine settlement. It has remains of ancient structures and an olive oil press (I.M.D.& Carta 1993).

Khirbet ed Dilba: A village located 8 km south-west of Hebron. Within the village there are ancient building stones, cistern, a tomb and caves (I.M.D.& Carta 1993; Al-Dabbagh, M. 1991).

Khirbet el Majur: A ruin in the Hebron Hills, 9 km south-west of Hebron. Here were found remains of a large stone square structure and another building. The shards indicate inhabitation in the Byzantine period and in the Middle Ages (I.M.D.& Carta 1993).

7. Bani Na'im:

A village located 6 km east of Hebron. According to tradition, it is named after 2 brothers whom Prophet Mohammed promised to give the district of Hebron to. It is built on the site of a Roman settlement. It has a local mosque and a tomb called en Nabi Lut (I.M.D.& Carta 1993; Al-Dabbagh, M. 1991). The surrounding area has the following sites:

Khirbet (es) Stabul: A village built on the ruins of a Roman town, it has the remains of walls, caves, columns, and mosaic floors (Al-Dabbagh, M. 1991).

Nabi Yaqin: A Holy Moslem tomb on the border of the Hebron Desert, 5 km south-east of Hebron adjacent to Bani Na'im village. Local tradition claims this is the spot from where Abraham viewed the destruction of Sodom and Gomorrah (nowadays known as the Dead Sea). It has the remains of a 10th century structure, apparently built over burial caves. The shards found indicate inhabitation in the Byzantine period and in the Middle Ages (I.M.D.& Carta 1993).

Khirbet Bani Dar: A tel of an ancient settlement in the Hebron Hills, 5 km south-east of Hebron. The old site is believed to be partially preserved because of its closeness to the nearby Moslem shrine in Nabi Yaqin. The finds include remains of buildings, caves and rock niches. At the foot of the tel is a spring and a tunnel. The found shards indicate inhabitation in the Iron Age, Hellenistic, Roman and Byzantine periods and in the Middle Ages (I.M.D.& Carta 1993).

8. Yatta:

A village in the Hebron Hills, 10 km south of Hebron. It is built on an old town, and has the remnants of buildings, tombs, a wine press and fragments of columns (Al-Dabbagh, M. 1991). The surrounding area has the following sites:

Khirbet el Karmel: A village in the Hebron Hills, 10 km south-east of Hebron. It was a large town during the Roman and the Byzantine periods. It was also a fortified city, protecting the route to the Negev in the Crusader period. The found shards indicate inhabitation in the Chacolithic period, the Bronze and Iron Ages, and the Byzantine and the Crusader periods. The site also contains a cemetery and a storage pool from the Roman-Byzantine periods and various tombs (including shaft and pit types) from the Roman period alone. The remains of two churches and a fort from the Crusader period were also found (I.M.D.& Carta 1993).

Khirbet Al-Aziz: A village located at the southern part of Yatta on the way to es-Samu'. It contains the remains of old Roman roads, columns, and the wine presses (Al-Dabbagh, M. 1991).

Beit Amra: An Arab village located 10 km south-west of Hebron. The site has ruins and remains of two churches (I.M.D.& Carta 1993).

Khirbet Munzeil: A settlement ruin in the Hebron Hills, 6 km south-east of Hebron. The finds include remains of structures and shards from the Roman-Byzantine period and the Middle Ages (I.M.D.& Carta 1993).

Rujum Barakat: A ruin located 6 km south-east of Yatta village. It has the remains of a Byzantine Church, column fragments, pools and other structures (I.M.D.& Carta 1993).

Khirbet Khraisa: A large ruin in the Hebron Hills, 10 km south of Hebron. It was inhabited during the Roman-Byzantine period and in the Middle Ages. It has the remains of many buildings; including a church or monastery with a mosaic floor, capitals and columns. In the nearby area there are caves and cisterns (I.M.D.& Carta 1993).

Khirbet Um el Amad: A ruin in the Hebron hills, 11 km south-west of Hebron. It has remains of a Byzantine church, columns and other architectural fragments, pedestals and capitals. Near the church, there are caves, cisterns and remains of houses. The nearby tel was inhabited during the Iron Age, and in the Hellenistic and the Roman-Byzantine periods (I.M.D.& Carta 1993; Al-Dabbagh, M. 1991).

Khirbet Majdal Ba'a (Kh.Majd el Ba'): A ruin in the Hebron Hills, 11 km south of Hebron. It has the remains of a large structure, apparently a church, whose walls are preserved to a considerable height. The found shards indicate inhabitancy during the Byzantine period and in the Middle Ages (I.M.D.& Carta 1993).

9. (Es) Samu':

A village in the Hebron Hills, 23 km south of Hebron. The surrounding area has the following sites:

Khirbet es Simya: A village located 13 km south-west of Hebron on the way to (es) Samu'. According to one theory, it is the site of Biblical city Eshan. Within the confines of the village there are remains of ancient structures and rock-cut cave-tombs of which one tomb has a row of columns. Shards indicate inhabitation in the Roman period and in the Middle Ages (I.M.D.& Carta 1993).

Rafat: Located in the southern boundary of (es) Samu', this site contains the remnants of an old mosque, remains of old buildings, wells, and tombs. Close to it there is a site known as "Deir Rafat" which contains the remains of a monastery and a cave (Al-Dabbagh, M. 1991).

Rujum ed Deir: A ruin of fort in the Hebron Hills, 6 km north of Sammu'. It has the remains of a fort built on a hill and surrounded by a wall. Shards indicate inhabitation in the Roman and Byzantine periods (I.M.D.& Carta 1993).

Rujm el Hamri: A ruin of a Roman-Byzantine fort on the border of the Hebron Hills and Desert, 4 km east of Samu'. It is rectangular in shape with a central courtyard lined with rooms. The walls are preserved to a height of 6 courses. In the nearby area there are burial caves, rock-cut cisterns and other remains. Shards indicate inhabitation in the Iron Age, and in the Roman and Byzantine periods (I.M.D.&Carta 1993).

Tel Qeriyyot (Khirbet el Qaryatein): It is a tel of an ancient settlement in the Hebron Hills, 8 km south-east of Samu'. The local caves were used as dwellings and have entrances built of dressed stones (I.M.D.& Carta 1993).

10. Al-Dhahriya:

A village 18 km from Hebron. It is named after the 13th century Sultan Baybars el Dahr. The site has remains of an Iron Age fortress (I.M.D.& Carta 1993). The surrounding area contains the following sites:

Ennab es Saghir: A village located 2 km west of Al-Dhahriya. The site has a tel that extends over an area of 15 dunums. Finds include: caves, wine presses, heaps of stones, columns and church remnants. Shards indicate inhabitation from the Iron Age until the Middle Ages (I.M.D.& Carta 1993).

Khirbet Kafr Jul (Jawr): Settlement ruin in the Hebron Hills, 4 km north-west of al-Dhahriya. It has remains of buildings, broken column shafts, rock-cut cisterns and cave-tombs. It has evidence of being inhabited in the Byzantine period and in the Middle Ages (I.M.D.& Carta 1993; Al-Dabbagh, M. 1991).

Khirbet Uttir: A small village south-west of Al-Dhahriya. Here are remnants of old buildings, tombs, wine presses, columns, and water cisterns (Al-Dabbagh, M. 1991).

11. Sureef:

A village Located 8 km north of Hebron and has the following sites:

Al-Hubbaileh: A village close to Sureef where the remnants of walls, a church with mosaic floors, columns, a well, and caves are found (Al-Dabbagh, M. 1991).

Khirbet Abu (esh) Shouk: Located to the south-west of Sureef. It has the remnants of buildings, cisterns, a wine press, and the trace of a Roman road (Al-Dabbagh, M. 1991).

12. Idna:

An Arab village 10 km north-west of Hebron, which is believed to be the site of Ashnah (Canaanite town). In the northern part of the village there is a hill with an ancient tel on the summit and a spring at its foot. The surrounding area has the following sites:

Khirbet Al-Khurraiseh: Close to Idna where the remnants of a small church, columns, Caves, and cisterns are found (Al-Dabbagh, M. 1991).

Khirbet en Nabi Salih: An Arab village in the Hebron Hills, 10 km north-west of Hebron, built on the ruins of an ancient settlement. Here the Tomb of en Nabi Salih is found (I.M.D.& Carta 1993).

13. Sa'ir:

An Arab village in the Hebron Hills off Bethlehem-Herodim-Hebron road, 4 km north-east of Halhul. It is believed to be the site of Zior (mentioned in Joshua, Holy Bible).

Within the village there are ancient remains from the Iron, Persian, Byzantine and the Middle Ages. Within the village and its environs there are rock-cut burial caves. The found shards indicate inhabitation in the Early Bronze Age. The surrounding area has the following site:

Khirbet Kuazeibah: A settlement ruin 9 km north-east of Hebron. It is believed to be the site of the Biblical city Cozeba that was called Koziva or Bet Koziva in the Byzantine period. Here are found remains of many Roman-Byzantine and Medieval structures, including a hewn stone building still extant to a height of 5 m (I.M.D.& Carta 1993).

Khirbet Ras et Tawil: A tel 5 km north-east of Hebron and 1 km south-west of Halhul. The found shards indicate habitation during the Iron Age, and in the Roman-Byzantine periods. Cave-tombs, cisterns and caves are scattered around the tel, some of the caves still used today (I.M.D.& Carta 1993).

Rujm el Qasr: Remains of a square Byzantine fortress on the border of the Hebron Hills and Desert, 8 km north-east of Hebron. Its walls have been preserved to a considerable height. Iron Age shards are also found here (I.M.D.& Carta 1993).

14. Taffuh:

An Arab village in the Hebron Hills, 6 km west of Hebron. It is partly built over ancient ruins with ancient building stones reused in the village houses. Shards found in the village indicate habitation in the Iron Age, Persian, Roman, Byzantine and the Medieval periods (I.M.D.& Carta 1993).

15. Beit Ula:

A village in the Hebron Hills, 10 km north-west of Hebron. It is built on a site of an ancient settlement. The surrounding area has the following sites:

Khirbet Qila: A village in the Hebron Hills, 15 km north-west of Hebron. Adjacent to the village is Tel Qila, the site of the ancient city of Keilah, which is mentioned in Tel al 'Amarna letters as an important city kingdom. After Babylonian Exile, it was a district capital and its residents participated in building the walls of Jerusalem. During Roman-Byzantine periods it was famous for its figs and grain. Christian tradition claims that prophet *Habakkuk* was buried here. Tel Qila has remains of walls and tombs. The found shards indicate habitation from the Middle Bronze Age to the Iron Age and from the Persian period until the Middle Ages (I.M.D.& Carta 1993).

Khirbet Tawas: A ruin in the Hebron Hills north-west of Qila. The excavated agricultural installations and shards indicate human settlement in the Iron Age, the Roman-Byzantine periods and in the Middle Ages (I.M.D.& Carta 1993).

Photo 3 Ibrahim Oak, Hebron City

16. Tarqumya:

A village located 10 km north-west of Hebron. It is built on the site of a Roman settlement called Tricomias. The surrounding area has the following sites:

Khirbet Kan'an: Here are found ruins of a Roman settlement and an ancient road from Hebron to Beit Gebrin which was probably paved in days of Emperor Hadrian. There are also remains of what appears to be a road fortress (I.M.D.& Carta 1993).

Magharat Tur es Safa: Large underground cave in the Hebron Hills 3 km north-east of Tarqumya. It contains prehistoric remains (I.M.D.& Carta 1993).

Khirbet (et) Tayyiba: A tel 7 km north-west of Hebron. It has remains from the Middle Bronze Age, the Iron Age, the Byzantine period and the Middle Ages. Near the tel there is a ruin, a well (Beir et Tayyiba), many cisterns, and rock-cuttings from later periods (I.M.D.& Carta 1993).

17. Hebron Desert:

Hilly Desert region on the West Bank's eastern boundary. In spite of the harsh climate and soil conditions the Hebron Desert was inhabited during the Chalcolithic period and after. There are many historical sites scattered around. Some of these sites are as follows:

Khirbet Um Zuweitina: Settlement remains in the Hebron Desert, 13 km north-east of Hebron. It has many tumuli scattered over the area, as well as remains of rectangular and round structures. It was inhabited in the Chalcolithic period, in the Early Bronze and Iron Ages, and from Hellenistic period until the Middle Ages (I.M.D.& Carta 1993; Al-Dabbagh, M. 1991).

Zahrat el Miqtah: Ruins of structures in Hebron Desert, 13 km east of Hebron consisting of rectangular buildings, a cistern and a round structure. Shards indicate inhabitation in the Iron Age and in the Roman period (I.M.D. & Carta 1993).

Khirbet (ed) Deir: Settlement ruin in the Hebron Desert. Inhabited in the Roman, Byzantine and Arab periods. There are remains of 3 square structures, 2 stone mounds, channels and water cisterns (I.M.D & Carta 1993; Al-Dabbagh, M. 1991).

Chapter Eight
Wastewater

Raw wastewater originates from domestic and industrial sources. The characteristic of wastewater is impacted by water consumption rates, population density, industrial practices, and habits of the population. The discharge of raw wastewater can present a major potential health hazard as it carries disease causing pathogens, and toxic elements. Disposal of raw wastewater mixes with seasonal surface water, percolates into the ground and may contaminate the groundwater. In arid and semi-arid regions, treated wastewater has potential for reuse for irrigation purposes.

Domestic Wastewater

Domestic wastewater originates primarily from residential, commercial, institutional and public buildings. Once domestic wastewater is discharged into the sewer, dilution and/or contamination may occur by added industrial wastewater and storm water. These together determine the final hydraulic and waste load at the treatment facilities.

The amount of domestic wastewater produced per capita per day is usually 80-90% of water consumption. The quantity of domestic wastewater produced in the Hebron District was calculated based on an assumption that sewage is 80% of the average water consumption, multiplied by the estimated population. The total annual produced wastewater is approximately 1.86 mcm.

As is the case in the rest of the West Bank districts, water quality and quantity data for the Hebron District is scarce. Few studies and measurements concerning the quality and quantity of wastewater have been conducted. In a recent study, carried out in August 1994 for the Palestinian Economic Council for Development and Reconstruction (PECDAR), wastewater samples were taken from different locations in the West Bank and Gaza Strip, including the Hebron District. These samples were analyzed at the Islamic University in Gaza City. The results of this study revealed the characteristics of raw domestic wastewater in Hebron District (Table 8.1).

Table 8.1: Wastewater characteristics in the Hebron District

Parameter	pH	BOD_5	COD	TSS	Cl^-	PO_3^{2-}	P	NO_3^-	NO_3-N	Na^+
Value	6.0	520	2736	1794	3540	133.5	413.8	33.4	7.6	839

*** All values, except pH, are in mg/l**

Industrial Wastewater

Industrial wastewater is the water produced by different types of industries which often contains heavy metals or organic loads and can have a negative impact on the environment. The major industries in Hebron City are: leather, tanning, shoe making, quarrying, and stone cutting. The most hazardous industrial waste comes from the tanning industry where its discharged wastewater contains Chromium ions. Industrial waste water is discharged into the sewer system or disposed into the wadis and open spaces without any preliminary treatment.

Wastewater Disposal System

Wastewater disposal constitutes a major threat to health human and the environment in the Hebron District. The wastewater sector has been neglected in the district, and as a result, sewage is managed poorly. Only 55% of the population are connected to the sewer system located in Hebron City, the rest of the population disposes of sanitary waste in cesspits and open drains. Cesspits are used by all residents in the rural areas. Open drain system is used by some residents in the refugee camps.

Cesspits

Cesspits are a common alternative for wastewater disposal in the absence of sewage system. Cesspits are usually designed to serve a single household or a multiple apartment building. The volume of the cesspit depends on the availability of land space and the economic status of the owners. They range from 5 to 25 cubic meter. Cesspits are usually emptied by vacuum tankers owned and operated by either the municipalities, UNRWA, or the private sector. Contents are disposed of at any available location, in many cases, in the streets and wadis. Sewage is apparently disposed of without consideration to the natural habitat, soil fertility, groundwater, or built-up areas.

Open drains

Open drains are most common in refugee camps, which are not served by a sewer system. Open drains are used at both of the district refugee camps, Al-Fawwar and Al-'Aroub. Domestic wastewater and storm water is collected in the open drains, it then flows outside the camp boundaries onto unattended land without any treatment. Overflow of the drains is predictable, especially during the winter time.

Sewage network

The present wastewater network in the Hebron District serves only 50% of the Hebron City. The present network is very old and has many problems, such as: accumulation of solid waste from stone cutting factories, workshops, and slaughterhouses causes regular clogging and flooding of the sewer system; and the absence of a storm water drainage system causes overload of the network, which results in blockage and flooding thereby leaving stagnant pools at the streets. Wastewater from the network is transferred through a main pipeline to the south of the city near wadi As-Samn, where the pumping station is installed. It should be pumped to the sedimentation ponds located to the east of the city, but for several reasons, the pumping station is non-functioning. The wastewater flows through wadi As-Samn to the south-west, impacting the crops, fruits and vegetables which are freely planted and irrigated along the sides of the wadi. Infact, the current situation encourged several several farmers to utilize the flowing sewage in irrigating their crops along both sides of the vally. Livestock also use the flowing wastewater for drinking.

Photo 4: Gaots drinking wastewater in wadi es-Samn

Wastewater Treatment

The main objective of wastewater treatment is to protect the environment from:

- high amounts of solids;
- excessive organic matter;
- low oxygen level in the disposed wastewater;
- high concentration of nutrients (N and P);
- toxic amounts of hazardous compounds; and
- contamination with pathogenic organisms.

This is done in order to:

- prevent the environmental nuisance;
- prevent the transmission of water borne diseases;
- utilize the effluent as a highly economic water resource for meeting the ever-growing water demand; and
- establish or maintain a healthy aquatic habitat for flora and fauna.

In the Hebron District, no treatment plant is available. Algal ponds were constructed and a pump station was installed in 1988. As mentioned above, the pumping station was clogged after 2 months of operation, and from that time, the pumping station and the ponds have not been used.

Simple primary treatment is performed in some of the stone cutting factories in the district by collecting the generated wastewater in adjacent ponds to allow separation of particles by natural settling. The treated water is then collected from the top of the pond for reuse in the stone cutting process.

Environmental-Related Problems

The major environmental-related problems found during the field survey in the district are as follows.

- Frequent flooding of cesspits throughout the district, and wastewater flow in wadi As-Samn, which crosses many villages in the district. There are major environmental and health problems, which can potentially lead to transmission of infectious diseases, in addition to foul odors and habitat for mosquitoes.
- Absence of a storm water drainage system causes overload of the existing sewage network, in Hebron City, which results in blockage and flooding.
- Contamination of groundwater aquifers and springs as a result of wastewater percolation from cesspits and wastewater flow in the wadis is possible.

- Irrigation with raw wastewater is another problem found primarily in the Wadi As-Samn area (Photo). This practice has great potential for problems because the irrigated crops including tomatoes, cauliflower, squash, eggplants, grapes, and other field crops, are often eaten fresh.
- Almost all of the car oil-changing facilities in the Hebron District, as well as the rest of the West Bank, dispose of their used oil in the open fields. The disposed used oil imposes a serious threat to the quality of groundwater and the fertility of the land.

Photo 5: Cultivated areas irrigated with raw wastewater, wadi es-Samn

The challenge of an adequate wastewater collection and disposal system requires immediate attention from the authorities and official institutions. Public awareness and education about the need to properly manage wastewater must be increased, especially among farmers and consumers. The potential danger of improper sewage disposal to human health and welfare should be stressed. Authorities must enforce regulations that require proper wastewater disposal by individuals, the commercial sector and industrial facilities, to prevent pollution.

Recommendations

To improve the existing situation the following recommendations are presented:

- A professional committee in the fields of sewage, including specialists in hydrology, health and environmental protection, should be affiliated to the national administration.
- Installation and upgrading of sewer systems and treatment facilities is needed to produce effluents meeting required standards. Those effluents meeting the standards can be used for irrigation purposes or to recharge the aquifer.
- Systems and cesspits to collect rural waste should be upgraded. People should be educated about the proper use and management of the cesspits. Disposal of waste removed from cesspits should be regulated to stop indiscriminate dumping.
- Installation of a separate drainage system for rain water which discharges to a well controlled and protected area is recommended in order to recharge the aquifer, and/or to be used for irrigation purposes.
- Industrial wastewater should be treated before disposal to the sewer network.
- Open channels should be replaced by collection systems.

Chapter Nine
Solid Waste

Introduction

Solid waste management is an essential urban service which is provided to achieve the following objectives:

- protection of public health,
- promotion of hygiene,
- recycling of materials,
- avoidance of waste,
- reduction of waste quantities, and
- reduction of emissions and residuals.

A healthy city must have a planned program for effective collection and proper handling and disposal of solid waste so as to create a safe and pleasant urban environment. Hence there will be national, regional and local issues to be addressed and, increasingly, an international dimension to be considered in formulating an environmentally sound program for solid waste management.

An organized program for solid waste management in urban areas is essential if cities are to be healthy places to live, and environmentally attractive to visitors and residents. Institutional planning is the key to achieving an acceptable and affordable system, but the success of any scheme will depend on the cooperation of the people and their aspirations for a safe and aesthetically pleasing urban environment.

The amount of waste per household and the volume of industrial waste are growing rapidly. The content of waste is also changing, requiring greater care in handling and disposal. Many municipal waste collection systems currently provided are inadequate, leading to waste dumping in wadis, road sides and open spaces.

The responsibility for waste collection in the Hebron District is divided between the municipalities, town or village councils and UNRWA in the refugee camps. There are common methods for waste disposal in the district: municipal or village council waste is disposed in waste dumps, or open dump sites, and a large amount of individual waste is disposed randomly in nearby open spaces or road sides.

Over the past decades the responsible parties have paid little attention to improving the financial and technical management of their solid waste operations and have made no attempt to encourage re-use and recycling of materials. Lack of public cooperation is also a significant obstacle to effective solid waste management.

Risks to Human Health

Solid waste is likely to contain human pathogens, from disposed baby diapers, paper handkerchiefs, contaminated food and waste from pets. Handling and disposal of solid wastes could present a potential for disease transmission similar to that of collection and disposal of excreta and sewage. In addition, inadequate storage and collection and poor disposal practices serve as breeding sites for rats, flies, mosquitoes, cockroaches and other vermin which can act as passive vectors in transmitting diseases.

Apart from the potential health risks arise from the possible presence of infectious agents in solid waste. General public, workers employed in solid waste collection and disposal are exposed to health risks. Thus, the public health concerns and safety risks which might be associated with solid waste are:

- exposure to pathogens,
- exposure to toxic and hazardous substances, and
- physical injury.

Domestic Waste

Collection of domestic waste in the district is either the responsibility of the municipality, town and village councils or UNRWA in the refugee camps. Table 9.1 shows the distribution of responsibilities for domestic waste collection and disposal.

Table 9.1: Distribution of domestic waste disposal methods

Responsible Party	Disposal oF solid waste (%)
Municipalities	52
Village & Town Councils	22
UNRWA	4
No Party designated	22

The quantity of the generated domestic solid waste in the district of Hebron is estimated to be 260 tons/day excluding the refugee camps. According to UNRWA officials, the two camps Al-'Aroub and Al-Fawwar generate close to 10.3 tons/day of domestic waste. The camps dispose of their waste in a dumping site near Beit Ummar village, this dumping site is nearly 15 km away from Al-'Aroub R.C. and 25 km away from Al-Fawwar R.C.

Collection containers and vehicles that are currently used throughout the municipalities, towns, and camps vary in number and size. In the Hebron District there are approximately 680 containers of which close to 83% are 1.0-4.9 m3 in volume, 11% are 0.4-0.9 m3, 3.0% are 6.1-9.0 m3, and 2.0% are 5.0-6.0 m3. The vehicles used for collection include hand carts, agricultural tractors, and trucks of various types and capacities. There are 22 carts, 3 agricultural tractors, and 15 trucks used throughout the district. More information is shown in Appendix 4, Table 9.2.

Photo 6: Young people picking through solid waste at uncontrolled dumping site

Industrial Waste

The Hebron District is distinguished in its industrial activities. Quarrying, leather and metallic industries are the core of Hebron's industrial base. Leather industries which include leather tanning, shoe factories, and workshops constitute approximately 40%, stone cutting factories and quarries constitute approximately 15%, and the metallic industries form about 14% of the total industries in the district (Hebron Chamber of commerce, 1995).

According to ARIJ survey, approximately 31% of industrial facilities are located in residential areas, 19% in industrial area, 26% in commercial areas and the remaining 24%

are located in agricultural areas. The major quarrying sites are found near Sa'ir and Yatta. Processing and manufacturing industries, mainly food and agro-processing, clothing, textile, leather products and furniture are concentrated in Hebron City. Units for tile production, and other construction materials are found in several locations in the district.

Quarrying and Stone Processing

Quarrying and stone processing are considered the leading industries in the West Bank, and are also major contributors to environmental degradation and pollution. Air pollution in these areas is of great concern as enormous quantities of dust and particulate matter are released into the air causing potential harm to the nearby residents and land.

According to the Hebron Chamber of Commerce, 60 stone processing facility exist in the district. The generated solid waste from these facilities is approximately 110,000 tons/year., the majority is stone debris, about 20,000 tons/y is stone slurry. The stone debris is dumped on nearby road sides or vacant land adjacent to the facilities. The generated slurry is disposed either in open areas where it clogs the soil pores resulting in soil and plant damage or into the wastewater network system causing many technical problems to the network or the pumping station. As mentioned earlier, the pumping station at Hebron City was damaged after only a few months of operation due to slurry disposal from the stone cutting facilities. The slurry in the district is not treated before disposal, unlike some other areas of the West Bank.

Tanning

Tanning of leather and hides has been an important industrial activity in the district. There are 10 tanning factories in the district located mainly in the industrial area of Hebron City. The produced leather is exported to Israel, the United States of America, and Turkey along with the local market. Irrespective of the immediate economic benefits of production, pollution from tanneries has a considerable negative long-term environmental impact. In addition to the traditional problems of air and water pollution, there are other environmental concerns such as chemical safety, contamination of land and groundwater, and the general nuisance of odor and noise of installations. Many of these impacts are on the health and safety of workers. The generated solid waste which is mainly of animal origin is a powerful pollutant in water and is also highly odorous when it decomposes. The generated solid waste from this industry is usually dumped and burned on vacant lands adjacent to the factories (Photo). The wastewater which contains large quantities of carcinogenic Chromium and Sulfide are disposed untreated in the wastewater network of the Hebron City which is subsequently disposed freely in the adjacent wadi. Table 9.3 shows the composition of a typical tannery effluent (UNEP, 1991).

Table 9.3: Composition of typical untreated tannery effluent.											
Parameter	**pH**	**TS**	**TSS**	**BOD**	**COD**	**SO_2**	**Total N_2**	**NH_4^- N**	**Cr**	**Cl**	**SO_4**
Concentration (ppm)	9	10000	2500	900	2500	160	120	70	70	2500	2000
Units are in ppm, except for the pH **source: UNEP/IEO Technical report series no.4**											

Several measures to help bringing improvements in the environmental performance of the tannery industry should be enforced and carried.

Other Industries

The analysis of approximately 20% of the industries in the district, other than quarries and stone cutting facilities, revealed that the solid waste is generated either when the materials are produced or during packaging. Packaging material, composed of paper, carton, metal, plastic, wood and Jute, constitutes considerable amount out of the total generated waste.

The major contributors to solid waste is the metallic and leather industries. Plastic factories generate small quantities of solid waste because most of the generated waste is recycled back in the production line. The seasonally generated olive pulp in the district is approximately 9000 tons/year.

Photo 7: Stone quarry in Sa'ir

The generated wastewater from the industries surveyed excluding quarries and stone cutting facilities equals approximately 29,000 cm/yr. Table 9.4 shows the number of surveyed facilities and the generated waste as supplied by the factories owners.

Table 9.4: Industrial waste, excluding quarries

Industrial Branch	Total no. of Factories	No. of Factories surveyed	Solid Waste of those surveyed tons /year.	Liquid waste cm/year.
Food & Beverage	37	9	219	14,500
Textile	30	2	7	0
Plastic	39	7	20	0
Chemicals	10	3	150	15
Printing	10	2	4	N/A
Fooder	N/A	2	8	0
Leather Tanning	10	4	328	13,350
Shoes Factories	28	11	100	0
Metallic	154	15	446	1200
Carton	4	3	110	0
Touristic	34	2	46	0
Sponge mattresses	1	1	24	0

Table Key Notes: N/A: Not Available data

Based on the surveyed industries, the generated solid waste is disposed of by different methods as shown in Table 9.5.

Table 9.5: Distribution of different methods of waste disposal

Method of Disposal	%
Municipal waste containers	32
Road-sides dumping	37
On-site burning	7
Reuse	8
All of the above methods	11

The industrial sector is expected to grow more than any other sector in the coming years, presenting an increased challenge to the protection of environment. Environmental awareness among the industrial sector and environmental standards must be implemented.

Photo 8: Solid waste from leather factory

Medical Waste There is a growing awareness, on a worldwide scale, of the need to impose strict controls over the disposal of wastes generated by hospitals and other health care services. Medical wastes are typically classified as follows.

1. Pathological waste. Including all human tissue (whether infected or not) such as limbs, organs, blood and other body fluids, and tissue from laboratories.

2. Infectious waste. This consists of used surgical dressings, swabs, cultures and stocks of infectious agents from laboratory work; dialysis equipment, apparatus and disposable gowns, aprons, gloves, etc.

3. Sharp objects. This category includes needles, syringes, scalpels, blades, saws, nails, broken glass and any other items which could cut or puncture.

4. Pharmaceutical waste. This includes pharmaceutical products, drugs, and chemicals which have been returned from wards, spilled or soiled, or to be discarded for any reason.

5. Chemical waste. Examples are discarded solid, liquid or gaseous chemicals from laboratories or other sources such as diagnostic work, experimental work, cleaning, housekeeping and disinfecting procedures. Hazardous chemical waste includes: toxic materials, corrosive (acids below pH 2.0 and alkalis above pH 12.0), highly flammable materials, reactive (explosive, shock sensitive, water reactive, air reactive), and genotoxic (carcinogenic, mutagenic).

6. Aerosols and pressurized containers. Included those used for treatment, instruction or demonstration purposes, those containing innocuous or inert gases and other containers which may explode if incinerated punctured.

The medical waste generated in the Hebron District is a threat to the population of the area, as little of the generated medical waste is properly treated before disposal and most ends up with the municipal garbage.

Before starting any proposed project to reduce the threat from medical waste, it must be considered that the waste should be disposed safely in all terms, from production to final destruction. This means, the surrounding not be polluted and that risk of infection for the people taking part in handling and disposing hospital waste should be minimized.

Three hospitals, ten private laboratories and three clinics in the district were surveyed by ARIJ. Approximately 25% of the medical centers are located in residential areas, 67% are located in commercial areas and 8% are located in industrial areas.

None of the medical centers which were visited have any special dumps or incinerators for the medical waste. Most of the waste is disposed and mixed with municipal garbage.

For example, nearly 86.7% of the blood samples are disposed directly into the garbage without any previous treatment to guarantee the prevention of microbial or viral contamination and infection, 6.6% usually incinerate the blood samples and 6.7% dispose of the blood samples in the sewage network. All other medical objects and tools are discarded with the municipal waste.

The sharp objects such as needles and lancets should be covered or placed in special containers before being disposed. More than 87% of all medical centers surveyed dump these sharp objects without any special treatment. This increases the risks of infection of those people who are dealing with such objects during collection of the garbage. Most of medical centers use septic solutions for cleaning bed sheets. On the other hand, only a few of them isolate sheets and instruments used by patients with infectious disease from the rest.

The only exceptional item sterilized by autoclave before disposal is petri dishes which are used for bacterial growth. Around 47% of the medical centers in Hebron District use autoclaving to treat petri dishes while 7% of them usually burned.

All the surgery wastes, from the general and hospitals, are held in plastic bags and disposed of into the garbage bins. Most of the lab technicians in hospitals, clinics and laboratories don't use safety equipment such as gloves or masks. Most also lack medical or health insurance coverage.

The health department does not perform any periodical inspection to medical and health centers. For example, around 87.5% of the medical centers were never subjected to any kind of inspection by the health department. A program needs to be implemented to manage medical waste in a way that reduces risks of infection, pollution, and protect the personnel responsible for handling and disposing of the medical waste. The major risks facing personnel are as follows:

- Personnel handling waste containing blood-soaked objects from patients in dialysis units must be protected against the transmission of hepatitis. Special

arrangements are necessary for the isolation, separation, collection and disposal of this waste.

- Custodial personnel, maintenance staff and porters could be at risk from waste that contains sharp items such as syringes and needles, if these have not been kept separate and safely packaged for disposal.
- Personnel involved in the final disposal of waste may be exposed to risk from pathological waste, especially if the wrapping or storage sacks are punctured or torn.
- Custodial personnel could be exposed to risk on any premises where leaks or obstructions in drain system result in the escape of gases or hazardous solvents that may be inhaled. Exposure to H2S escaping from blocked sewers is a well known hazard.
- Personnel working in or visiting clinical laboratories where pathogenic micro-organisms, infectious agents or pathological materials are examined, handled or stored could be at great risk from wastes which may be generated there.

Recommendations

- Sanitary landfill should be constructed for the Hebron District, taking into account environmental impacts on the site and leachate monitoring and control.
- Treatment of solid waste should be introduced to reduce the mass or volume of the waste and achieve one or more of following objectives:- improvement of its acceptability in environmental terms,- separation and recovery of recyclable material or energy, and- reduction of transport costs.
- Public awareness about proper waste management should be increased. Health and hygiene instructions must include home and community hygiene and stress the health implications of poor solid waste storage, collection and disposal practice.
- Hazardous waste, including medical waste, should be collected and disposed of separately.
- Municipalities and village councils need to have solid waste storage facilities and vehicles.

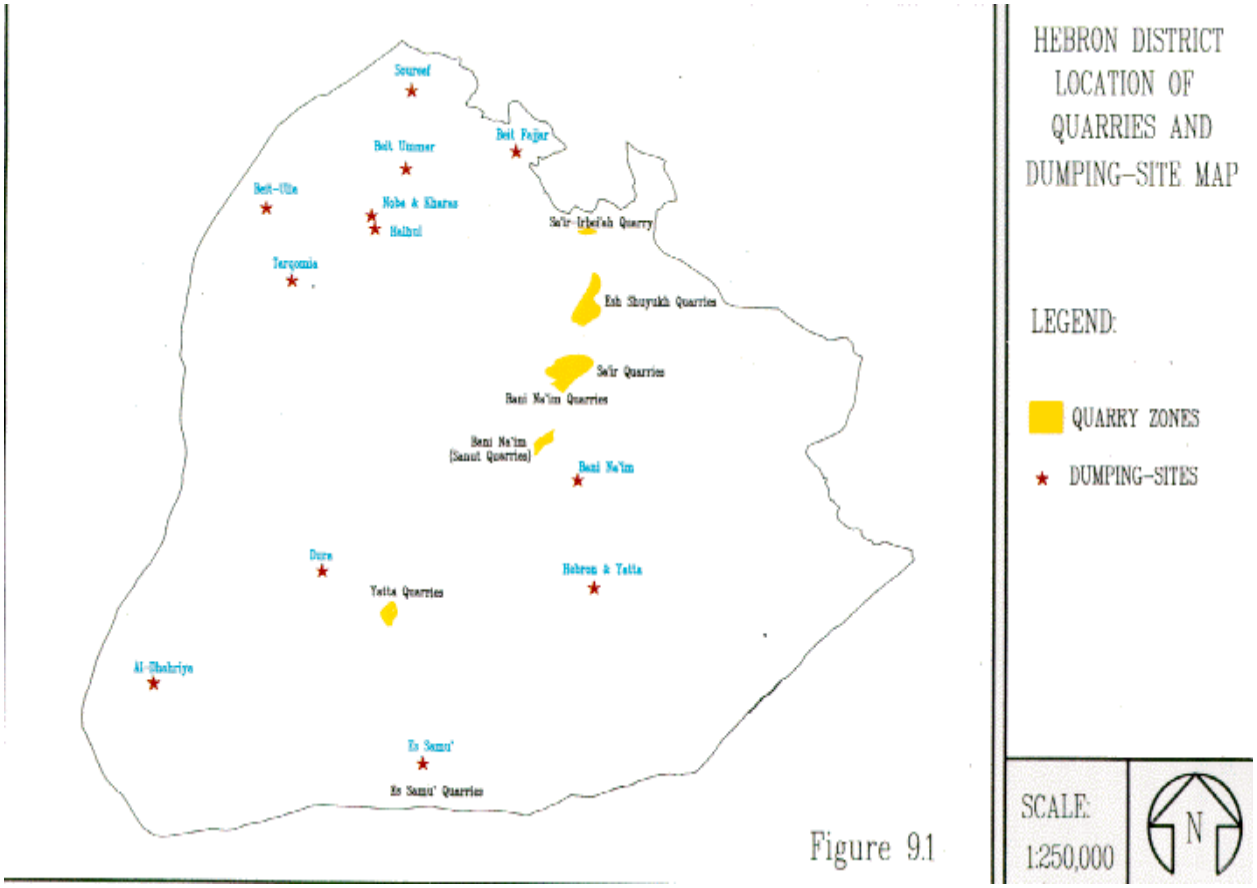

Figure 9.1: Location Of Quarries And Dumping Sites

Chapter Ten
Air And Noise Pollution

Some air pollutants are formed and emitted through natural processes, however, near cities and in populated areas, more than 90% of the volume of air pollution is a result of human activities. The main sources of air pollution are, energy production, transportation and industry. Hebron District has a fairly dense population and an active industrial sector; these factors play a significant role in increasing air pollution. Dust levels are naturally high in Palestine, where hot and dry sand storms from the eastern desert (khamaseen) occur frequently.

Industry is also a major source of gaseous emissions. Although large industrial plants with high emissions production don't exist, clusters of small-scale plants operating obsolete equipment, and under little regulation are significant polluters.

About 20% of the population of the West Bank lives in Hebron, they own 21.2% of the of the vehicles in the West Bank. These vehicles (totaling 23,248), including cars, buses, trucks, motorcycles and others, emit pollutants such as carbon monoxide, sulfur oxides, nitrogen oxides and particulate matter. A high percentage of the vehicles are more than 15 years old.

Table 10.1: Types and numbers of transportation vehicles in the Hebron District

Type	Private	Commercial	Bus	Taxi	Truck	Motorcycle	Other	Total
Number	16763	2793	187	218	1290	131	1866	23248

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

The district lacks a developed urban road system and the management of traffic is ineffective, causing increased vehicle emissions. Dense vehicular traffic causes air pollution problems mainly in the center of Hebron City where it is very crowded. Black soot emitted from diesel-powered vehicles is the cause of visible changes in the buildings such as soiling, discoloring or darkening of the surface. As the rate of motorization increase, air quality may further deteriorate. The following table shows the contribution of the vehicles in air pollutants.

Table 10.2: Transportation air emission inventories.

Year of production	Engine capacity	Unit (u)	CO (kg/u)	SO_x (kg/u)	NO_x (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 1400-2000 >2000	1000	28.44 28.44 28.44	1.39 1.68 2.13	1.5 1.72 1.97	2.84 2.84 2.84	0.09 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 15.73	1.27 1.62 1.85	1.5 1.78 2.51	2.23 2.23 2.23	0.09 0.11 0.14

Source: World Health Organization, Geneva, 1993

Rough calculations show that the annual emission of air pollutants due to gasoline combustion is close to 0.6 tons per vehicle. Furthermore, an estimated 12,660 tons of CO, 900 tons of SOx, 1040 tons of NOx, 1540 tons of VOC and 10 tons of Pb are emitted each year in the district due to local driving only.

Political changes in the region are expected to increase the traffic volume in the district. Higher usage of buses, taxis, trucks and rental vehicles will contribute to higher emission of gases into the atmosphere, and will demand new programs in traffic management and control to reduce congestion and emission of poisonous gases. The new autonomy may also allow for changes which serve to protect the air quality such as a regulatory program for emissions, vehicle inspection and establishment of a traffic management program using traffic lights (banned under Israeli military occupation) and traffic police.

Fixed sources of air pollution are primarily from industries, such as quarries and stone cutting facilities, that release large quantities of particulate matter and dust into the

atmosphere. Most industries lack necessary air filtration systems for collection of dust and particulate.

Most building materials, namely sand, and both coarse and fine aggregates, are dumped and left uncovered on the road sides. These materials are often left at the construction site for extended periods of time and contribute to the particulate matter carried in the atmosphere. Strict construction laws and regulations should be established which limit the amount of particulate matter. Obtaining a building permit should be made conditional upon the adherence to these regulations. The planting of trees in front of buildings should be encouraged as it will moderate the atmosphere and filter pollutants.

A high level of air pollution negatively impacts both humans and the environment. High lead concentration in the air can affect the blood system, the nervous system and the renal system. Vegetation can be damaged from dust and polluted rain (acid rain) and can sometimes leave residue on the produce. Impact on wildlife can be through their consumption of polluted vegetation and water.

In the West Bank, there is a lack of raw data on air quality, atmospheric dispersion conditions, the impact of Israeli's traffic and industrial activities, etc. An air monitoring system will provide the needed data for the establishment of regulations and standards for air quality.

In the near future ARIJ will conduct a study on air quality and pollution. Air quality monitoring system will be installed to cover most of the West Bank to serve the national goals and research requirements.

Photo 9: Dust on agricultural land adjacent to stone quarry, Beit Ummar

Noise Pollution

Noise, an output of urbanization and industrialization, is increasingly recognized as an environmental pollution affecting basic human health and well being. The sources of noise pollution in urban areas are: traffic and motor vehicles, road construction and buildings, and industrial activities. The level of noise is affected by the type, age, maintenance level and quantity of vehicles and the location of industrial activities. In rural areas of the district, noise is mostly caused by Israeli military aircrafts and military training activities. Noise pollution has not been studied in Palestine, scientific measurements and data about noise levels are not established. However, field observations give an idea about different noise sources and levels that are commonly found in the district. The main sources of noise are: low flying Israeli military aircrafts, especially when they break the sound barrier producing sonic booms; roadway traffic, especially in the center of Hebron City where frequent traffic jams occur; construction noise; and stationary sources such as stone cutting facilities.

The need for well enforced regulations specifically addressing noise pollution is justified by the fact that sustainable loud noise may cause problems for human hearing and nervous systems. Moreover, it may interfere with the work environment, normal speech, communication, sleep, inter-room privacy, as well as being annoyance. In addition to its effects on the wildlife and their habitat.

Recommendations

- Research on air pollution control and air quality monitoring should be expanded.
- An air quality monitoring system should be established to cover all the Palestinian areas.
- A national center for air quality data storage and analysis, based on data obtained from the proposed regional monitoring network, should be established.
- Air quality standards, should be established and be in accord with international requirements.
- Regulations to prohibit burning of waste at disposal sites are needed.
- Old vehicles, including buses, trucks, taxis and private that not able to meet an emission standard , should be taken out of service. Importation of old vehicles should be regulated.

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