



FACULTY of ENGINEERING

**URBANISM IMPACT ON THE ENVIRONMENT:
RAMALLAH LANDFILL AS CASE STUDY**

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The findings, interpretations and conclusions expressed in this study do not necessarily express the views of Birzeit University, the views of the individual members of the MSc Committee or the views of their respective employers.

DEDICATION

To my father's immaculate soul and his encouragement to continue my education.

To my mother and her continuous encouragement and support in everything.

To my mother in law and her support in taking care of my baby.

To my husband and his patience, support, and encouragement to finish my thesis.

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ABSTRACT

Environmental protection and conservation are of utmost importance to many urban development and planning across the world. Not only are the specific effects of development to be mitigated, but attempts shall be made to minimize the overall effects of development on the local and global environment. This is commonly done through environmental assessment of urban infrastructure.

Environmental planning which aims to integrate the public sector urban planning with environmental concerns to ensure sustainable development, with special emphasis on resource extraction, energy production and waste disposal. Urban planner is likely to use a number of quantitative tools to forecast impacts of development on environment.

Solid waste disposal in Palestine did not follow any environmental planning legislations in the past. The open random or planned dump sits became a landscape feature in the area and one of the land use forms. The site selection of current municipal dumpsites was not according to environmental or urban planning standards. Attempts to investigate the social and environmental impacts, as a result of these practices are lacking.

The aim of this study was to assess the social and environmental aspects of the land use forms in urban planning. The landfill sitting of Ramallah city was taken as a case study.

The study was based on Quantitative data obtained from lab analysis of storm water runoff over the landfill that gave an indicator of the pollution to the ground water and the area surrounded. Also qualitative data analysis using questionnaire was made to assess the social and public health impacts of close landfill on the built up areas, the analysis of the data and tabulation was performed using the SPSS 0.9 program.

The study results showed that the storm water runoff over Ramallah landfill carries a high concentration of Cr, Mn, Cu, Pb, and Fe, which reached in some samples respectively about (0.126 mg/l, 0.307 mg/l, 1.557 mg/l, 0.081 mg/l, and 5.65 mg/l). The presence of high concentration of heavy metal in water means that the water is polluted, toxic to human health.

Also the site investigation showed that 77.4% of the families living nearby the landfill are suffering from odor problems, 62.7% are suffering from dust emission in the area, 68.0% are suffering from the smoke emission, and 23% of the families explained that one or more family member suffers from breath diseases and allergies due to the air pollution from the dust and smoke released from the dumpsite. Furthermore 79.7% of the people agreed on that the dumpsite affect their daily social activities not only the health.

In general the landfill has an negative impact on the social activities and on the public health issues, which recommend to the landfill fast closure, and in the present time preventing the open solid waste burning at the landfill which needs enhancing of the dumpsite control.

ملخص

تعتبر حماية البيئة والحفاظ عليها من أهم الأمور التي تؤخذ بعين الاعتبار في كثير من دول العالم في عمليات التخطيط والتطوير التنموي بشكل عام. والاهتمام في البيئة يشمل محاولات التخفيف من جميع المؤثرات السلبية للتطور على البيئة المحلية والعالمية، ويتم ذلك عن طريق التقييم البيئي لجميع مشاريع البنية التحتية الحضرية، خلال ما يسمى بعملية التخطيط البيئي.

التخطيط البيئي هو احد مجالات التخطيط الحضري والتي تعنى بدمج البعد البيئي كجزء من عملية التخطيط الحضري بهدف تحقيق التطوير المستدام، والذي يعنى أيضاً بمصادر البيئة وإنتاج الطاقة والتخلص من النفايات والفضلات بطرق بيئية سليمة. كما أن التخطيط البيئي هو علم يوفر أدوات تساعد المخططين في توقع تأثير التخطيط على البيئة. وبالتالي إن التخطيط من أجل إدارة النفايات الصلبة يجب أن يتم من خلال التخطيط البيئي.

في فلسطين التخطيط من أجل التخلص من النفايات الصلبة لم يتم ضمن محددات ومقومات بيئية في السابق، وأصبحت مكبات النفايات العشوائية جزء من المشهد الفلسطيني البيئي و شكل من أشكال استخدامات الأراضي. كما أن اختيار مواقع مكبات النفايات لم يتم بطرق بيئية ومعايير تخطيطية سليمة، بالإضافة إلى أن محاولات دراسة مدى التأثير البيئي المجتمعي لهذه المكبات قليلة.

الهدف العام من هذه الدراسة هو تقييم التأثير البيئي والمجتمعي لشكل من أشكال استخدامات الأراضي في التخطيط الحضري، من خلال اعتماد حالة دراسية وهي موقع مكب نفايات مدينة رام الله.

تم الاعتماد في هذه الدراسة على معلومات كمية وأخرى نوعية وصفية، حيث أن الكمية تتمثل بنتائج بعض التحليلات المخبرية لمياه الأمطار الجارية فوق المكب، والتي دلت على وجود تلوث سوف يؤثر على المدى البعيد على المياه الجوفية والمناطق المحيطة للمكب. والمعلومات وصفية التي هي تحليل لمعلومات تم الحصول عليها عبر استبيان تم توزيعه في منطقة الدراسة لدراسة مدى تأثير المكب على البيئة المجتمعية والصحة العامة للمنطقة المحيطة بالمكب وتم تحليل الاستبيان والمعلومات من خلال برنامج SPSS.

وأظهرت نتائج التحليلات المخبرية لمياه الأمطار الجارية فوق المكب، أن المياه الجارية فوق المكب تحمل تركيز عالي من المعادن الثقيلة المذابة وهي (Fe ، Pb ، Cu ، Mn ،Cr) حيث وصل أعلي تركيز لبعض العينات للمعادن السابق ذكرها على التوالي كما يلي: (0.126 ملغم /لتر، 0.307 ملغم /لتر، 1.557 ملغم /لتر ، 0.0808 ملغم /لتر، 5.65 ملغم /لتر)، مما يدل على أن المياه ملوثة ولها تأثير سلبي على الصحة البشرية.

وأظهرت نتائج تحليل الاستبيان أيضاً أن 77.4% من العائلات التي تعيش بجوار المكب تعاني من انبعاث الروائح الكريهة من المكب، وأن 68% من العائلات تعاني من انبعاث الدخان من المكب، وأن 62.7% من العائلات تعاني من انتشار الغبار في الجو في المنطقة بشكل كبير من المكب مما أدى إلى أن 23% من العائلات يعاني أحد أفرادها من مشكل في التنفس وحساسية في الجهاز التنفسي. بالإضافة إلى أن 79.7% من العائلات التي تسكن بالقرب من المكب أكدت أن وجود المكب بجوار مناطق سكنهم يؤثر على النشاط اليومي للعائلة و لا يقتصر التأثير على الوضع الصحي فقط.

بشكل عام أكدت الدراسة أن وجود المكب بجوار مناطق سكنية له تأثير سلبي علي الصحة العامة والنشاطات الاجتماعية، مما يقود إلى أهمية إغلاق المكب حين يتوفر مكب بديل، أما في الوقت الراهن لا بد من إيقاف عمليات الحرق في مكب النفايات عن طريق تحسين عمليات إدارة المكب.

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LIST OF ABBREVIATIONS

CFU	Colony-Forming Unit
COD	Chemical Oxygen Demand
EE	Environmental Education
EIA	Environmental Impact Assessment
EQA	Environment Quality Authority
ERM	Environmental Resource Management
FC	Fecal Coliform
MEnA	Ministry of Environmental Affair
MoLG	Ministry of Local Government
NEAP	National Environmental Action Plan
NGOs	Non Governmental Organizations
OPT	Occupied Palestinian Territories
PCBS	Palestinian Central Bureau of Statistics
PDP	Palestinian Development Plan
PEnA	Palestinian Environmental Affair
PSI	Palestinian Standard Institution
UN	United Nations
UNEP	United Nation Environment Program
TC	Total Coliform
TDS	Total Dissolved Solid
TKN	Total Kjeldahl Nitrogen
TSS	Total Suspended Solid
UNRWA	United Nation Relief and Work Agency
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Background

The developing countries are facing enormous challenges in achieving environmental protection. The high population growth and rapid urbanization have resulted in increasing demands for different land uses, water, and energy. The continuous pressure on the natural resources created a crippled planning extension and unprecedented environmental damage.

The deterioration of the environmental situation called for the insertion of the environment dimension in the urban development in the whole world, and so in 1992 the United Nations (UN) held a conference about the environment and development in Rio de Janeiro in Brazil, and one of the conference objectives was how to insert the economic, environmental and social intents together in the national level, and how to create a sustainable development (Ganaiem, 2001).

The case of Palestine is not so different from any other developing country the environmental situation has been rapidly deteriorating due to many reasons such as, rapid unplanned urbanization and the unplanned urban land use structure which are the eco of the highly rapid population growth and demands. Also the shortage of natural resources (water, land, vegetation... etc), the steadily growing population with wide spread poverty and the bad economical situation in this area created environmental hazards and practices with detrimental results.

On the other hand, the lack of environmental awareness and education as a result of the prolonged Israeli occupation which made part of the Palestinian population except the fact as it is and become accustomed in living with the environmental condition below the human level. Also the absence of the proper legislations and laws to control the existing environment situation added significantly to the catastrophe of the environmental situation.

Nowadays, the environment issue in Palestine attracted the attention of the officials, and dealing with the environment in an effective way became an absolute necessity to prevent any future deterioration of the Palestinian environment, and so in December 1996 the Palestinian Environmental Affairs (PEEnA) was established (PEEnA, 1997). It is concerned in development of regulations, strategies, management plans and monitoring programs that helps to stop damaging the environment and enhance its' condition, also it aims to protect the environment, emphasize the public awareness and environment education, and pollution control.

In the same context, in February 2002 the governing council /Global Ministry Environment Forum in Cartagena/Colombia, adapted unanimously decision concerning the environmental situation in the occupied Palestinian territories in its' session, and it was the seventh special session, with the cooperation of the United Nation Environment Program (UNEP) to identify major areas of environmental damage requiring urgent attention, and all the reports that were alarmed were related to the pollution of water, dumping wastes, lose natural vegetation and pollution of coastal water in the region (UNEP, 2003). all these pollution came as a result of the rapid urbanization that the region are suffering

from, where the political situation and acts played a major role in making the situation worst.

The solid waste are one of the sources of environmental pollution as mentioned previously, that needs an urgent attention, and the landfills came as a solution and one of the land use elements as a respond to the rapid urbanization in the area, this research will focus on the impact of urbanization on environment taking landfills in general and Ramallah/Al- Bireh district landfills in specific as a study case, since it is one of the land use elements that fulfills an urban need in this area.

1.2 Main Goals and Objectives

The main goal of this research is to study and evaluate the impact assessment of urbanization and urban structure on environment taking the landfill as one of the urban development needs and land use form, and study its' impact on the environment surrounding it and its' components to reverse and prevent any future deterioration of the environment.

While the objects are:

- Describe the present status of the Palestinian environment, associated with urban development projects.
- To assess the existing situation of the solid waste management in the Occupied Palestine, with emphasis on Al Bireh/Ramallah district.

- Describe the urban Development and trends of Ramallah city and its impact, on Environment.
- Evaluate the impact of landfills on the environment of Ramallah and Al Bireh District, especially the possible socio-economic impacts and natural environment.
- Suggest Future strategies to conserve the environment, and reduce public health hazards.

1.3. Methodology

The literature review depended on data collection of local and international reports, books, documents and papers; also it depended on some personal interviews of stake holders in Ramallah municipality and different urban plans analysis of Ramallah city. There is part of the literature review, which are the house hold solid waste management depended on the analysis of the raw data that was obtained from the Palestinian Central Bureau of Statistics (PCBS), and done in personal environmental study. The main part of the study which is the study of Ramallah existing landfill impact on Environment since it is a form of land use planning, depended on two types of data, which are:

1.3.1. Qualitative data

Qualitative data was collected through questioner designed with a help of the (PCBS), which means according scientific matters, and was designed taking into account the objective of the study (Appendix1).

The questioner was distributed to the residential area around the dumpsite with radius effect of 1km to study the impact of the expansion of residential areas toward the dumpsite, and the number of sample was about 95 families, this number was decided according to the following equation:

$$N=n/(1+ne^2)$$

Where: e: margin of error

n: total population number

N: sample size

The number of the families around the dumpsite according to the municipality map of Ramallah estimated to be 10000 inhabitants, and the margin error that are accepted for master thesis are 10% (90% confidence). Also the analysis of the data and tabulation was performed using the SPSS program (Statistical Package for the Social Sciences).

1.3.2. Quantitative data

The qualitative data depended on analysis of 10 samples of runoff rain water over the dumpsite to study the level of pollution that could be caused to the rain water and its effect on Environmental quality.

The samples were taken in different parts of the dumpsite to cover all the pollutions that could be carried (Fig 1.1), the analysis of the water samples carried out at Birzeit University labs.

To study the level of the pollution of the storm water runoff, the following water quality parameters were measured:

- Chemical parameters (NH_4 , NO_3 , COD, CaCO_3 , TKN, Se, Cr, Mn, Cu, Pb),
- Physical parameters (TSS, TDS),
- Microbiological parameters (fecal and total coliforms).



Fig 1.1: Runoff Water Sample Location

1.4. Thesis outline

The thesis is divided into seven chapters, starting with the introduction and main goals of the research in the first chapter, then chapter two gives an over view of the Environmental status in Palestine, in order to present its importance and the source of pollutions that affect it. The third chapter is about the solid waste management system in Palestine and the household solid waste management in Palestine too. The fourth chapter is a study of landfills definitions and concepts, also the site selection criteria for the landfill was studied in the same chapter, in additional to the study the local study case of landfill site selection criteria. The Fifth chapter is a descriptive, analysis chapter of the urban and history development of Ramallah city planning, and its relation with the sitting of the existing dumpsite. The Sixth chapter is a study of Ramallah Landfill Environmental Impact assessment and the results and discussion of the study are presented in the same chapter. The last chapter is the seventh chapter where the conclusions and recommendations are posed.

CHAPTER 2

OVER VIEW OF THE ENVIRONMENTAL SITUATION IN THE OCCUPIED PALESTINIAN AUTHORITY

2.1 Back ground

The environment is the surrounding or the special field where the human lives in, influenced by it and affects it (reversal impact), (The Palestinian Environment Encyclopedia, 1997). In addition, environment could be defined as the totality of all the external conditions affecting the life development and survival of an organism which has many components which are: physical (geology, topography, soils, water resource, air quality... etc), biological (fauna, flora, biodiversity and ecosystem), and social (culture, religion and local values).

Palestine is known by its' unique environment, and its' area is defined by its' rich natural resources, which includes the water resources, soil, stone, sand, air quality, vegetation and biodiversity and culture heritage. This chapter presents a brief over view of the environment in Palestine.

2.1.1 Geography

Occupied Palestinian territory (West Bank & Gaza strip) is characterized by its' varied topography that consists of (Fig 2.1):

- 1- High land in the center, where most of the population exist and live in.

- 2- Semi- arid rocky slopes.
- 3- Arid rift valley and rich plains in the north and west of the West Bank.
- 4- Low lying stretch of sand foreshore plain with slope up to an elevation of 90 meter in Gaza.



Fig 2.1: Topography map of the West Bank and Gaza (ARIJ, 2000)

Most of the hills in the West Bank are limestone hills of 700 to 900 meter high, where the lowest point is at 410 meter below sea level and this area is the dead sea, and the highest point is at 1,022 meter above the sea level which is on The mountains of Hebron (UNEP, 2003). While the eastern slopes and grassland of West Bank are covered with brown lithosols and loessial arid brown soil, and the fertile soil are found in the plains, but this soil cover is thin.

2.1.2 Vegetation

Gaza and West Bank can be divided into five ecological sub-regions (Fig 2.2): (UNEP, 2003)

- 1- The Mediterranean shoreline coastal plain.
- 2- The upper coastal plain.
- 3- The central highland.
- 4- The semi-arid eastern slope steppes.
- 5- The arid semi-tropical Jordan valley.

Some parts of the area such as the south of West Bank, the eastern slopes and the central Jordan valley are composed of Mediterranean savanna grading into land dominated by steppe brush and spring dwarf shrubs, and other part are influenced by Sudanian vegetation which are south the Jordan valley. While Gaza includes six main vegetation zones: (UNEP, 2003)

- 1- The coastal littoral zone.
- 2- The stabilized duner and blown-out dune valleys.
- 3- The kurkar.
- 4- Alluvial and grumosolic soils.
- 5- The loessial plains.

6- Three wadi river areas.



Fig 2. 2: Agro - ecological map of the West Bank and Gaza strip (ARIJ, 2000)

2.1.3 Climate

Palestine is located in the Mediterranean region, which is known by its' hot and dry summer and short cool wet winter, with the hot dry season is the summer

which mostly last for four months, and cool short winter with rain that mostly stays from November to march.

Palestine is known by its' varied climate where the central highland have occasional frost, snow and hail, and in the south the climate is warm and dry and Gaza could be classified as a temperate area. The climate can be summarized as follows: (UNEP, 2003)

- 1- The average summer temperature is between 30°C – 22° C through the area.
- 2- The mean range in winter is between 13°C – 7°C through the area.
- 3- The average annual precipitation is 450 – 100 mm through the area.
- 4- The annual average relative humidity is about 72% - 52%.
- 5- Winds prevail from the North West and winter from southwest.

2.1.4 Demography

The local community characteristics are considered as one of the main factors that affect the environment, so it is important in this term to study the demography of Palestine, which is strongly influenced by the political development that played (political development) a significant role in the growth and the distribution of population in different governorates.

The demographic statistics (about the Palestinian territories) those were available before the year 1997 were characterized by the multiplicity and variation of its sources, of which minified its accuracy, and so it not will be used in this part of the research. The demographic statistics that will be used are those were

collected after 1997 by the Palestinian Census indicating the current and the forthcoming years because of its importance to lay out future plans and policies.

The number of population in West Bank and Gaza strip is estimated by forecasting, since the First field collection for population was in 1997 by the Palestinian Authority, and the results were that the total population in Palestinian territory in 1997 is 3 millions. Over 1 million lives in Gaza strip and the rest in the West Bank. While, The population projection revealed that by the mid of the year 2003 the total population will be 3,647,875 persons, Where 2,313,609 live in the West Bank and the rest in Gaza strip (PCBS, 2003). The last field collection for the population was in 2007 and it was for the West Bank only and the results showed that the total population is estimated to be 2,350,583 people (PCBS, 2008).

The population growth rate in Palestine estimated to be 3.1% in the year 2000 and the forecasting (based on the present fertility rate) show that the population in Palestine will continue to grow substantially, where the total population is expected to reach 4,935,264 by the year 2010 assuming an average growth rate of 3.5-4.83% for the years 2000-2010 (Palestinian National Authority 2003), The population is localized in 686 localities, 54 localities are urban, 603 localities are rural, and 29 localities are refugee camps (PCBS, 2003).

This increase of population causes more pressure on the natural resources and more demand on food, water, services, urban spaces and also more pressure on the environment.

2.1.5 Land use

The distribution of land use is affected by the physical and natural aspects on one hand which are soil, topography, climate ... etc, and by the political situation on another hand, which have no space here to be mentioned.

In general, land use could be distributed as follows: (The Palestinian Environment Encyclopedia, 1997)

- 1- Residential area: The residential area in the West Bank is approximately about 312.5 km² contains 590 communities, and about 46.94 km² in Gaza contains 9.25 km² refugee camps.
- 2- Agricultural area: It presents 28.9% of the total area of the West Bank and 38.5% of Gaza area.
- 3- Industrial area: there are seven small industrial areas distributed along the West Bank, with bad infrastructure which has a bad impact on the environment, while there are small industrial areas in Gaza which are in the districts of the residential area. There are also seven Israeli industrial areas on the West Bank.
- 4- Dumpsite: is the site that used to dispose solid waste (PSBC, 2004).

In West Bank, the number of dumpsites is used to be 171 dumping sites according to the results of the local community survey of 1998, but this

number decreased to be 133 dumpsites according to the findings of the year 2001. In Gaza strip, there is no changing in the number of dumping sites, which are four dumpsites. In 2005, one survey conducted by the PCBS counted 161 such dumping sites in West Bank and 3 in Gaza Strip, none of which were subject to any monitoring or control by the Palestinian Ministry of Health (PCBS, 2006) or other authorities.

- 5- Stone quarries: the cutting stone could be considered as one of the major sources of income in Palestine, especially that the Palestinian stone is known by its' various types and colors and it is fashionable in world market. At the same time, stone cutting are contributors to environment degradation and pollution, and this type of industry is rapidly increasing since the construction activities have expanded specially after the establishment of the Palestinian National Authority (EQA, 2003). There are about 700 quarries distributed all over the West Bank, most of them are located in the residential and agriculture areas. In addition, the quarries extract solid waste about 450,000 tones /yr.

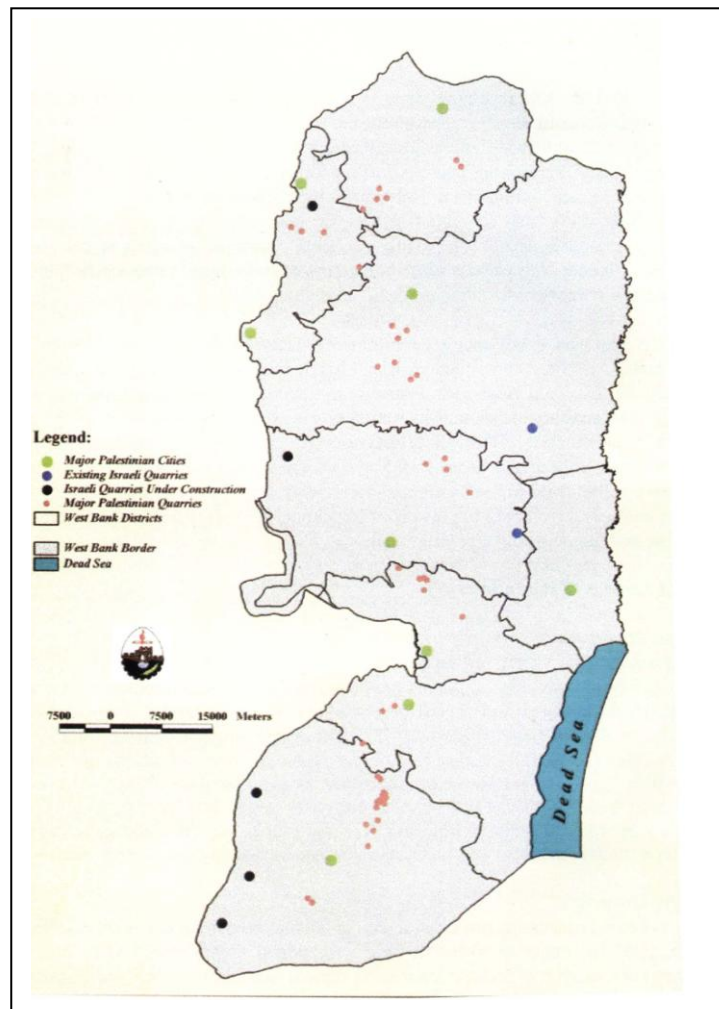


Fig 2.3: Distribution of the major stone quarries in the West Bank (ARIJ, 2000)

- 6- Israeli settlements: these settlements presents a very big threat to the Palestinian lands, where there is about 193 Israeli settlements that established in 77.8 km² in the West Bank, and there are 23 settlements in Gaza strip, that occupy around 9.05 km² of the area. In addition, many Israeli military areas occupy around 0.75% of the total area of the West Bank and Gaza strip (The Palestinian Environment Encyclopedia, 1997). Also the area around the Israeli

settlements and military areas (protected security areas) are much bigger threat to the Palestinian land and city expansions.

- 7- Roads: there are about 1255 km of main roads and 2556 km of rural roads in the West Bank. Also, there are Israeli ring roads that connect the settlements and present 1.5% of the West Bank area. In Gaza, the transportation net work is around 564.8 km (The Palestinian Environment Encyclopedia, 1997).
- 8- Natural protected areas: is the land where it is forbidden to build on or do any industrial and agricultural activities, in order to protect the nature from any damage or extinction. In Palestine some areas are called as natural reservation areas for political purposes - there are no place here to be mentioned – in general natural protected areas presents 5.68% of the West Bank area.
- 9- Forests: there are about 93 sylvan areas that cover area of 51.6 km² of the West Bank, which presents 0.89% of the total area of the West Bank. Many of these forests are threatened because of the despotic tree cutting. While in Gaza, there are no areas that could be called as forests since the huge damage operations of the forests that were done by the Israeli Authority in Gaza.
- 10- The yellow area: This area is only located in West Bank and it covers 16.55km² which is about 4.5% of the total area of West Bank (The Palestinian Environment Encyclopedia, 1997).

2.2 The Environment Situation in Palestine

The environmental parameter could be classified into four general categories which are (Petry, 1993):

- Natural physical resources.
- Natural economic development resources.
- Human / economic development resources.
- Quality of life values.

In this part of this chapter a brief definition of the natural physical resources of Palestine will be given as one of the environmental parameters that are mostly affected by the rapid urbanization, miss used, less awareness... etc. Also the source of pollutions and their impact will be mentioned.

2.2.1 The Natural Resources

Natural Environmental resources present the Natural supply that gives a great benefit to the humanity, these resources are divided into non living resources such as (water, air, soil,...etc), and living resources such as (vegetation, biodiversity,...etc), or could be classified into three categories depending on the rate of exhaustion as follows:

- Permanent resources (sun light, air, and water)
- Regenerating resources (soil, vegetation, and animality sources).
- Ingenerating resources (metals, coal).

In general the natural resources that will be discussed are:

- 1- Water Resource: West Bank major water resources consist of ground water where there are three ground water preserves in West Bank which are the western preserve, the north eastern preserve, and the eastern preserve, the most pollution resource for these preserves are the Palestinian solid waste dumpsites and the solid waste that produced in the Israeli settlements.

Also rain water harvesting is an good water source, where there are 40 municipal wells in the West Bank and the annual yield is around 30 million m³, and private wells with approximately 6.6 million m³ annual yield, in additional, there are some agricultural wells which are used for domestic purposes (UNEP, 2003)..

There are more than 300 springs in the West Bank, more than 100 springs are considered to have sustainable yields, and the total average annual yield of the 300 springs is around 60 million m³ (UNEP, 2003).

- 2- Soils: the soil in Palestine varies due to the variety of the raw materials that forms the soil, and due to the variety of the climate around the area. Overall the important factors that affect the formation of the soil are: (Land Research Centre, 2000).
 - The land cover which differs in its thickness from one climate to another.
 - The topography of the area.
 - The soil erosion.

In general there are nine types of soil in Palestine which are: the Terra Rossa Soil, the Brown Soil, Rendzina Soil, Brown Alluvial Soils, Alluvial Soils, Colluvial- Alluvial soils, Desert Alluvial Soil, Sandy and Loessial sandy soil, and Loess Soils (Land Research Centre, 2000).

- 3- Vegetation Cover: the land cover in Palestine in general could be classified into two main kinds (EQA, 2003): a- The zonal part that are influenced by the climate variation in the area. b- The zonal part which presents the affect of the soil factor and climate.

The unique Palestinian land cover is facing many challenges that are causing the extinction of many vegetation cover species, the unplanned rabid urbanization is the most effecting challenge, since the new human needs, and behavior that causes an Environmental pollutions effecting the land cover of the area such as the over grazing that made the Eastern slopes of the West Bank almost scarce of vegetation (EQA, 2003). The stone quarries and the waste water that results from the stone cutting process which is harmful to the land and its ability to be planted, and the random unauthorized solid waste dumpsites which pollute the soil and the air and so the land cover too.

In general, the vegetation of the West Bank can be described as limited and scarce, limited on agricultural crops and orchards in the plains of the semi coastal areas, the mountains plateau and the Jordan river valley, while the western slopes and mountains area mostly consist of olive trees and small

agricultural fields and shrub lands. In Gaza, few original Sahara- Sindian Flora still exist.

The most obvious land cover and vegetation in the Palestinian Authorities area are (EQA, 2003):

- Quercus Calliprinos.
- Pistacia Palestina
- Rhamnus Palestina
- Sarcopoterrium Spinosum.
- Fumana Arabica.
- Citstus Creticus.
- Salvia Fructicosa
- Teucruim Polium.
- Phlomis Viscosa.
- Pinus Halepansis.

And many more there are no place to be mentioned. However there are approximately 2,500 different plant species that has been identified, which shows the very rich natural vegetation and landscape that Palestinian areas have, and need to be protected. (EQA, 2003)

- 4- Biodiversity: the previous discussion about the land vegetation cover gives an idea about diversity of vegetation in Palestine. This diversity is not limited on plants but also there are approximately 95 types of different mammals animals, 6 amphibian species, 93 types of different kinds of reptiles and 470 different species of birds.(ARIJ, 2001)

The numbers above shows the importance of the Palestinian Environment and gives an over view of the biodiversity of the area that facing the threat of extinction due to the Environmental pollutions, such as the pollution that caused from the haphazard dumping sites.

2.2.2 Source of pollution

After studying some of the natural resources in Palestine and discussing the scarcity of these resources, it is wisely to study the sources of pollutions that affect the natural resources, which in general could be briefly discussed as follows:

2.2.2.1. Solid Waste: Solid waste disposal and management causes Environmental pollution, also uncontrolled dumping of the solid waste on vacant lands and roadsides can cause many Environmental health problems.

2.2.2.2. Wastewater: The occupied Palestinian territory faces a series of wastewater and sanitation related problems. Where there are large scale discharge of untreated wastewater, leakage of collected wastewater from sewage system, cesspits and uncontrolled reuse of untreated wastewater by the irrigation sector (EQA, 2003)

2.2.2.3. Industrial waste: wastes that are discharged from the industries to the environment as wastewater or solid waste. Mainly these wastes carries high concentration of heavy metals causing dangerous Environmental pollutions.

2.2.2.4. Hazardous wastes: there are very few estimates of the amounts of hazardous waste generated in the OPT, in part because of the absence of separation of waste (EQA, 2003)

2.2.2.5. Agricultural practices: about 10 % of the Palestine is cultivated irrigated agricultural area, this type of cultivation practice could potentially have negative effect on long term sustainability. Also intensive agriculture had negative side effect due t its dependence on agrochemicals, plastics and the re-usage of untreated wastewater, which causes groundwater pollution (UNEP, 2003)

2.2.2.6. Air Emissions: dust is the major air pollutant emitted from stone crushing quarries, vehicles and open dumpsites

2.3 Legislation and Environmental issue in Palestine

The environment legislations that were used in the area during the Israeli occupation are an old legislation that were taken from the legislation of the Ottoman period of occupation, British period occupation, Jordanian period rule in the West Bank and the Egyptian period of rule in Gaza Strip, in addition to set of Israeli military orders were put to serve the benefit of the Israeli goals and settlements.

After Oslo I and Oslo II, a Palestinian ministry became responsible for the environmental issue, and the Environmental Quality Authority was established which inherited a mix of contradiction legislations from the previous system and

these legislations and laws are very weak in terms of environmental protection, also there was an overlaps between these inherited laws and the new environmental laws by the Palestinian Authority and Israeli military law causing an contradictions (UNEP, 2003).

In 1996 the Palestinian Authority started to work on new legislations that are adequate and suits the new development demands and the creation of sustainable urban environment (Isaac & Ghaniem, 2000).

The legislation of environment law might be not the only ideal solution to limit the pollution and guaranty the sustainable development, but also it should be one of the strategies to obtain a sustainable development which should be included in the economic and technological initiatives. For this reason it was suggested that these legislations should put a norms or standards for some activities and organize some economical activities. (Ganaiem, 2001).

In 1997 the environmental authority was established to take over the environmental responsibility, a year later the Ministry of Environmental Affairs (MEnA) which has been currently replaced by the Environmental Quality Authority (EQA) was established to take over the legislations related to environment, environmental strategies development and environmental planning in order to promote sustainable environmental development for the Palestinian society, as it will be mentioned in the following section.

In June 1999, the Palestinian Legislative Council adapted a frame work law [(the Palestinian Environmental Law no (7)], which was formulated by the

Environmental Quality Authority (EQA), and where approved by the Palestinian authority in December of the same year, this law divided into five parts with ten chapter, it is' mainly objected on: the protection of the environment by preventing all types of pollution, the protection of public health and social welfare, introducing environmental protection fundamentals into the social and economic development plans, the protection of the environmentally sensitive areas, the preservation of biodiversity, the promotion of the public awareness, encourages sustainable resource development, and the protection of the natural historical and archeological areas, the rehabilitation of the environmentally deteriorated areas. Also the Palestinian Environmental Law defines a number of principles and basics for the environmental legislations illustrated through several articles as follow: (MEnA, 1999)

- Article (3): every Palestinian individual has the right to pursue the enforcement of the right to a clean and healthy environment against any party, he or she may also obtain any official information about the environmental impacts of any planning activity.
- Article (4): the protection of the environment through collective and individual initiative for voluntary work shall be encouraged through environmental education in schools, universities, institutions and clubs.
- Article (5): every Palestinian individual has the right to a sound and clean environment and to the best possible health care and social

welfare where the protection of country's natural resources and the preservation of its historical heritage are maintained.

Environmental legislation must include the planning for land use and urban planning subjects, and the environmental impact assessment (EIA) should be one of its' basics in order to evaluate any proposed projects and any existed ones. to make it worth to do, it is necessary to have an executive authority (the Government is now in spite of the difficult political situation work on).

2.3.1 the Environmental Protection Actions In Palestine

Some actions that the Palestinian Authority took were to limit the deterioration of the environment situation in the occupied Palestinian territories. These actions include identifying the gap of the existing laws related to the environmental management in the area. These actions could be summarized as follows (UNEP, 2003):

- 1- Palestinian Development Plan (PDP) 1999-2003: it is a five year Palestinian plan that covers the period between the year 1999 and 2003 and gives the top environmental priority of the public sectors to the optimal use of natural, and identifies the needs for a review of legal and institutional systems and forces finalizing the organization structures of the various ministries and other public bodies. Also, it under line the importance of scientific research, transfer of technology and protection of the environment against the pollution.

In PDP the highest priority was for the infrastructure development and natural resources management, and then to the water, waste water, solid waste, energy, and transportation.

2- National Environmental Strategies: these are ten years strategies that will be updated every three to five years for the years between 2000-2010. They aim to identify and analyze the environmental problems and their causes, and put the priorities which are nine as the Palestinian Authority defined:

- Depletion of the water resources.
- Deterioration of water quality.
- Depletion of natural resources.
- Land degradation.
- Air and noise pollution.
- Shoreline and marine pollution.
- Depletion of biodiversity.
- Landscape degradation.
- Threats to cultural heritage.

The authorities (ministries and municipalities) are responsible for this action under the supervision of the Environmental Quality Authority (EQA).

3- National Environmental Action plan (NEAP): it is an instrument to translate the general themes and priorities set out in the National Environmental Strategies into concrete and prioritized actions. These

plans and projects covers three years period (2000-2002), the actions and projects that were proposed include:

- Waste water managements..
- Water resources management.
- Solid waste management.
- Agricultural and irrigation management.
- Industrial pollution control.
- Natural and diversity.
- Land use planning.
- Environmental standards and regulation.
- Monitoring.
- Twenty four guidelines focusing on the environmental health, the public health and the role of women.

2.4 Environmental Education and Public Awareness

Implementation of every environmental policy, program, project and plan comes down to the same common denominator - environmental education (EE). Effective timely and targeted EE lies at the core of operation these paradigms, especially at the local level (Al Khatib *et al*, 2008).

There has been a changing vocabulary in local environment management - from 'simple' concepts such as community participation, to expanded issues such as capacity building, informed consent, public choice, decision-making, awareness building, governance, decentralization, local autonomy, information

disclosure...etc. Therefore, EE and Public Awareness is about understanding the causes and effects, of positive and negative aspects, of global and local issues, of immediate and long-term issues, and of direct and indirect impacts.

In Palestine, as it was mentioned in the previous sections, one of the reasons for the rapid deterioration of the environment is the lack environment awareness and low environment education due to the prolonged Israeli occupation and the very changeable political situation also the power attracted the attention and caused in many year of environmental neglecting.

The public awareness and environmental education became one of the major fields that the Palestinian Environmental Authority (PEEnA) emphasizes on (PEEnA, 1997), and some initiatives has been taken in environmental education through the education system for environmental awareness programs launched by a group of private schools in the West Bank.

The most important sectors that should be involved in the public awareness programs are women, children and farmers (EQA, 2003), since women and children are mainly the mean to active clean Environment in building their environmental protection awareness through increasing the education regarding environmental issues. Also, children are the future generation and women are responsible in raising the new future generation. Farmers (agriculture) in Palestine present the economic development and so it is important that the farmers be involved in public awareness programs that must include the effect and impact of fertilizers and

pesticides on environment pollution and various environmental issues, to active environmentally sound social and economic development.

CHAPTER 3

SOLID WASTE MANAGEMENT IN PALESTINE

3.1 Solid Waste

Solid waste is a useless and sometime hazardous material with low liquid content, and solid waste include municipal garbage, industrial and commercial waste, sewage sludge, waste resulting from agricultural and animal husbandry operations and other connected activities demolition waste and mining residues (PSBC, 2002).

In this part of the research, we will talk about the solid waste types, sources, components, and then the solid waste management (collection, transfer and transport, disposal and treatment).

This part could be considered as a back ground to help understanding the solid waste management situation in the area.

3.2 Solid Waste Types and Source

Solid waste can be classified as follows:

- 1- Domestic waste: The households generate such waste; most of it is from kitchen, where the organic part is the largest one as the households wastes account for 45% - 50% of the total solid waste (PCBS, 2003).

- 2- Commercial waste: this type of waste results for the market, stores, offices, restaurants, warehouses, and hotels. Most of these wastes could be easy separated because they are mainly concentrated of one type of waste

depending on the commercial type, for example, restaurants most of the wastes are organic wastes that results from the food (Eaton *et al*, 2003).

- 3- Institutional wastes: these wastes results from schools, governmental and private offices ...etc, and most of the waste components are paper and cardboard.

The commercial and institutional wastes present 25% - 30% of the total solid waste.

- 4- Construction waste: the waste that results from construction activities are usually in big amounts and thrown in dumpsites with other wastes.

- 5- Industrial waste: This results from packaging materials, food waste, discarded metal, plastic, textiles, fuel- burning, and a big amount of wastes that result from stone Quarries. In addition, this type of waste could also be separated in the source.

The construction and industrial sectors together constituting 20% - 25% of the total solid waste components (UNEP, 2003).

- 6- Street waste: this waste is the waste that results from street sweeping, and from wastes that thrown in the streets from households or other sources mentioned before, and the amount of such waste differs from space to another related to some social and cultural behaviors. Such wastes usually are in little amounts.
- 7- Agricultural waste: such wastes do not consider being dangerous since it is mostly organic waste, such as leaves and plants. However, there are some

solid wastes, which are inorganic such as (plastic covers, plastic pipes, etc). One of the most important agricultural wastes in the West Bank is the olive wastes, where mills produce large amount of solid waste, some of this waste used in making soap and the rest are thrown in dumpsites.

8- Hospital wastes: and such wastes could be classified as :

- Non hazardous waste, like the wastes that results from the kitchen and offices material.
- Hazardous waste, such as syringes, needles, tips, drugs, toxic material ... etc.

There are other wastes, but in a little amounts such as, the animal manure.

3.3 Solid Waste composition

The last studies about solid waste composition for all sources in Occupied Palestinian territory was in September 2000, and these studies and surveys indicate the composition of municipal solid waste in West Bank and Gaza strip as follows (Fig 3.1): (Al-Hamaidi, 2002)

- Organic waste, presents 60% - 70% of the total waste.
- Paper and cardboard, present 7%-10% of the total waste.
- Plastic, presents 5%-10% of the total waste.
- Glass, presents 3% - 6% of the total waste.
- Metal, presents 2% - 3% of the total waste.
- Other wastes, presents 3% - 7% of the total waste.

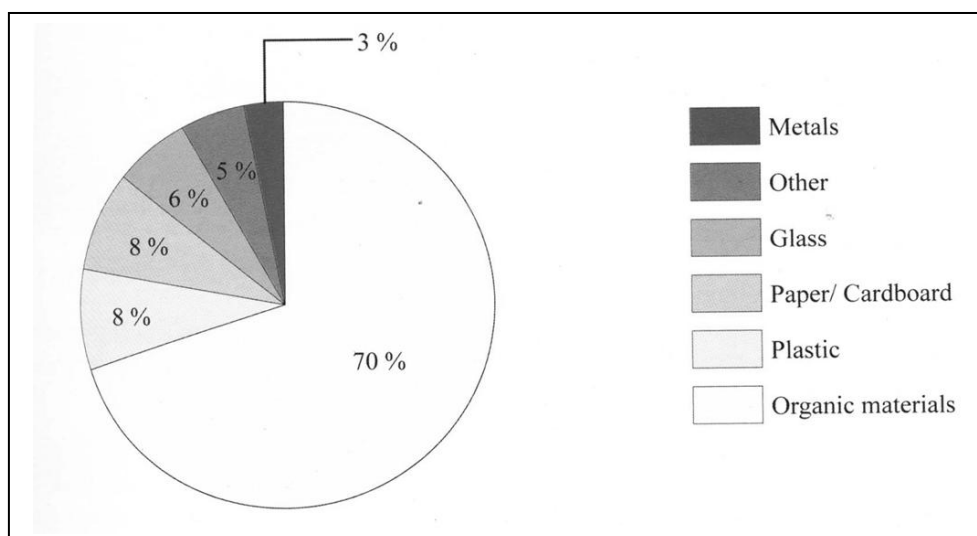


Fig 3.1: Composition of municipal solid waste in the occupied Palestinian territories
(UNEP, 2003)

The organic waste is the highest percentage and this is the case in many other countries. For example the organic waste in Mali in Nigeria presents one third of the total solid waste (Eaton, 2003), and in India the organic waste is approximately 40-50% of the total solid waste (Zurabrug, 2004), and such waste could be useful in producing organic fertilizers. The quantity of organic waste varies depending on the income and life style also on the season. The next table (3.1) shows the solid waste components in some districts in Palestine.

Table (3.1): Solid Waste components in some of the West Bank and Gaza Districts.

the Districts	The organic waste	Paper	Plastic	Glass	Metal	Fabric	Other
Gaza	72.8 %	12.4 %	11 %	2.2 %	1.7 %	--	--
Ramallah	56.1 %	3.9 %	1.7 %	3.9 %	1.2 %	0.4 %	21.7 %
Qalqilia	67 %	4 %	7 %	1.7 %	5 %	--	7 %
Jericho	67 %	7 %	17 %	6 %	--	--	3 %
Hebron	55 %	19.7 %	11.1 %	2.7 %	4.1 %	4.1 %	8.3 %

Source: (Isaac *et al*, 2000).

It is worth mentioning that, the amount of the solid waste in any society could give an indication to the amount of the consuming, and the amount of solid waste produced daily by the Palestinian is approximately 0.7 – 1.0 kg/person, while the average amount of solid waste produced daily by the Israeli is approximately 1.6 kg/person, and in the United State of America is approximately 2.5 kg/person (UNEP, 2003).

3.4 Solid Waste Minimization

In this stage it is important to talk about solid waste minimization as one of the integrated sustainable options that are required to deal with all waste streams (Worcestershire stakeholder consultants, 2004).

To insure solid waste reduction policies should take place to encourage minimizing, reuse and recovery of solid waste, especially in this area where the most first component of the solid waste produced by the house holders are paper and cardboard, which can be reused.

These policies should consider education, incentives, constrains and enforcement as their strategies to reach their goal of reducing solid waste, where:

- Education of a public is important to encourage them to act responsible.

For example in Austria as a result of the national government role in the education and information for the public, the whole population is involved in the re-cycling, which made it sufficient. On another hand,

education should also target the waste producers such as industry managers, and this would act as means of dissemination.

- Incentive for minimization schemes are needed, using awards and rebates.
- Constrains in waste productions such as packaging taxes or other methods. For example in Ireland the policy of charging on plastic bags has raised the profit of waste management (Worcestershire stakeholder consultants. 2004). Also, these constrains should focus on the most harmful waste to the environment, and producers must reduce waste by bearing at least some of the cost of waste production.

3.5 Solid Waste Management

The main coordinating agency for solid waste management in the occupied Palestinian territories is the ministry of Local Government, having all responsibility for the relevant functions of the local authorities, while the solid waste plants construction is the responsibility of the Regional Solid Waste Councils. In addition, the ministries of planning and international cooperation are responsible for the overall planning and fund raising.

In summary, the solid waste collection, transfer and disposal is the responsibility of the Local Authorities, and in the big cities the local municipality hold this responsibility, while in small villages the village councils play that role with the cooperation of the district Authorities.

3.5.1 Solid Waste Collection and Transfer

The solid waste collection and transfer is the responsibility of the local municipality in most of the developing countries such as India, Syria, and Lebanon...etc (Research Center, 2003). Moreover, in occupied Palestinian territories the solid waste collection and transfer is the responsibility of the local municipality in big cities and the village councils in small villages, while the UNRWA (United Nation Relief and Works Agency of Palestinian Refugees in the Near East) is responsible for collecting and transfer the solid waste of the Palestinian refugee camps (Al-Khatib *et al.*, 2006)

Such service causes a financial load on the municipal authority (Summa *et al.*, 2006) and that could be the reason why such service in the developed countries is not fully covered where in India only 50% of the residence are served by this service and in the occupied Palestine territories this service covers 70% of the residence in the West Bank, and 99.4% of Gaza (Isaac, 2000).

In the occupied Palestine territories This service is daily done causing a financial load on the municipals and village councils, while in developed countries such services is a weekly service, and that could be related to the level of the social awareness and residences cooperation since some of the collection system and transfer cost is a residential responsibility and many private companies are responsible for such services (Isaac, 2000)

The existing procedures are based largely on international or local professional planning. There are now many studies to improve this service in West

Bank and Gaza. These studies focus on serving adequately a large portion of the population as possible while keeping cost low (UNEP, 2003).

There are also door-to-door collection system, this system is a relevant solution in a situation with large number of unemployed work force, and is active (using donkey, and handcarts) in some towns areas where it is difficult for the vehicle to move. In such system the residence, pay the fees that would fully cover the cost.

The general way of collection and transfer of solid waste could be summarized according to the type and resource as follows:

- The solid waste that results from households, either the house members send their domestic waste to a municipal containers (small ones 1100, or a big ones 6000 liter) or the municipal worker collect the domestic solid waste from the households and send it to the containers then to the dumpsites by municipal trucks.
- Other sources, the solid waste usually sent to the dumpsites either by the municipal trucks or by private vehicles.
- Some wastes such as the animal manure are handled by the owner and used as fertilizers.

The last statistical studies about the solid waste collection show that: (PCBS, 2003)

- 193 localities (32%) do not have the service of collection solid waste. And the local authorities provide collecting solid waste services in 328

localities, of which 309 in the West Bank and 19 in Gaza Strip; while private contractors collect the solid waste in 13 localities of which 12 in the West Bank (Fig 3.2).

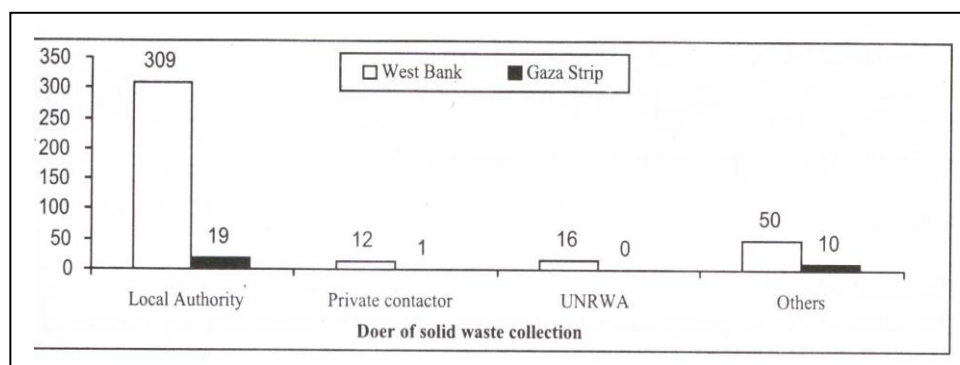


Fig 3.2: Distribution of localities in the Palestinian territory by doer of solid waste collection and region 2003 (PCBS, 2003)

- The wastes are collected daily in 121 localities in Palestinian territory, distributed in 103 localities in West Bank and 18 localities in Gaza Strip. The collection is made more than once a week in 265 localities, 253 of them in West Bank and 12 in Gaza Strip.
- The wastes are collected by using a specialized car in 332 localities in the Palestinian territories, of which 308 localities in the West Bank and 24 localities in Gaza Strip. Also there 74 localities in the Palestinian territories which use a tractor as a mean of collecting wastes , 69 of these localities are in the West Bank (Fig 3.3).

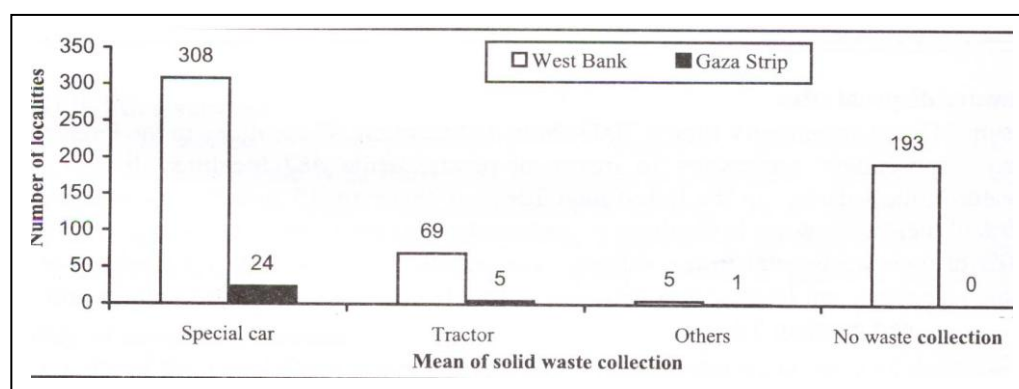


Fig 3.3: Distribution of localities in the Palestinian territory by mean of solid waste collection and region 2003 (PCBS, 2003)

3.5.2 Solid Waste Treatment and Disposal

The options or the most common options for solid waste treatment and disposal are:

- Incineration
- Compositing
- Advanced Central Sorting
- Disposal In Sanitary Landfills

Any municipal solid waste management system must have a landfill for the remaining portion of the solid waste stream. Furthermore, recycling activities must be complementary to other treatment and disposal and not to be competition.

The desk study on the environment in the OPT that was done by the UNEP showed that sanitary landfill was the least expensive disposal methods under normal conditions and Using (low tech compositing), While the Incineration and the advanced central sorting is the most expensive (UNEP, 2003) (Fig 3.4).

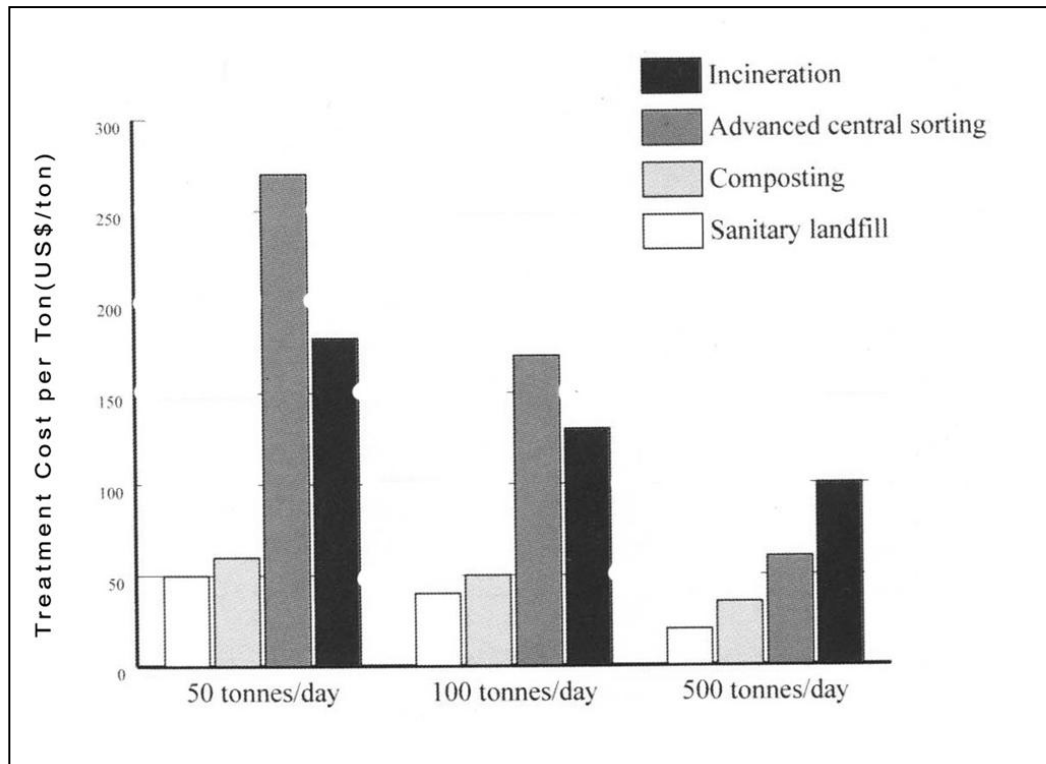


Fig 3.4: Treatment cost of solid waste by waste volume and method of treatment.

(UNEP, 2003)

Dumping of solid waste in open, unmonitored sites throughout the OPT is the common method of waste management for the majority of localities in the OPT, especially in the West Bank. In 2005, one survey conducted by the PCBS counted 161 such dumping sites in the West Bank and 3 in the Gaza Strip, none of which were subject to any monitoring or control by the Palestinian Ministry of Health (PCBS, 2006) or other authorities.

The extent of open dumping practices is closely linked to availability of collection services. For example, in 2005, 166 localities within the West Bank did not have any solid waste collection services at all (PCBS, 2005).

The most common way of solid waste treatment was the burning as a method of getting rid of solid wastes in 248 localities, and as it shown in the statistical studies of the local community survey, 228 localities burn more than 50% of its' wastes, where 227 of these localities are in West Bank . In addition, there are 83 localities that bury their wastes, 62 localities in West Bank and Gaza Strip bury more than 50% of their wastes (PCBS, 2002).

3.6 Household Solid Waste

This part is a study case of the household solid waste in the Palestinian families in the West Bank and Gaza strip. This study relied on analyzing a raw data of the survey of PCBS in 2003.

The main finding that this part includes is about:

- The household solid waste quantity.
- The household solid waste components.
- Method of collecting household solid waste.
- Method of household solid waste disposal.

3.6.1 Solid waste Quantities

The previous results showed that the approximate quantity of house hold waste produced daily is less than 4 kg for 56.5% of the total solid waste quantity of the households in the Palestinian territory, and this quantity is quite acceptable

since most of this quantity is organic wastes, and so we could say that the household solid waste do not really present a heavy weight on solid waste management problem (Tables 3.2, 3.3).

Table 3.2: Approximate daily quantity of solid waste in (kg).

Quantity (kg)	Frequency	Percent (%)
Less than 4kg	1602	56.5
From 4-7 kg	981	34.6
More than 7kg	252	8.9
total	2835	100

Source: (PCBS, 2003)

Table 3.3: Cross Tabulation between the region and the Approximate daily quantity of solid waste.

Regions	Approximate daily quantity of solid waste in (kg)			Total
	Less than 4kg	From 4-7 kg	More than 7kg	
North West Bank	14.0 %	8.3 %	2.1 %	24.4 %
Middle West Bank	14.0 %	5.4 %	4.5 %	19.5 %
South West Bank	13.3 %	7.1 %	0.4 %	20.8 %
Gaza Strip	20.0 %	13.8 %	1.9 %	35.7 %
The Total	56.5 %	34.6 %	8.9 %	100 %

Source: (PCBS, 2003)

The previous table shows that most of the quantity of the household solid waste is produced in Gaza strip where it produces about 35.7% of the total quantity, and the least solid waste quantity is that produced in the middle of the West Bank, which presents 19% of the total quantity, This could be related to the public

awareness of the solid waste problems in OPT, and the level of education in the communities.

3.6.2 Solid waste components

The solid waste components that were included in this survey are:

- Food waste.
- Paper and cardboard.
- Agricultural waste.
- Plastic.
- Baby's snap.
- Other wastes.

In the study of the most first component of the solid waste produced by the house holders the result was that 83.7% of the households consider the paper and the cardboard the first important components of the solid waste, while 12% of the households consider food waste the second important component of the solid waste. (Table 3.4)

Table 3.4: House holder solid waste component.

Solid waste components	Frequency	Percent (%)
Food Waste	340	12.0
Paper and Cardboards	2372	83.7
Rubber	65	2.3
Agricultural Waste	49	1.7
Plastic	6	0.2
Other	3	0.1
total	2835	100

Source: (PCBS, 2003)

These results could lead us to study the suitable solution to reduce the quantity that household produces by recycling specially that food waste could be used in other sectors as organic fertilizers, which are friendly with the environment.

3.6.3 Solid waste collection

The sides that are responsible of solid waste collection are classified as follows:

- Household member.
- Local authority.
- United Nation Relief and Works Agency of Palestine Refugee in the Near East (UNRWA).
- Private contractors.
- Household and the previous doer.
- Others

The local Authority collects solid wastes for 60.1% of the household in the occupied Palestinian territories which are divided into (18.3% in North West Bank, 17.4% in the south of the West Bank, 8.6% of the household in the middle of the West Bank and 15.9% are in Gaza Strip) , UNRWA collects approximately 9% of the total solid waste produced in household in the occupied Palestinian territories, 21% are collected by household member (Table 3.5) (Table 3.6).

Table 3.5: Side of Solid Waste Collection.

The Doer	Frequency	Percent (%)
Household member	597	21.1
Local Authority	1705	60.1
UNRWA	255	9.0
Private Contactor	19	0.7
Household & other mentioned Doer	124	4.4
Other	135	4.8
Total	2835	100

Source: (PCBS, 2003)

Table 3.6: Cross Tabulation between the region and The Side of Solid Waste Collection.

Regions	The Side of Solid Waste Collection						Total
	Household member	Local Authority	UNRWA	Private Contactor	Household & other mentioned Doer	Other	
North West Bank	2.0 %	18.3 %	3.2 %	0%	1.0 %	0 %	24.4 %
Middle West Bank	1.6 %	8.6 %	0.8 %	0.4 %	2.9 %	4.8 %	19.0 %
South West Bank	2.9 %	17.4 %	0.5 %	0 %	0 %	0 %	20.8 %
Gaza Strip	14.6 %	15.9 %	4.5 %	0.2 %	0.5 %	0 %	35.7 %
The Total	21.1 %	60.1 %	9.0 %	0.7 %	4.4 %	4.8 %	100 %

Source: (PCBS, 2003)

The most efficient way for collecting solid waste is by using a private contractors (as mentioned in the previous sections), but this system is very unique in Palestinian territories as shown in the previous results, this could be due to the bad economic situation, since the fees of the private contractor are fully covered by the household members.

3.6.4 Solid waste disposal

The methods that are used for solid waste disposal in the occupied Palestinian territories are:

- Thrown in the nearest container.
- Burned.
- Thrown in dump.
- Thrown randomly.
- Used for certain purpose.
- Other.

The common way for solid waste disposal are to throw the solid waste in the nearest container, where 49.2% of the total householders in the occupied Palestinian territories use this way, and 33% of the total householders in the occupied Palestinian territories throw solid waste in the dump (Table 3.7).

Table 3.7: Solid Waste Disposal Methods.

Method of Solid Waste Disposal	Frequency	Percent (%)	Valid Percent (%)
Thrown in the nearest container.	355	12.5	49.2
Burned.	91	3.2	12.6
Thrown in dump.	238	8.4	33
Thrown randomly.	22	0.8	3.1
Used for certain purpose.	12	0.4	1.7
Other.	3	0.1	0.4
Missing System	2114	74.6	-
Total	2835	100	100

Source: (PCBS, 2003)

While 12.6% of the householders burn the wastes which causes smoke, most of the regions that suffer from the smoke that results from solid waste burning are North West Bank and Gaza Strip (Table 3.8).

Table 3.8: Cross Tabulation between the region and the solid waste disposal methods.

Regions	The Doer of Solid Waste Collection						Total
	Thrown in the nearest container.	Burned	Thrown in dump.	Thrown randomly.	Used for certain purpose.	Other.	
North West Bank	4.9 %	3.6 %	1.1 %	0.3 %	1.5 %	0.1 %	11.5 %
Middle West Bank	5.1 %	1.8 %	9.0 %	1.5 %	-	-	17.5 %
South West Bank	1.0 %	2.6 %	6.8 %	0.7 %	0.1 %	0.3 %	11.5 %
Gaza Strip	38.3 %	4.6 %	16.1 %	0.6 %	-	-	59.5 %
The Total	49.2 %	12.6 %	33.0 %	3.1 %	1.7 %	0.4 %	100 %

Source: (PCBS, 2003)

CHAPTER 4

LANDFILL DEFINITION AND CONCEPTS

A landfill is an area designated to receive solid wastes, such as municipal solid waste (MSW) (household trash), construction debris and sludge from sewage treatment and other processes (<http://en.wikipedia.org/wiki/Landfill>). Also landfill is provide for the environmentally sound disposal of waste that could not be reduced recycled, composed, incinerated or processed in some other manner.

In another words landfills are the physical facilities used for the disposal of residual solid wastes in the surface soils of the earth (University of Canterbury, 2000).

Nowadays landfill obtains a great importance in planning process in which it presents a form of land use, where the site selection of the landfill should be taken in consideration in all planning process. Landfill sitting, design, operations and monitoring have under gone major advances over the last years, due to the awareness of the issue related to managing various categories of waste, together with concerns over the environmental effect of waste disposal. Thus there was a significant improvement in the sitting, designing, operation and monitoring of waste disposal facilities in countries where waste disposal practices are harmful on environment and public health.

The following paragraphs will explain the relation between landfill and legislation, landfill sitting philosophy and site selection criteria, and finally the strategic planning and landfill relationship.

4.1. Landfill and legislations

There is no what can be defined as international landfill legislations or international legislations with respect to landfills. Each country has its own legislations with respect to its unique environmental tools and situation, but it could be notice that all the laws and legislations are put to promote the sustainable management of natural and physical resources (University of Canterbury, 2000), which means in another phrase that most of the legislations and laws agree on that any projects, activities, or any life-supporting capacity of resource must be safeguarded, and adverse effects of activities on the environment must be avoided and guaranty the safety of health and environment (including the protection of outstanding natural features, landscapes, significant indigenous vegetation ground and surface water, soil, air quality, the preservation of coastal environment, wetland, lacks, and rivers).

In conclusion, the legislations related to landfill are under what called “Environmental Laws or Actions” that elaborates on environmental impact assessment, environmental monitoring, licensing, inspection and the sitting of sanctions and penalties for violating the environmental law.

4.1.1. The Palestinian Legislations Related to Solid Waste

The management of solid waste in the Palestinian territorial has never been achieved on an environmentally sound basis, it suffered from great ignorance during the Israeli occupation era where the Israeli authorities aimed to serve their interest with no concern to the environment and the quality of infrastructure services provided to the Palestinians. This has contributed to the occurrence of several environmental problems with detrimental impacts on human health and socioeconomic well-being.

Through the peace negotiations between the Israelis and the Palestinians the basis of environmental protection was reached, both parties agreed to cooperate and share the responsibility of preventing damage to the environment and taking measures to ensure that activities in areas controlled by one party do not cause environmental damage to areas controlled by other party. Also, in reference to Article 12 of the Oslo II agreement it was agreed on the following : (ARIJ. 2005), (Israeli Ministry of Foreign Affair, 1995)

- Promote proper treatment of domestic and industrial wastewater, as well as solid and hazardous waste.
- Prevent uncontrolled discharge of wastewater to water source.
- Adopt, apply and comply with international recognized environmental standards concerning the level of pollutant discharged through emissions and effluents, the acceptable level of wastewater and solid waste treatment, the way and means for

disposal of such wastes, the use, the handling, transportation and storage of hazardous substances and wastes.

- Ensure that comprehensive environmental impact assessment (EIA) is conducted for all major development programs.
- Take precautions to prevent water and soil pollution as well as other environmental safety hazards.
- Take measures to prevent noise, dust and other nuisances from quarries.
- Cooperate in the implementation of internationally accepted principles and standards of global environmental concern, such as protection of the ozone layer, endangered species of fauna and flora, conservation of migratory species, and preservation of existing forest and natural resources.
- Cooperation to promote public awareness of environmental issues, to combat desertification, to carry out environmental studies, and to control transfer of pesticides.

The Palestinian Environmental Law no (7) discussed many rules and regulations related to a wide scope of environmental issue (See Chapter 2, Section 2.3). The first chapter of the second section of the law deal with issues related to solid waste through several articles, which are: (ARIJ, 2005)

- Article (7): the ministry has to set up a comprehensive plan for solid waste management on the national level, leaving the responsibility

for the implementation of solid waste management operational services to the local authorities.

- Article (8): the different specialized agencies have the right to take the proper requirements to minimize solid waste generation and encourage solid waste reuse and recycling.
- Articles (9): the ministry in cooperation with other specialized agencies has to develop standards for the solid waste disposal sites.

4.2. Strategic Planning

The decision of land use planning matter should be the responsibility of many authorities especially in the waste disposal site selection matter. Also the environmental agencies advices must be taken into account to ensure that the best use is made of its expertise and information, and to avoid duplication between the planning and pollution control system.

In planning for waste management facilities in general, plans must be an integration offer from local authorities, such as municipalities, other planning authorities, and environmental authorities, with the consultation of the environmental agency, in order to:

- Reduce the risk of conflicting requirements.
- Avoid duplication of controls being imposed on developers under the planning and pollution control regimes.
- Reduce the risk that subsequent development may damage or disrupt pollution prevention measures taken at current or former facilities.
- Will minimize delays and costs.

Site Selection for landfill siting matter should be involved in the strategic waste management issues, and should be taken in consideration in all planning stages, to prevent mixed use in future

The need for a new landfill site usually results from either a community's solid waste management planning process, or a private company's commercial decision (or possibly a combination of the two).

Consultation undertaken during the strategic planning phase should, ideally, be linked through to appropriate stages in the site selection process to provide continuity with respect to the various individuals, groups or communities involved.

Issues to consider during the strategic planning stage include: (University of Canterbury, 2000)

- size of site required to meet current and future disposal requirements;
- potential for, or likely effects of, the use of other waste management options including
 - reduction
 - re-use
 - recycling
 - composting, and
 - incineration

- waste management plan of the district in which the landfill is to be located.
- waste management plans of the districts that the landfill will serve.
- regional policy statement and applicable regional plans.
- location with respect to communities from which the refuse will come.
- Access to transport, either on the appropriate standard of roads or other access.

These are not the only Issues that should be taken in consideration during the strategic planning stages of landfill the next paragraphs will discuss the planning considerations and criteria for site selection of landfill.

4.3. Landfill Sitting Philosophy

The philosophy behind landfill site selection is to ensure that the selected sites provide both a high level of containment, through their natural, geological, hydrogeological and topographical characteristics, and is located so as to cause minimum disruption to the community in the area surrounding the site.

The use of a robust site selection process and sitting criteria to select the most appropriate landfill sites will help to avoid, or reduce potential environmental problems by reducing the potential impact on people and environmental receptors. In addition, appropriate site selection may: (University of Canterbury, 2000)

- Reduce reliance on engineered liner systems.

- Reduce requirements for technically-based contingency and mitigation measures.
- Allow more efficient and effective site management.
- Result in savings in development and operating costs.
- Reduce levels of public concern and opposition.
- Avoid potential delays in obtaining the necessary resource consents.

Also the site selection of landfill depends on the design of a landfill. There are two major types of landfill design.

- **Landfill Types**

The two types of landfill design are, The Sanitary landfill and The Natural attenuation landfill. (Middle East Technical University, 2004)

4.3.1.1.Sanitary landfill

Sanitary landfill is the healthy environmental way for solid waste disposal, and designed to protect humans and environment from harmful gases and fluids, and it contains a system of collection for methane gas and pipes for leachate collections, also wastes in sanitary landfills are contained in cells which are covered with a layer of soil. Landfills are mainly designed for 20 or 30 year lifespan and still require post closure monitoring up to 30 years to ensure the environmental health. When the landfill's operational life has ended, a final layer of

soil and optimal synthetic liners are added along with a vegetative cover to limit percolation and erosion. (Fig 4.1)

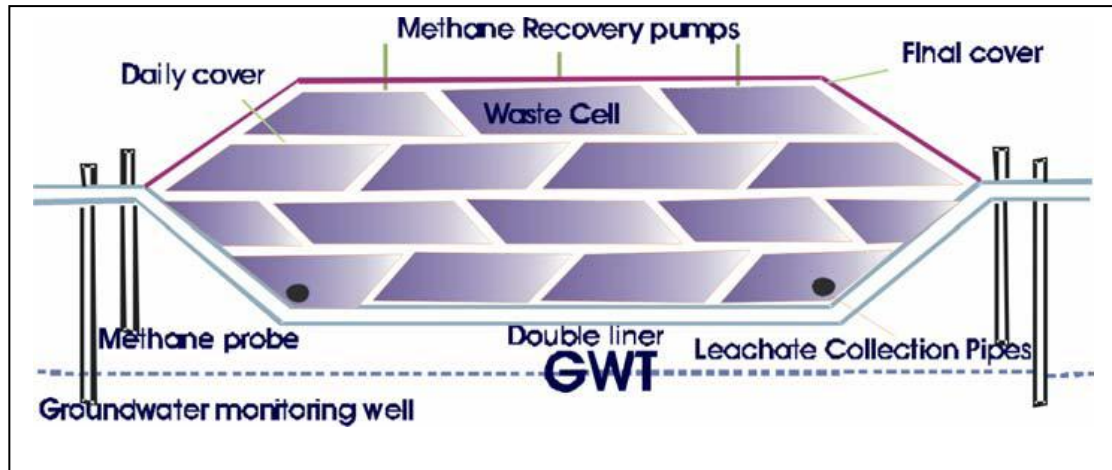


Fig 4.1: Composition Schematic representation of a sanitary landfill with design components. (Middle East Technical University, 2004)

4.3.1.2. Natural Attenuation landfill

This type of landfills allows the leachate to transfer through soil using the natural geological and hydrogeological characteristics of the ground subsurface. The leachate will go through biodegradation, filtration, sorption, and ion exchange which help the purification of the groundwater. This type also has relative minor cost of construction, operation and maintenance compared with sanitary landfill. But still it is not environmental safe especially to the ground water (Fig 4.2).

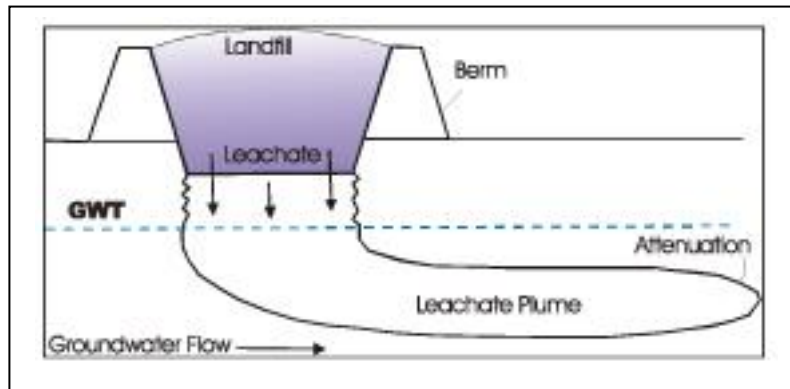


Fig 4.2: Schematic representation of a natural attenuation landfill. (Middle East Technical University, 2004)

The main difference between these types are the control the leachate generated by the landfill, the sanitary landfill more environmental safety since the release of leachate is controlled in an artificial liners, while the natural attenuation landfill utilizes the surrounding environmental characteristics in order to decompose released leachate.

4.3.2. Criteria of landfill site selection

The landfill site selection process is to ensure that the disposal facility is located at the best location possible with little negative impact to the environment or to the population, that's why sitting of solid waste landfills requires a careful examination and evaluation of all of the parameters that could potentially result in adverse effects on the environment, and based on sound scientific and engineering principals.

The site selection process and criteria set out in this section should not be viewed as absolute; these criteria are mentioned since they are a comprehensive

criteria and deals with many aspects such as environmental, political, financial and economical, hydrologic and hydrogeologic, topographical, and geological, each criteria will be briefly in the following section mostly (but not all) depending on the guild line for landfill site selection that are taught in the Middle East Technology University in Turkey, since these criteria are collective criteria for most developed Environmental world agencies, and cover all the Environmental issues.

4.3.2.1. Environmental Criteria

In the following paragraphs will discuss the environmental criteria, which include the study of: ecological values of the flora and fauna, odour and dust nuisance, nuisance by traffic generation, risks for explosion or fire, ecological and scientific or historical area, and tourist recreation area.

- Ecological Values of the Flora and Fauna

The use of land as landfill will have a negative impact on the vegetation of the land, which will destroy the actual fauna, this includes the indirect and direct special use of a landfill, where the indirect use is the disturbance of the quietness in the surroundings caused by the activities on the landfill.

When making a decision, the ecological value of the actual Flora and fauna should be evaluated carefully for the candidate area. Ecological value is based on diversity, naturalness and characteristic feature. Some countries

prefer to construct the landfills near forests so to use the forest as a buffer zone. (Montgomery country council, 1988)

- **Odour and dust nuisance**

The odour and dust emissions should be taken in consideration in the planning stage of landfill. Normally the air quality issues will be raised at the planning stage as well as pollution control issues (Cornwall Country Council, 1994).

This criteria indicates that landfill should not be located within a distance close to housing area; and the distance determining for the landfill from the housing areas depends on the local wind direction and speed, to prevent sensing dust and odor. Also the transfer of solid waste to the landfill plays a role in dust emission and that's way trucks that transfer solid waste should be covered and not opened trucks.

The problem of odor and dust can be minimized and controlled by using adequate covering soil, and building green wind breakers.

- **Nuisance by traffic generation**

The traffic generated from the construction and monitoring the landfill will cause nuisance, and this depend on the distance of the landfill to the collection area, the kind of transport vehicle and the use of transfer station.

Therefore, in planning for landfill siting it is important to study the passage roads for the landfill site and in many cases the roads are designed within the landfill stage planning and implementation. The appropriate passage is the roads through the open country sides, since the passing through housing area will cause more nuisance.

Other nuisance includes vermin that is attracted by the organic parts of the waste on the landfill (rats, mice, birds, insects), windblown litter, noise caused by construction, compaction or trucks on the landfill. The daily cover is a solution for nuisance developed by the presence of vermin. Continuous grading of soil cover to fill in low spots is essential to prevent the development of stagnant pools of water in which mosquitoes can breed.

- **Risks for explosion or fire**

This criteria is very rare to happen but it should be taken in consideration, because of the presence of landfill gas, there is a chance for explosion and/or fire. Soil cover also functions to smother fires and to form a barrier preventing the spreading of fires. Proper policing of incoming trucks can further reduce fire risk by minimizing the dumping of flammable loads. (Wilson, 1977)

- **Ecological, scientific or history area**

Some values may seem not that important to other values in site selection process, but still should be taken in consideration and given the

value weight according their assessment. In the same context the National parks, natural conservation areas and also historical areas are not suitable for the location of a landfill and should be given a great importance.

- **Tourist and recreation areas**

Landfill should not be sit on tourist or recreational areas or adjacent to it. It is important to notice that some recreational areas such as the car racing fields, landfills can be planned on it if there are no other choices instead, since the final use of a landfill can be recreation area (Middle East University, 2004).

4.3.2.2. Political Criteria

The political criteria that are involved in sit selection process can be classified as follows:

- **Acceptance by the local municipality**

In some cases the selection of landfill location can be decided in different region, because of different reasons such as lack of land in the same region, or the suitability, and potential sites are located in different region. In these cases the level of political acceptance has influence on the willingness of the local municipalities to make their regional physical plans and to give permission for the construction of a landfill. The unwillingness will cause to a delay of the decision on the landfill location, as it will be

seen in the study of the site selection process for Ramallah and Al Bireh sanitary landfill in the next sections.

- **Acceptance by the pressure groups involved**

In the decision making process the acceptance by the public to construct their landfill in their own region or municipality is important also. The so-called NIMBY (not in my backyard) syndrome is becoming a common attitude. The influence of the public is significant if there are local groups, which are well organized and having good relations with the local authorities, the media (papers, radio and television) and have a great influence on the public. The level of the public acceptance can be measured how far the local pressure groups are succeeding to delay the decision making process. Also these criteria will be seen in the study of the site selection process for Ramallah and Al Bireh sanitary landfill in the next sections.

- **Property of the landfill area**

The Property of the landfill area are considered as internal political issue in some studies, where the ownership of the needed land for the landfill is very important, the public ownership is easier than private ownership because the private ownership will give problems with the cost of the land and will probably do not accept the negotiations around his land. Sometimes, expropriation is needed and this procedure will cause

delays. In most cases the private lands are excluded from the alternatives lands.

4.3.2.3. Financial and Economical Criteria

These criteria depend on the financial status for the construction of proposed landfill, which includes the following:

- **Land Cost**

This criterion depend on the land estimated price for the land that the landfill should located on specially if the land is private ownership, and how this will affect on the land prices in the surrounding area of the selected land.

The actual use of the land is important for the price which influences the level of compensation for the owner or actual users. The potential landfill with the lowest costs is more preferable.

- **Costs for landfill access**

The road network is an important factor to locate a landfill, because costs for the access of the landfill depend on the condition and the presence of roads close to the landfill. If reconstruction of actual roads is needed, the costs will increase.

- **Transportation Cost**

The distance between the landfill and the source of waste generation can be defined as the transport distance of solid waste, where the transport cost are determined by this distance and depends also on the way of collection. The other factor that affecting transport costs are the need for waste transfer stations. It is worth to mention that the transfer distance for the solid waste has impact on environment, which also increases the environmental protection cost.

- **Costs for personnel, maintenance and environmental protection**

The personnel costs do not differ that much in between different potential landfill, the costs that will differ is the maintenance costs that depend on the availability of soil needed for daily covering and for the stability of the landfill. The areas where the soil are not available will have an extra costs for importing soil and so the maintenance costs will increase. Moreover, technical provisions should be placed to prevent the pollution of the soil, groundwater and surface water at the landfill. Monitoring the drainage system and the quality of the leachate and surface water are also important factors in the maintenance costs. The potential

landfill with the lowest maintenance costs is more suitable for a landfill.

- **Costs for the after – care**

After the closure of the landfill the preparation of the final use of the land also will cost what called after-care costs, which also depend on the provisions to monitor the groundwater quality, existence of gas, the winning of gas and the stability of the completed landfill.

The needed provisions are depending on the characteristics of the filled waste, the kind of subsoil, the hydrogeological situation and the kind of final use.

4.3.2.4. Hydrologic/ Hydrogeologic Criteria

In the site selection investigation for landfills the protection of surface water and ground water is also an important criterion, in the following sections this criterion is discussed in specific:

- **Surface water**

To protect surface water from contamination by landfill leachate; landfills should not be located within the surface water or any water resources protection areas. Also safe distances from meandering and non-meandering

rivers should be achieved to prevent waste from eroding into rivers and major streams. (Environmental Protection Agency, 1998)

According to the Middle East Technology University in Turkey the landfill should be located within the following (Bagchi, 1994):

- 30.48 m from any non-meandering stream or river, or any large bodies of water.
- 91.44 from any meandering stream or river.
- A buffer zone of land should separate large ponds, lakes, and reservoirs from the landfills to prevent blown debris and runoff from harming aquatic habitats.
- If the drinking water of the region are mainly from surface water, the entire watershed should be excluded in the site selection process.

- **Groundwater**

Landfills should not be located on sensitive and high quality groundwater resources areas. Since potential leachate leaks will travel down gradient, landfills should be placed greater than 30.48 m up-gradient from water wells. Aquifer depths less than 15.24 m should be considered less suitable than sites with a depth-to-groundwater of 60.96 m (Belton, 2002) (Table 4.1).

Table 4.1: Groundwater depth and landfill suitability depending on the depth of groundwater from the natural ground surface level

Depth to groundwater(m)	Suitability
Over 60	High
15- 60	Moderate
Under 15	Low

Source: (Belton, 2002).

fresh groundwater which TDS more than 1000mg/l should be avoided or protected with a compound liner system and monitoring wells (Bagchi, 1994) (Table 4.2).

Table 4.2: Groundwater depth and landfill suitability depending on the groundwater Quality

Groundwater Quality (TDS in mg/l)	Suitability
Over10000	High
1000- 10000	Moderate
Under 1000	Low

Source: (Bagchi, 1994).

The groundwater characteristics, velocity, and location plays a role in the site selection process for the landfill, since: (Environmental Protection Agency, 1998)

- The high velocity of the groundwater flow will increase the spreading of eventually leachate beneath the landfill, (The velocity of the groundwater flow is dependent of porosity of the soil and the filtering speed). The potential landfill location with the lowest velocity of the groundwater flow is more suitable for a landfill.
- Also, high groundwater level or a nearby high river level will cause more risk to pollute the groundwater or river water. The potential landfill location with the lowest groundwater or river level is more suitable for a landfill.
- Impermeable layers in the subsoil are minimizing the risk of polluting the groundwater. Especially clay layers have a low permeability. The location with subsoil layers which have a high impermeability is more preferable to locate a landfill.

4.3.2.5. Topographical Criteria

The topography of an area is an important factor on site selection; furthermore, deciding the type of landfill design (area-, trench-, and depression-type landfills) is directly related to topography of a site.

The best kind of topography for landfill sitting is the flat gently rolling hills that are not subjected to flooding (Montgomery Country council. 1988), but it is also suitable for other land uses like agriculture, residential or commercial development

that lead to higher land prices. Lands with slope greater than 15% should be considered unsuitable for waste disposal site. (Bagchi, 1994)

Site topography can reduce or increase the potential for adverse effects on the environment from odour, noise, litter, and visual effect on neighboring properties. Also, landfill site topography could have an impact on ground or surface water, for example unstable caverns are not suitable for landfill siting since they may cause contamination of groundwater source. (University of Canterbury, 2000)

4.3.2.6. Geological criteria

Suitable geology is important to ensure containment of leachate in the long term, or in the case of failure of engineered containment systems. The geology of an area will directly control the soil types created from the parent material, loading bearing capacity of the landfill's foundation soil, and the migration of leachate. Rock and its structure type will determine the nature of soils and the permeability of the bedrock.

Geologic structure will influence the movement of leachate and potential rock-slope failure along joints and tilted bedding planes. It is generally undesirable to site a landfill in areas with the following characteristics: (University of Canterbury, 2000)

- High permeability soils, sands, gravels, or substrata.
- High permeability seams or faults.

- Regions with highly soluble rocks (Table 4.3), sinks and caverns (for example, limestone areas).

Where a landfill is developed in these geological environments, the design should incorporate a higher level of engineered leachate control and appropriate contingency measures.

Table 4.3: Landfill suitability of rock layer.

Rock Type	Suitability
Unfractured crystalline	Very high
Shale and clay	High
Limestone	Fair to poor
Sandstone	Poor to very poor
Unconsolidated sand/gravel	Unsuitable

Source: (Oweis *et al*, 1998).

The assessment of geology and site soils should consider (University of Canterbury, 2000):

- the availability of on-site materials for lining, cover and capping. Soils with a high percentage of clay particles (but which are workable in wet conditions) are generally the preferred soil type.
- the suitability of on-site materials for the construction of dams and drainage systems.
- potential sediment management problems, with highly erodible soils.

- existing site contamination and discharges, if present.
- suitability for on-site disposal of leachate by surface or subsurface irrigation.
- the potential effects of failure of leachate containment and collection systems.

Geological factors also influence storm water, and groundwater controls, the containment and control of leachate and gas, as well as the availability of final cover materials.

4.3.2.7. Site Stability criteria

Site stability should be considered from both short and long-term perspectives, including the effects of settlement.

It is generally undesirable to site a landfill in the following areas (University of Canterbury. 2000):

- areas subject to instability, except where the instability is of a shallow or surface nature that can be overcome, in perpetuity, by engineering works.
- active geological faults.
- areas of geothermal activity.
- regions with highly soluble rocks, sinks and caverns (for example, limestone areas).

In assessing the suitability of a site for a landfill the local soils need to be considered with respect to the following:

- Localized subsidence areas. Differential movement could render a landfill unusable due to rupture of liners, leachate drains or other structures.
- Landslide prone areas. The future weight could, through a wide variety of mass movement, destabilize the landfill. Instability may also be triggered by earthquakes, rain, freezing and thawing, and seepage.
- Local/onsite soil conditions that may result in significant differential settlement, for example compressible (peat) or expansive soil, or sensitive clays or silts.

Where there is potential seismic impact, the ability to design containment structures, including liner, leachate collections systems and surface water control systems, to resist the maximum acceleration in lithified earth material for the site, must be assessed.

4.3.2.8. Other Criteria

- Compatibility with Surrounding Land Use

The proximity of a potential landfill site to existing, or proposed, land uses needs to be considered. Separation distances, or buffer areas, can be used to preserve the amenity of surrounding areas.

The assessment of the suitability of the site should take in consideration the following (Middle East Technical University, 2004):

- Landfills construction should not be within the distance less than 1000m to settlements. Only if there are natural barriers like hills, trees or forests between the landfill site and the settlements, the construction of landfills in a distance less than 1000 m to settlements may be allowed after approval of the Ministry of Environment and upon order of the highest local authority and the concerned municipality.
- Areas used for the testing of military equipment or training of military personnel are not open for public usage.
- The presence of birds is a real danger for airplanes. Because birds are attracted especially by organic waste, landfills should be located at certain distance from airports.
- Industrial areas are not principally excluded as location of a landfill. Dependent of the kind of industry such as not sensible for dust or food factories, an industrial area or close to it is suitable for a landfill. An advantage of an industrial area is the presence of infrastructural provisions.

- **Difficult infrastructural provisions**

If the location of the new landfill come across with existing infrastructural provisions such as cables, roads or existing plans for drainage, it is very difficult to make the location suitable for the use as a landfill (Middle East Technical University, 2004).

- **Climate criteria**

The site selection process must consider climate characteristics such as prevailing winds, precipitation, and temperature variations because they are related to odors, dust, leachate generation, blowing litter, cover soil and erosion (Middle East Technical University, 2004).

However, all potential locations need to be considered in the light of site-specific characteristics, which may result in some parameters being given a greater weighting than others.

- **Community Issues**

The local community will have a significant input into determining whether or not a site is suitable for development as a landfill. Many of the issues, which can be of greatest concern to the local community, may not be those identified through technical studies or investigations (University of Canterbury. 2000). These issues, many of which are detailed above, include, but are not limited to:

- Design life of the landfill.
- Nuisances associated with odour, vermin, birds and flies, noise, litter, dust and visual effects.
- The potential effects of failure of containment, leachate collection or landfill gas systems.
- Protection of local amenity values.
- Traffic effects.

- Health risks.
- Cultural issues.
- Heritage issues.
- Loss of property values.
- Long-term compliance with consent requirements.
- End use of the site.
- Sometimes it could be the less awareness of what is sanitary landfills

Consultation and negotiation with the community during the sitting process is required to determine issues of site-specific importance, the actual, or perceived, risks and appropriate measures to avoid, remedy or mitigate adverse effects on the environment. Since the community issues could cause a delay for the landfill implementation as it will be seen in the next section in the discussion Palestinian case in landfill site selection.

4.3.3. Criteria of landfill site selection (Palestinian study case)

The “Palestinian Environmental Strategy”, a document produced in 1999 by the Ministry of Environmental Affairs (MEnA), identified the need for at least five new sanitary landfills in West Bank and two in Gaza Strip in order to stem serious deterioration of water, land, and air quality (MEnA, 1999).

One of these landfills was proposed for Ramallah/Al Bireh Governorate, In this section the site selection investigation and criteria for Ramallah/ Al Bireh

Governorate sanitary landfill will be presented in order to view the site selection criteria that were used in Palestine.

The identification of regional landfill site serves Ramallah/ Al Bireh Governorate has followed a process that has integrated environmental, administrative, social and economical considerations. This process ensured that the chosen site will be located in an environmentally appropriate location as well as in a location that respects the needs of the area.

The site selection of the landfill started by the Palestinian Ministry of Planning in 2001, through sieve analysis for a very wide area, considering that the proposed landfill should not impact sensitive areas to an unacceptable level. Sensitive areas were defined as those that met the following criteria:

- 1- Within distance of 500m from main or regional road.
- 2- Cultural heritage sites nearby.
- 3- Agricultural suitability.
- 4- Landscape.
- 5- Inter agreement area (the land categories according to Oslo agreement A, B, C)
- 6- Water sensitive recharge area
- 7- Closeness to urban areas.
- 8- Fauna and flora survey of the proposed site for landfill sitting will be undertaken in the next stage, to develop a baseline of life forms that make

use of the proposed site location, and rare species will be identified (no data or information were studied up to now)

According to these criteria, 14 sites were considered as potential areas for landfill sitting.

After the evaluation of the 14 sites two were chosen as the most acceptable sites for the landfill sitting, but due to political conditions of their location in area "C" no Israeli approval were obtained. Therefore, four additional short list sites were identified in 2003, and evaluated according to the following table:

Table 4.4: Site evaluation for landfill sitting for the four second site alternatives.

Site ID	Closeness to built up areas	within distance of 1000m from main or regional road.	Cultural heritage sites nearby	Agricultural suitability.	Inter agreement area	Water sensitive recharge area
1	Deir Dibwan (2km)	yes	None	Moderately suitable for agriculture	Area B	Low Sensitive Area
2	Deir Dibwan (1.5 km)	No	Remotely Close to Cultural Heritage Site	None	Area B	Moderately Sensitive Area
3	Deir Jarir (1 km)	yes	Close to Agricultural site	Moderate to low sensitivity	Area B	High Sensitive Area
4	Abu Shukheidim (250 m)	No	Close to Agricultural site	Moderate to low sensitivity	Area B	High Sensitive Area

Source: (Environmental Resource Managements, 2005).

Site number 1 was identified as the perfect location for landfill to serve Ramallah/Al Bireh Governorate. Thus, the suitability of this site has been further assessed against additional criteria which are:

- Distance of the landfill border to settlements.
- Distance of landfill border to important wells or reservoirs used for water supply of settlements.
- Rivers and flooding zones with a return period of 50 years.
- Zones of unstable slopes (areas, where soil or rock movements can occur due to tectonic processes)
- Natural protection zones.
- Areas closed for military or security purposes
- Geological faults.
- Less than 3000 m distance of the landfill border to airport.

The final assessment concluded that the site is generally appropriate for the landfill sitting.

Further detailed assessments for the site was taken in consideration, such as:

1. The access road

2. Technical evaluation of the preferred landfill site, and evaluating the site regarding to its technical suitability related to:

- Geo- technical matters and aspects of site construction, such as (the collection of the leachate, the catchments area of the surface water and its location to the landfill)
- Morphological (topographical) situation.
- Volume of landfill.
- Land ownership.

3. Environmental Evaluation:

- Flora and fauna.
- Nature protection, land use, Archaeology.
- Meteorology, Climate and Emissions.
- Geology
- Groundwater and surface water.

After the detailed investigation the site was approved as suitable, but there was a public rejection from the residents of the villages around the proposed landfill site, due to the lack of public awareness of the landfill concept and lack of public participation through the project planning.

Therefore, new alternatives for the landfill sitting were suggested. Four locations was described as suitable for landfill sitting, and the sites were evaluated according to the previous criteria and one of them was chosen, which was close to Al Tayba village. Also the public rejection caused a new delay for the landfill construction. Recently, a site close to Ramoun village is chosen to establish the sanitary landfill on,

It's worth to mention that the previous investigation criteria do not cover all the environmental aspects, and more detailed environmental, social, political and economical aspects should be evaluated before the final decision of the landfill sitting are to be taken. For example the political criteria was absent in the evaluation of the site selection such as the acceptance by the local municipalities and the acceptance of the pressure groups in the communities that the landfill is proposed to be site in, and that was a source of delay for the landfill construction. But at the sometime the investigations for the site suitability still under search, and in each investigation stage more criteria are been taken in consideration, which leads to the conclusion that these Palestinian landfill sitting criteria are not final yet.

CHAPTER 5

URBAN DEVELOPMENT IN RAMALLAH CITY

5.1. Urban Development and Trend in Palestine

Urbanization is the physical growth of rural or natural land into urban areas as a result of population high natural growth and heavy immigration to an existing area, affecting the physical concentration of people, land use structure, social structure and interactions, service providing, and economic activity and production.

The exact definition and population size of urbanized areas varies among different countries. In Palestine the urbanized areas are the areas with population rate around 4000- 9999 inhabitant, and provide the four main services which are: electricity network, water network, mail office, health center 24 hour service, and secondary school. According to this, there are 54 urban areas from 666 localities in Palestine (ARIJ, 2005).

Following the history of urban development in Palestine, it could be notice that the development of the Palestinian cities have veered from ancient traditions of urban development and suffered greatly since the middle of the twentieth century, where in 1967, the territories administered by Jordan and Egypt came under Israeli occupation rule, and the Palestinian urban centers under Israeli occupation became disconnected from the urban cores of other Arab States. The Palestinian urban

centers resumed their growth under Israeli occupation with a slow mode, due to the Israeli restrictions and complexities. In 1987 to 1993 Palestinians cities, towns, and villages reduced and limited the development because of the political struggle in the first intifada (Khamaisi, 2006), while strengthened the Israeli occupation and control over the Palestinians, this control includes economic development, confinement of institutionalizations and the limiting of accessibility and mobility between the localities. Such Israeli actions coincided with increased development of Israeli settlements, which continue to surround Palestinian cities and limits their expansion and development.

The obvious growth of the population in the urban areas in Palestine came after the peace process (1991-1994), where the urbanization start to follow a rapid growth mode, and the speed of development rapidly accelerated and many geo-political, economic and social changes took place in OPT, reflecting in the physical development of the cities and towns. This rapid urban development was affected by many factors that are (Shaheen, 2007):

- The spread of peace expectations among the Palestinian people encouraged them to use their savings and invest in building.
- The establishment of the Palestinian National Authority and its urgent need for buildings and headquarters to accommodate its institutions.
- The return of many Palestinians to their home land.

- The establishment of many non-governmental organizations (NGOs), and foreign institutions, in the main cities.
- Internal immigration of people from rural areas to the main cities
- The flourishing of the economy, and the ensuring international financial donations to support the peace process.

Thus, the Palestinian cities were expanding rapidly in uncontrolled manner, causing adverse effects on land use, urban services, and the quality of living environment, specially Ramallah city.

In the peace process negotiations some issues were postponed to final negotiations such as Jerusalem, which are the future capital of Palestine. Due to this postponement the Palestinians chose to temporarily establish most governmental institutions in the Ramallah-Al-Bireh twin cities, with other branches established in Gaza city. The dual establishment of governmental and public institutions, and the division between Gaza and Ramallah cities came as a result of an existing division of the OPT between the West Bank and Gaza Strip. Ramallah and Al Bireh cities functioning as the core and the administration capital of OPT.

After 2000 the development process has been radical deceleration due to the second intifada and the bad political situation. And since 2003, Israel began to built separate wall surrounding the area were Israel define Jerusalem and achieve its interests (Brook et, al. 2005), Ramallah resumed to grow again, in its limited boundaries.

In general, these geo-political and national circumstances after the interim agreements, which include establishing of the official governmental institutions of Palestinian Authority located in Ramallah, imposed rapid transformations and changes on the small city, which previously developed organically according to its population needs. The city began to cope the new challenge of rapid growth necessary to function as the core of the new nation state, Palestine. The challenges, which put forward Ramallah planning activities and process, will be described in the next sections

5.2. Ramallah Urban Development Through History

Ramallah began to grow and establish in the Ottoman era as an agricultural village of about 400 inhabitants in the 16th century. With time Ramallah became a rich town attracting families to the area. It developed as any ordinary village which was predominately Christian. The 19th century brought about an arrival of church representatives and missionaries to the area, resulting in the development of church institutions such as schools and hospitals (Al Joabah, 2002).

In this period Ramallah city began to grow outside its original village (the old city of Ramallah nowadays (Fig 5.1), where new houses appeared with enclosed gardens and beautiful stone and masonry work, which indicates that it is a time of social development, especially when the economical situation started to grow as the Ramallah natives in America started to build and invest in their mother land, together with employment prospects under the British Mandate government, created a new Ramallah bourgeoisie who moved from the old village to the area

around it and built their new villas. Ramallah grew, particularly along the main roads and in the direction of Al-Bireh, bringing the two villages yet closer (Riwaq, 1998).



Fig 5.1: Ramallah old City Location in Ramallah Map (Ramallah municipality, 2009).

In 1908 the municipality of Ramallah was established when its population reached about 3300 persons. The town growth as center of sub-district Ramallah served the villages around. The village land was 17858 donumes. The town

expanded slowly without an official outline plan. In the mid twentieth century, it suffered from negative migration abroad (America, Europe, and Australia) (Ramallah municipality, 2000). During the 1920s and 30s the empty houses in the old city were taken by families from the Hebron area who came to work for mandate officials (Riwaq, 1998).

In 1946 Ramallah residents were about 6000 inhabitant, but 1,500 of them emigrate from Ramallah to America. after two years of this emigration there was an influx of refugees to Ramallah from families forced to run away from their homes in 1948 (Nakbah) by Israeli forces. Also in 1953, one third of the native population had left and were living in America, where at the same period, Jordanian period (1950-1967), Ramallah evolved into a tourist destination, due to its good weather particularly in the summer, and the town began to grow as a result of population growth based on positive immigration from the rest of the West Bank and on natural increase (Fig 5.2) (Ramallah municipality, 2000).

During the War in 1967, Israel captured Ramallah, immediately imposing a military closure, and conducted a census a few weeks later. Ramallah remained under Israeli military rule for three decades, and The Civil Administration established in 1981, was in charge of civilian and day-to-day services such as issuing permission to travel, build, export or import, and host relatives from abroad, and did not give any attention to plan for Ramallah future expansion. Ramallah at that time played as a suburban area for Jerusalem district that serves the villages around (<http://en.wikipedia.org/wiki/Ramallah>).

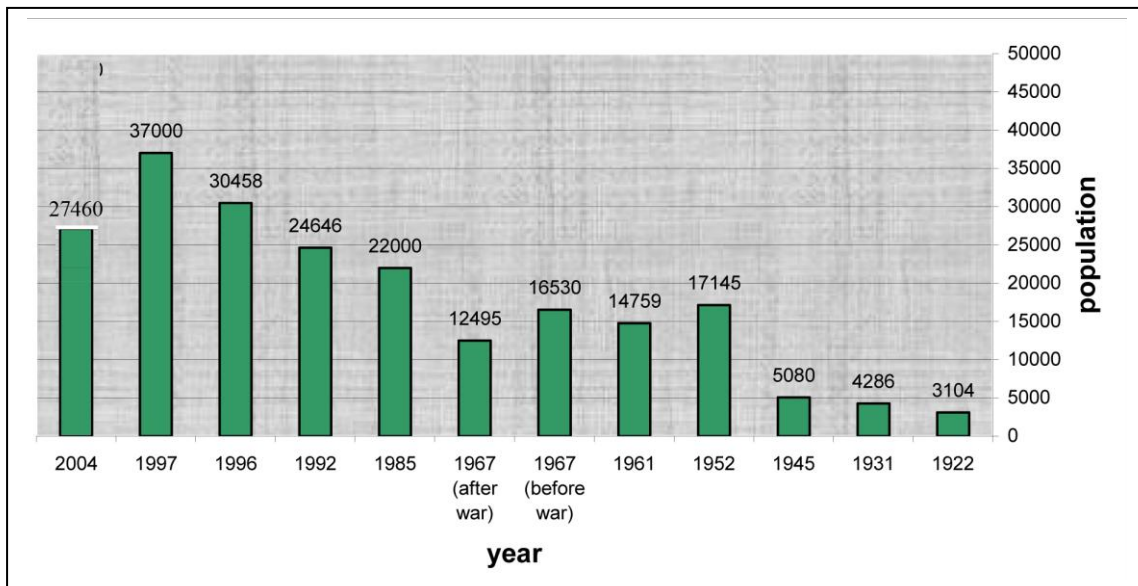


Fig 5.2: Ramallah Population Through Years (PCBS, 2004) (PCBS,2009).

In December 1987, the popular uprising known as the Intifada erupted, and the situation in Ramallah City Was bad as any other part in the West Bank, in which the city started to grow after the Intifada wound down and the peace process moved forward, normal life in Ramallah resumed. The years between 1995 and 2000 brought relative prosperity to Ramallah, and Many expatriates returned to establish businesses there and the atmosphere was one of optimism, which was result for Ramallah population doubly increasing after 1992 (Fig 5.2), this population growth was as natural increases and immigration; including Palestinians returnee that comes after establishing of the Palestinian Authority, These population growths join with growth demand of housing and public facilities and create economic activities as will describe in short below (Khamaisi, 2006). This urbanization process have had occurred a transformation and changing of urban social, community, economic and institutions fabric, this beside the physical

structure of the city which change it to be part or urban semi-metropolitan with the cities of Al Bireh and Bietunya.

In 2000, unemployment began to rise and the economy of Ramallah declined, at the same time expansion of Israeli settlements around Ramallah increased dramatically. A network of bypass roads for use of Jewish residents was built around Ramallah, and land was confiscated for settlements. In July 2000 the second popular uprising Al-Aqsa Intifada started, and In 2002, Ramallah was reoccupied by Israel the living conditions had become intolerable. The Israeli West Bank barrier has furthered Ramallah's isolation, but recently Ramallah started to grow and expansion since the political situation in Ramallah are better than any other city in West Bank.

5.3. Ramallah Urban planning

It was until 1963 when the first urban master plan was drawn by the Jordanian authorities to organize the development of Ramallah city, before that Ramallah developed organically -as it was mentioned previously- from a build up core that are in the flat area of Ramallah, then the city started to expand eastward, connecting Al Bireh city without any physical planning to organize it (Fig 5.3, 5.4).

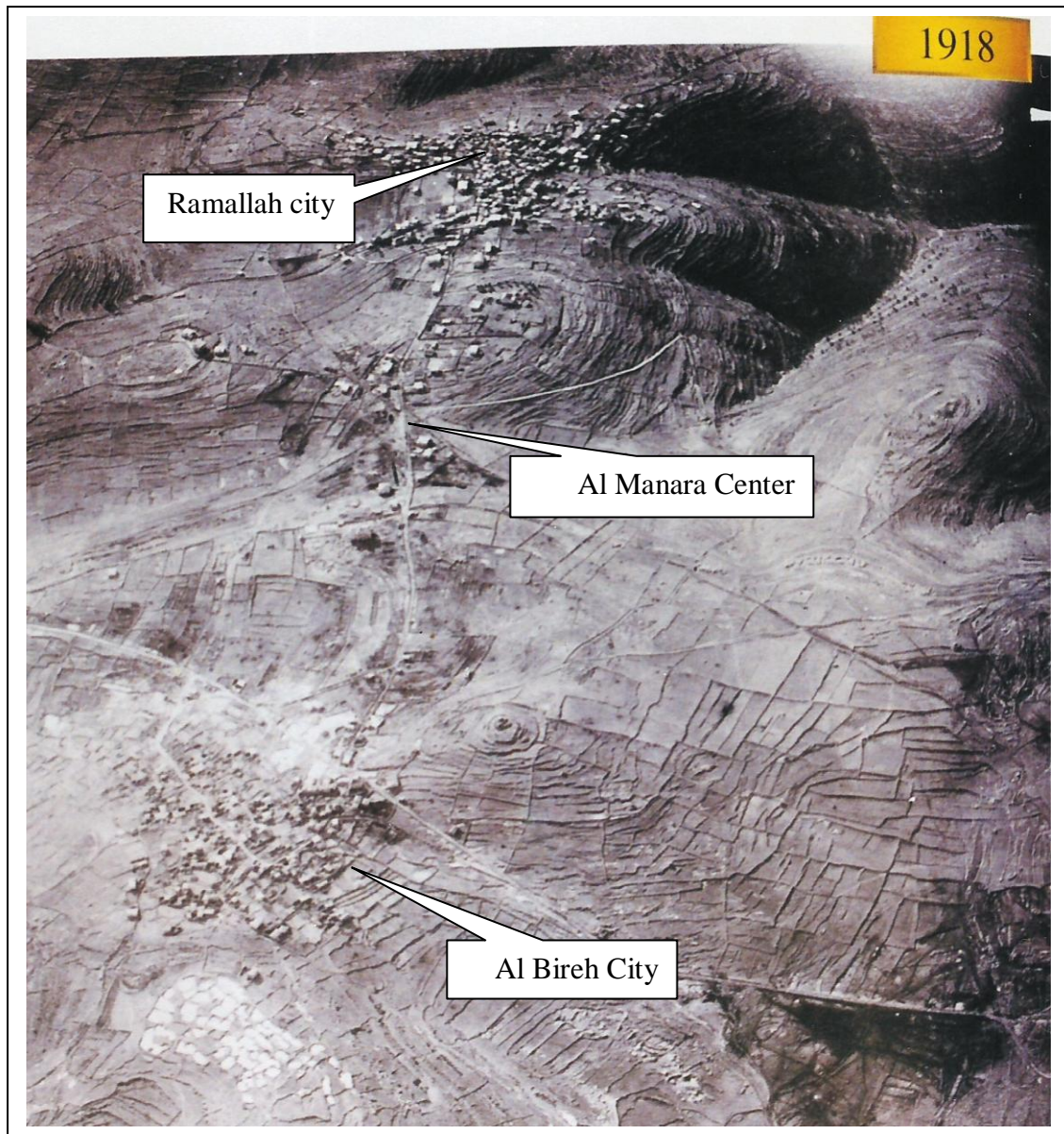


Fig 5.3: Aerial Photo of Ramallah and Al Bireh City in 1918 (Al Bireh Municipality, 2009)

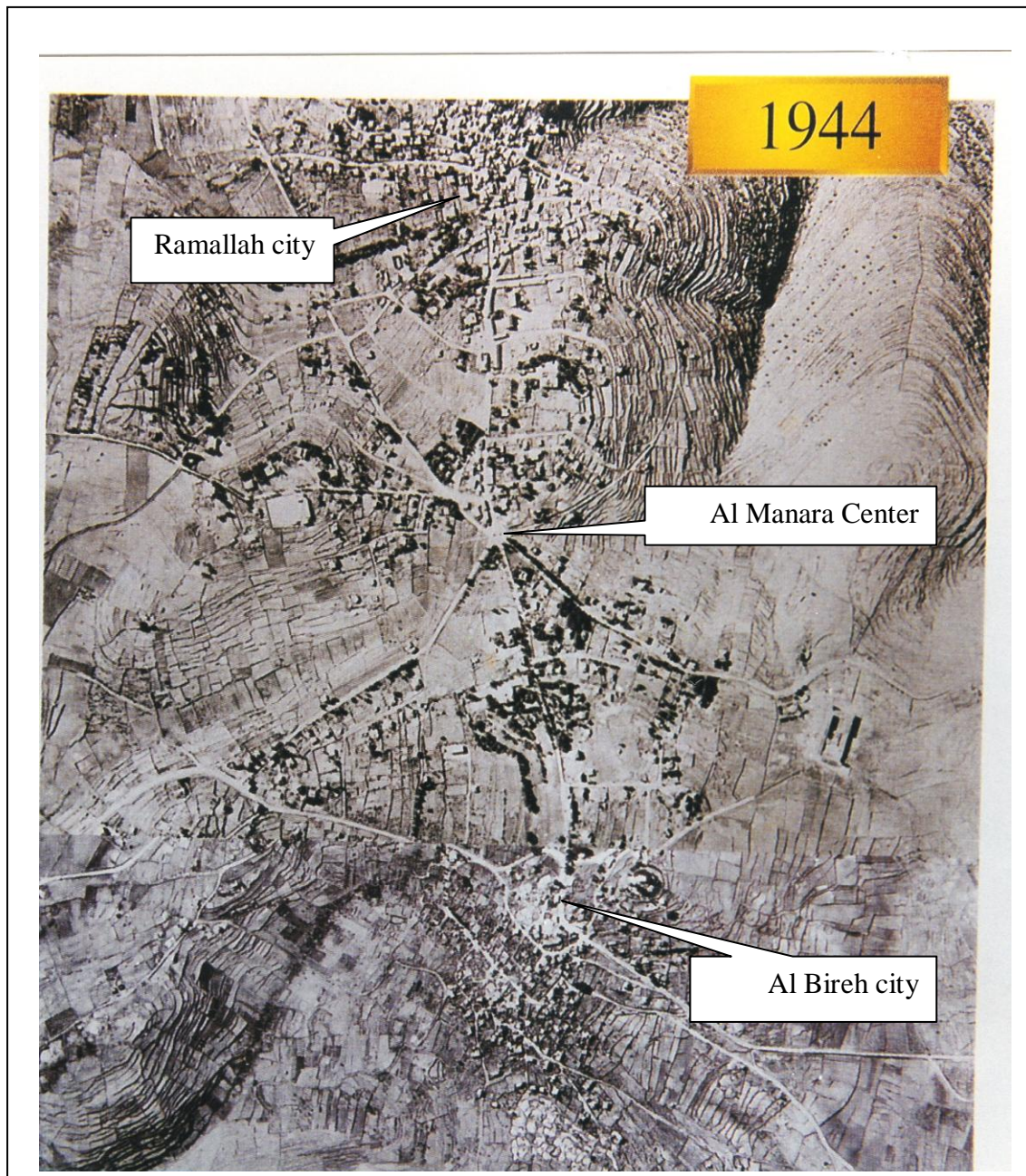


Fig 5.4: Aerial Photo of Ramallah and Al Bireh City in 1944 (Al Bireh Municipality, 2009)

Also the previous Figures show that the urban expansion was in the southern west direction too. This leads to that the planning process occurred after the city was established and gained sovereignty. The master plan covered about 5000 donum which included the city center and the surrounding area, and the land was divided in to the following use as in table (5.1)

Table 5.1: Approximate land use distribution of Old Ramallah according to 1963 city master plan.

Land distribution)	Dunums (approximate	Percentage
Roads	1,500	30
Residential	2,100	42
Commercial	1,400	28
Total	5,000	100

Source: (Musleh, 2006).

The city started to grow out the city plan, and the city started to face an industrial establishments in 1970's outside the master plan in the south west side. In 1985 an outline urban plan was made by the Israeli military sovereignty, but this plan was not approved. Ramallah with Al Bireh city in this plan was considered as a one unit as it shows in (Fig 5.5), and as regional center for Jerusalem metropolitan (Khamaisi, 1998).

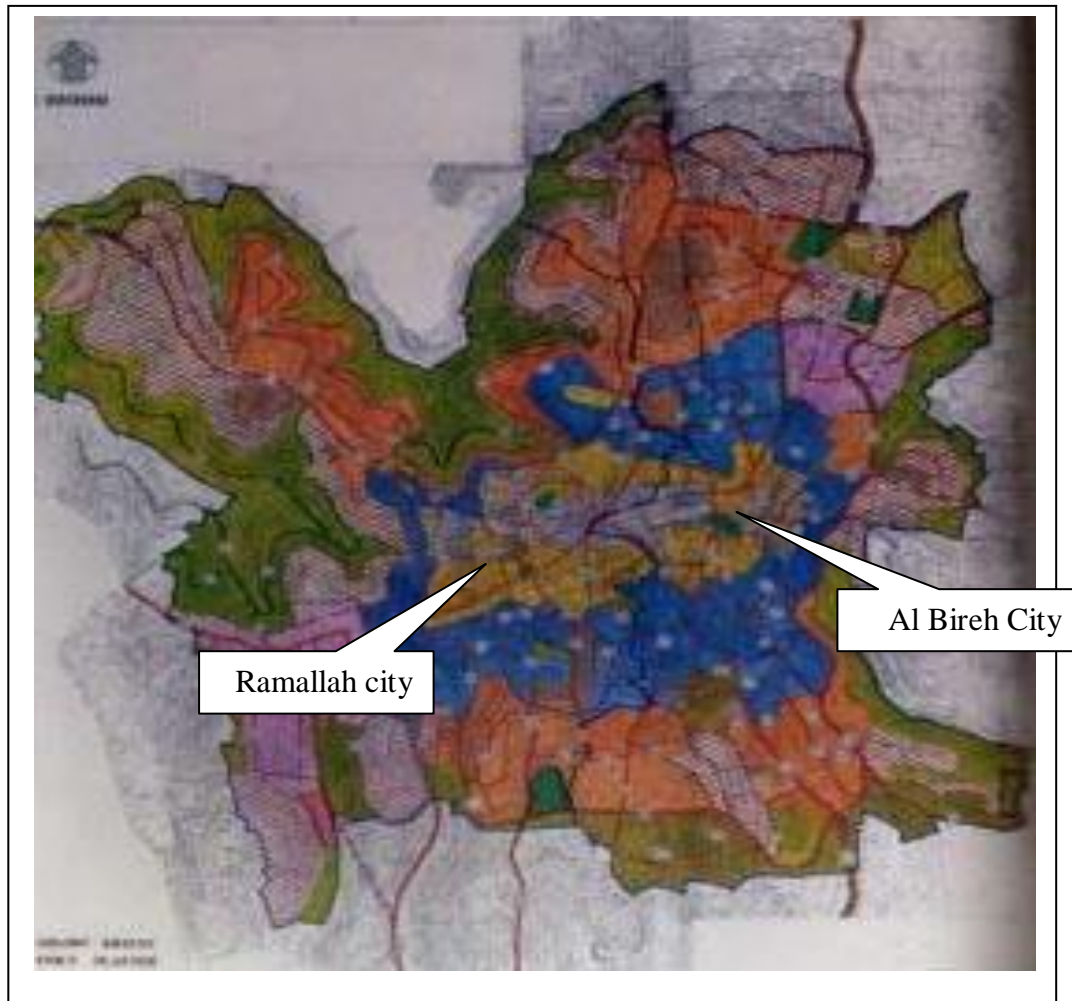


Fig 5.5: suggested Outline plan of Ramallah in 1985 (Khamaisi, 1998).

Many private and public developers initiated preparations for a local and detailed plan of their private land out the city master plan. In addition to that, the municipality of Ramallah lacks a general plan to cope with the increase of building permit applications, nor does it have a mechanism for accepting or rejecting, or giving guidelines for local public and private developers. Furthermore, the built up area of Ramallah was expanded during the period of 1989-1994 in 16.1 percents, the built-up area growth in average of 397 donums per year, while in the period between 1994- 2000, the built up area of Ramallah grown in 24.5 percents, since the peace process started to take actions in Ramallah, the built up area growth in average of 585 donums per year. Therefore the second master plan was done in

1999 to cope with the new circumstances, which included the city center and surrounding area within the jurisdiction of the municipality, which was approximately 14500 donums (Khamaisi, 2006).

According to Ramallah municipality, the 1999 master plan for Ramallah city, relied on the master plan of 1963 and the outline plan of 1985, and no changes was done to the master plan of 1963 the planning was only for the unplanned areas which is about 9,587 donums of the city within the jurisdiction of the municipality (Fig 5.6), which are divided to the following land uses (Table 5.2).

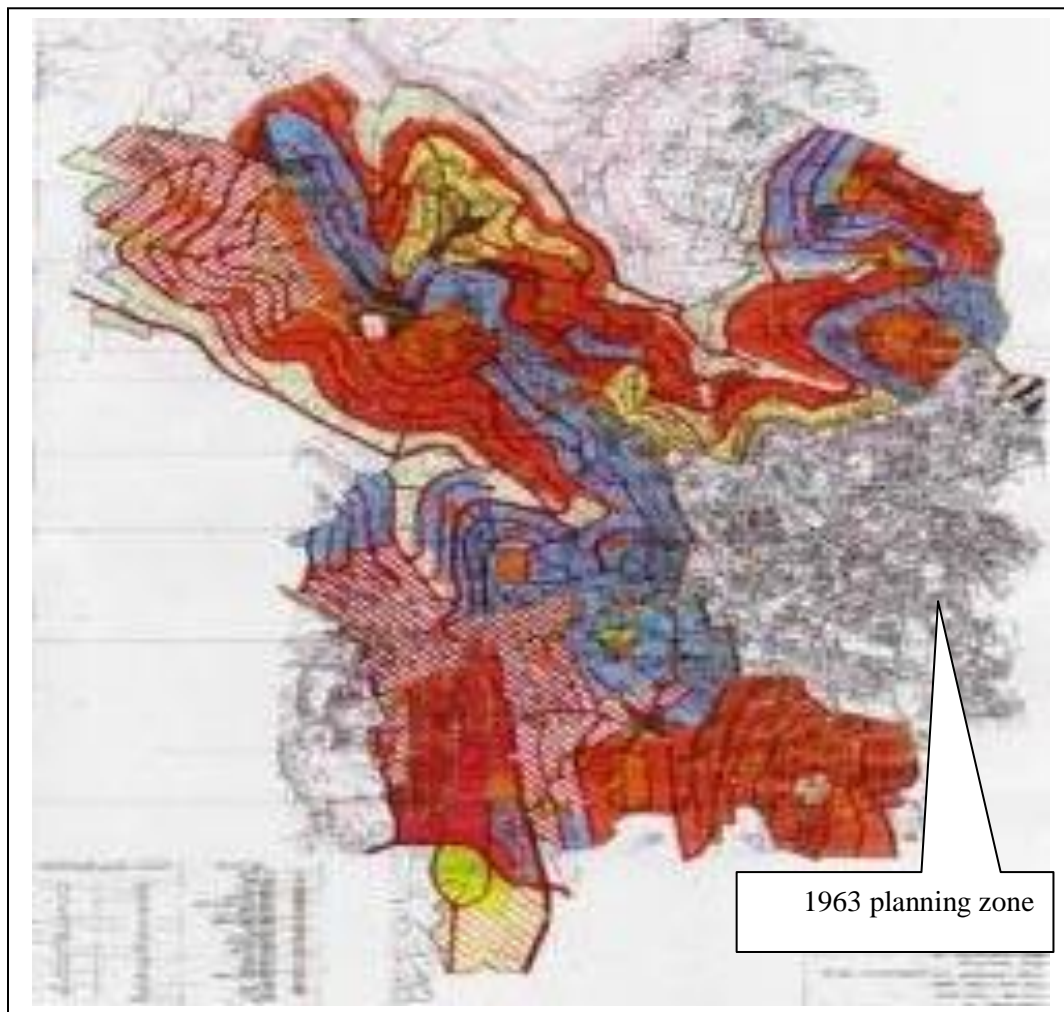


Fig 5.6: Approved Master plan of Ramallah in 1999 (Khamaisi, 1998)

Table 5.2: Land distribution according to the second master plan 1999 (excluding old Ramallah area).

Land distribution	Area (dunums)	Percentage(%)
Residential zone (villas)	476	5.0
Residential zone "A"	1,963	20.5
Residential zone "B"	1,736	18.1
Residential zone "C"	432	4.5
Commercial zone	73	0.8
Industrial zone	284	3.0
Mixed zoning	563	5.9
Public buildings	409	4.3
Public areas zone	210	2.2
Cemetery	31	0.3
Exhibition area	126	1.3
Hotels	25	0.3
Industrial engineering establishments	53	0.6
Transportation center	32	0.3
Open roads	1,315	13.7
Suggested roads	847	8.8
Pedestrian crossings	43	0.4
Agricultural land	814	8.5
Future development area	155	1.6
Total	9,587	100.0

Source: (Musleh, 2006).

The boundaries of Ramallah city expanded in the year of 2000, there was an incremental urban plans to cover the new unplanned areas which was about 2760 donums and the plan was approved in 2005. Nowadays the urban planning department in Ramallah municipality finished the renewing of the general master plan but still not full authorized by the Palestinian national planning system.

5.4. Ramallah urban Planning and Dumpsite Sitting

The investigation of the site selection criteria that guided the sitting of Ramallah existing dumpsite showed that dumpsite location was chosen randomly without any urban or environmental bases, but according to the municipality of Ramallah the only reasons of the site location was the land ownership which is public, and the location approximately close to the served areas, which was necessary in that time since the solid waste transforming was by donkey, and handcarts.

The Dumpsite started as solid waste disposal site in 1967 (Al-Khatib, 2003), after the first master plan of Ramallah was done (in 1963). Before that the solid waste was randomly disposed in vacant lands near residential houses and some residence used to dispose solid waste in what are called nowadays Al Terah area, which is in the western side of the old Ramallah city (according to Ramallah municipality).

The analysis of the 1963 master plan of Ramallah city showed that the dumpsite is located outside the municipality juristic, and after the land use of Ramallah city was classified. The dumpsite was located in the east direction which is classified as residential areas but not built up yet. This indicates that the dumpsite was located without any consideration for the residential expansion (Fig 5.7).

In the early 1970s the industrial area was established also outside Ramallah municipality juristic within the area around the dumpsite location in the south west direction of the built up residential areas, this obliterate the discussion that justify the reason for the dumpsite sitting is the existing of industrial area location, and the industrial waste disposal area. In 1983 the dumpsite and the industrial area was within the municipality juristic as it appears in the following Figure(5.7) .

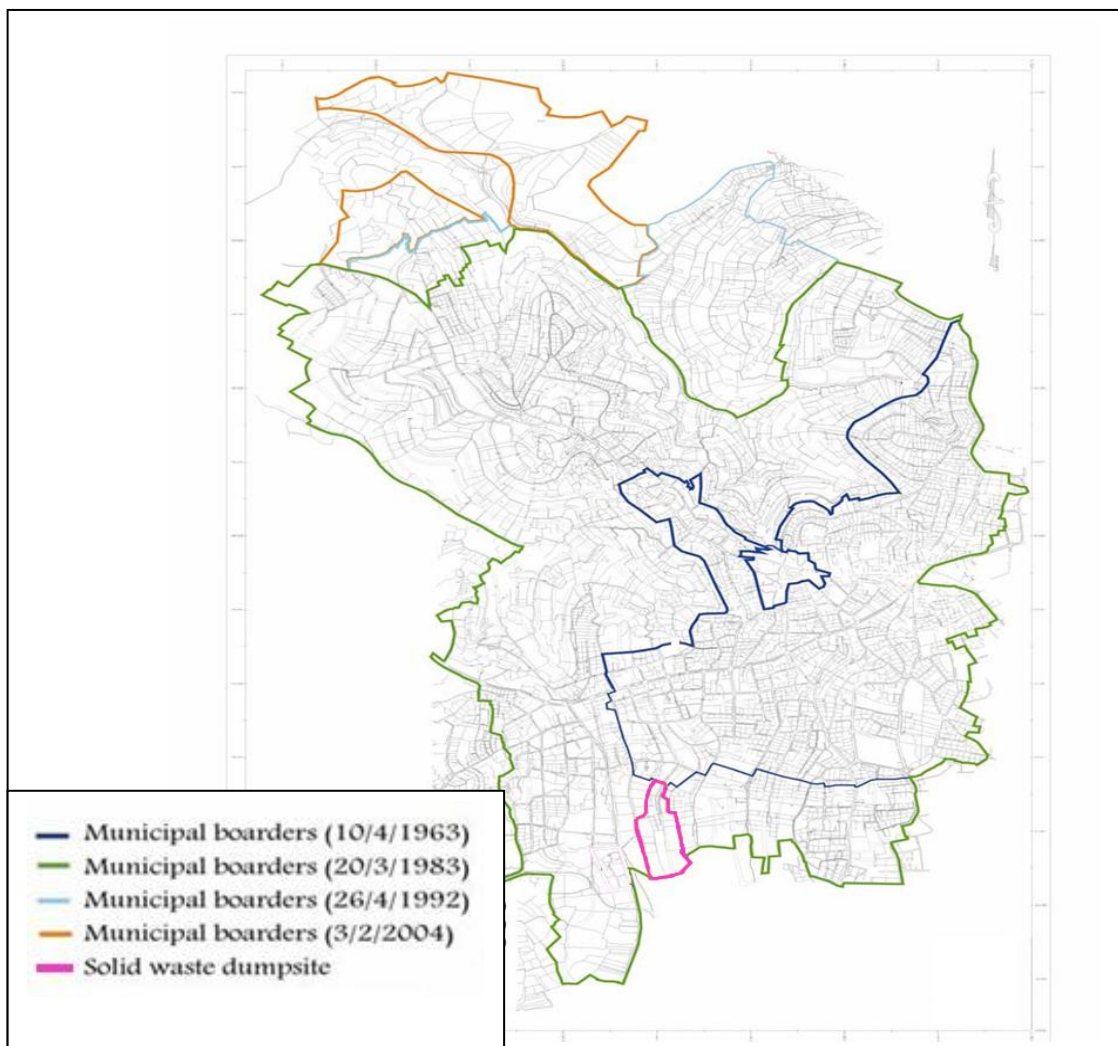


Fig 5.7: Ramallah city development through different years (Musleh, 2006).

In the second master plan of Ramallah in 1999, the dumpsite location was classified as trade exhibitions areas, 200m far from a residential area (defined as A

residential area) from the eastern side (Fig 5.8) , which means that the dumpsite should be closed and transfer into another area, this was as a response for the Palestinian Environmental Strategy document produced in 1999 that suggested the closure of all the random dumpsites in the OPT, and the establishment of five sanitary landfills as solid waste environmental disposal method . But there were no alternatives until the year 2005, when the site investigation for sanitary landfill for Ramallah governorate started as it was mentioned in the previous chapter, and the municipality started to give building permits according to the master plan ignoring the existence of the dumpsite.

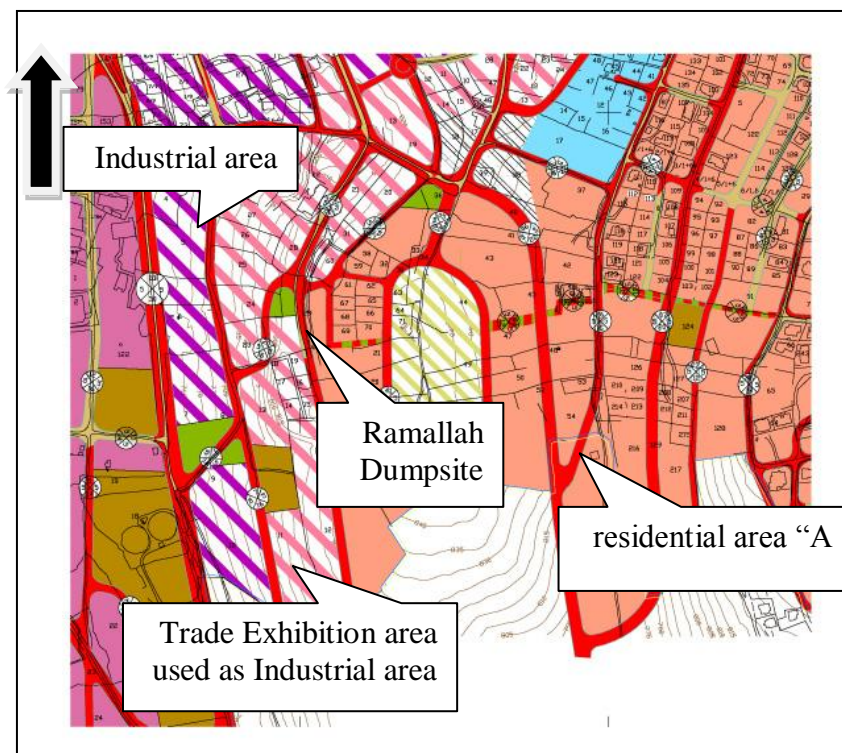


Fig 5.8: The Master Plan of the Dumpsite and its Surrounding.

As conclusion, the sitting of Ramallah dumpsite was not according to urban planning criteria. In the next chapter the location of the dumpsite socio-environmental impact will be analyzed.

CHAPTER 6 RAMALLAH DUMPSITE ENVIRONMENTAL ASSESSMENT

6. General view

As it was mentioned in the previous chapter, due to the solid waste problem towards the atmosphere, water supply, and human health (ARIJ, 1997). A document produced in 1999 by the Ministry of Environmental Affairs (MEnA), The “Palestinian Environmental Strategy”, identified the need for at least five new sanitary landfills in the West Bank and two in the Gaza Strip in order to stem serious deterioration of water, land, and air quality (MEnA, 1999).

Also a team of environmental experts, from the United Nations’ Environment Program (UNEP) in 2003, found the extent of environmental degradation occurring in the Occupied Palestinian Authority (OPT) to be ‘alarming,’ and identified the solid waste management issue, as one of the most critical problems (ARIJ, 2007).

One of the reasons for the environmental degradation, is the method that are used for solid waste disposal in OPT. where the most common method for solid waste disposal are using open dump and unmonitored sites, especially in the West Bank. As it was mentioned in previous chapters, one survey conducted by the PCBS counted 161 such dumping sites in the West Bank and 3 in the Gaza Strip, none of which were subject to any monitoring or control by the Palestinian Ministry of Health (PCBS. 2006) or other authorities.

In this chapter the socio – environmental impact assessment of Ramallah city open dumpsite, or as some references name it as landfill, will be discussed, Starting by the description of the historical aspects of the dumpsite, then site description and site forces. After that the results of the site socio – environmental investigation (see the methodology) will be discussed. To lead to the last chapter of this thesis which are the conclusion and recommendations

6.1. Ramallah solid waste management

Solid waste in Ramallah city is generated by households, industrial, commercial and institutional sectors (including the hospitals), the waste generated is estimated to be 1.10kg /day per capita (350 ton) (Ramallah municipality, 2007), this amount are increasing due to the rapid increase of the population due to the internal migration that results from the political and economical caused since Ramallah are considered a long with Al Bireh city the administrator and economical capital of the OPT, and a major urban area. The increasing of the solid waste will increase with the increasing population with 3% per year (ERM, 2006).

Wastes are collected from all generators (including hazardous and non-hazardous waste) by the municipality of Ramallah (public sector), significant quantities of wastes are either dumped on “vacant” land or escape from the communal containers.

The collected solid waste are disposed of in semi-controlled manner in open dumpsite owned by Ramallah municipality. Solid waste disposal site are

located close to the urban area and residential area, also the dumping site have no technical installation to prevent or control potential environmental impacts associated with the waste or its decomposition, and the burning waste are common in the site.

The existing disposal site has not been selected on the basis of environmental criteria, and it is not adequately operated or monitored. Also there are no separation of waste in any point in the all the waste management system.

In the next sections the impact assessment of the disposal site will be studied in a specific matter depending on quantitative and qualitative analysis (see the methodology)

6.2. Historical aspect of Ramallah Dumpsite

Ramallah landfill started as one of the random dumpsites, far away from the residential urban area, close to the industrial area in 1967. The area of the dumpsite at that time was approximately 4500 m². The total accumulation of solid waste was limited because the burning of the solid waste was common (Al-Khatib, 2003)

In the early 1990s, the municipality of Ramallah stopped the burning of the wastes in the dumpsite, which in real did not stop since some individual burn the wastes (as the municipality claimed). The main reason for the burning stop decision is the urban expansion of the built-up residential areas toward the dumpsite location.

In 1995 the municipality of Ramallah decided to close the dumpsite immediately, but the land availability in the city is lack, also this dumps site are used by Bietunia city and the Al Bireh city Solid waste that are collected in the afternoon since the Israeli control over Al Bireh city dumpsite in the year 2000.

As a future approach, the dumpsite will be closed and might be used as waste collecting Transition site, after the establishment of the sanitary landfill for Ramallah- Al Bireh District.

6.3. Description of the Dumpsite location

The existing disposal site is located in a valley at west Border of Ramallah, about 1.5 km from the commercial Ramallah city center, the valley shows a slope with a total height difference from the bottom to the top about 100 m. the municipality of Ramallah started waste disposal more than 30years ago at a height of about 70m above the bottom of the valley. (ERM. 2006)

The dumpsite is located in area A (the land categories according to Oslo agreement A, B, C). As it was mentioned in the previous section, in 1995 the built up areas expanded toward the disposal site since there are no other expansion direction to the city, where the city of Ramallah is surrounded by Al Bireh city from the eastern and Northern Side, and Bietunia City from the western side.

The area where the dumpsite is located are near the industrial area, recently office building have been built near it also. To the bottom of the valley in the eastern side a treatment plant is located (Fig 6.1).

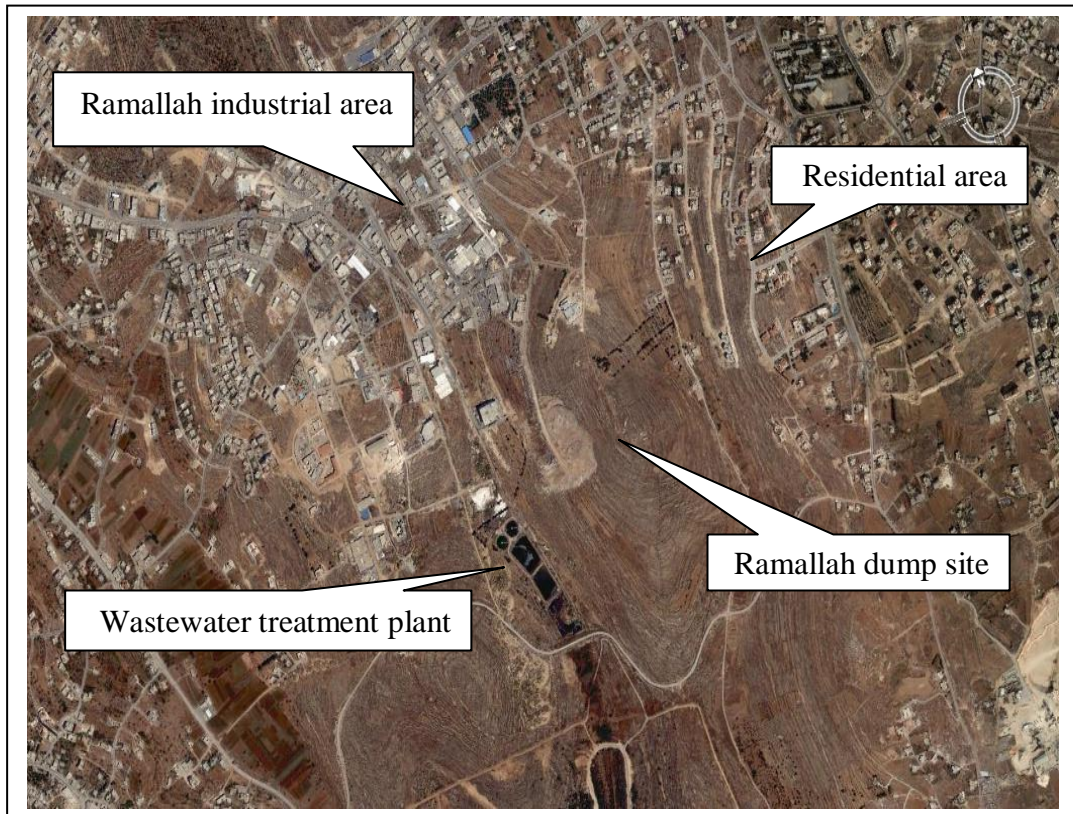


Fig 6.1: Site Location of Ramallah Dumpsite

Currently, waste disposal site area shows a length about 550m in a north south direction and a width of about 230m a west east direction, also the dumpsite ends at south western side with a steep slope about 50% and a height range about 45 to 50 m, this slope is not interrupted with terraces, and as a result there is a danger of waste slippage (Fig 6.2).

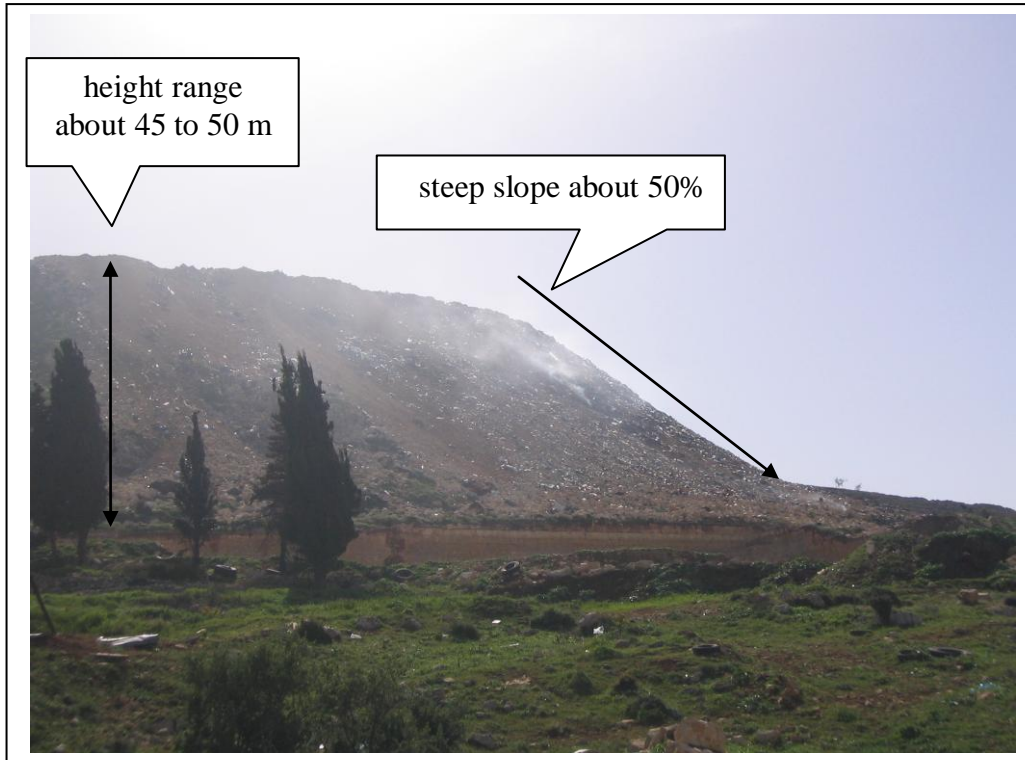


Fig 6.2: Image of the existing dumpsite shows the steep slope, and the height of it.

The environmental characteristics of the site can be divided as follows:

6.3.1. The geological Environment

The area where the landfill (dumpsite) is located, is mainly composed of thin bedded dolomitic limestone at the bottom which became massive toward the top. The total thickness is about 216 m. the lower part of the formation consists of marly limestone with marly parting and or bedded limestone, somewhat dolomitic at the top. The total thickness is around 180 to 205 m (ARIJ, 1996)

Most importantly, limestone dominates the site area regarding the geological situation, which means that it is highly soluble rocks (see chapter 4), that are highly affected by the leachate, therefore the dumpsite location regard to the

geological characteristic can be described as fair or poor for landfill suitability siting.

6.3.2. Hydrological Environment

There are three main ground water aquifers in the West Bank, in the north eastern, the western and the eastern side (Daghray, 2005), Ramallah governorate are located on part of the eastern and western aquifer (Fig 6.3).



Fig 6.3: Ground water aquifer location in West Bank (PSSIA, 2002)

The existed location for the landfill of Ramallah city is described as moderate sensitivity toward the groundwater according to the Ministry of Local Government Metropolitan studies in 2004, and moderate sensitivity means that the ground water are between 15 -60 m depth (Bolton, 1995) (Fig 6.4).

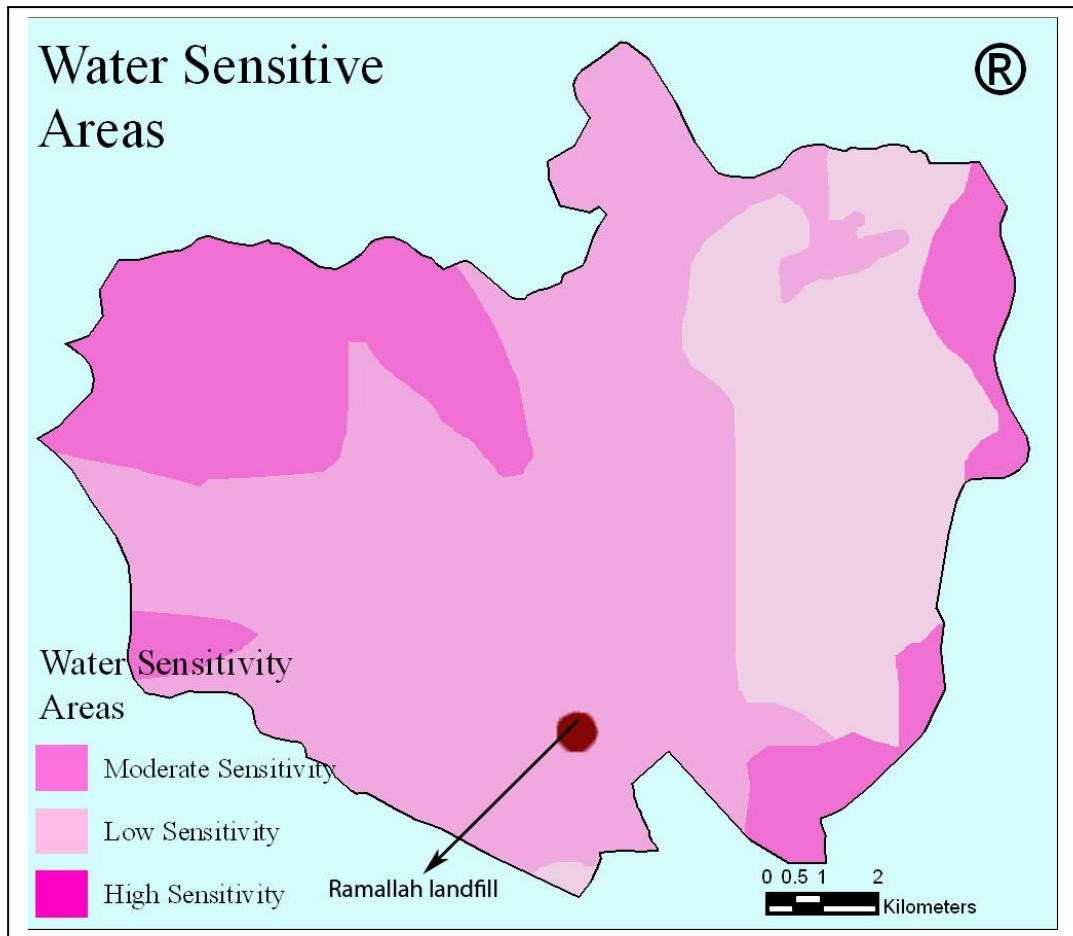


Fig 6.4: Water Sensitive Areas map for the Metropolitan proposed area for Ramallah, Al Bireh And Beitunia Cities (MoLG, 2004)

6.3.3. Soil and Land use

Ramallah city is considered to be part of the Central Highlands region; the main soil type is “terra rossa”. This is the most typical soil of the mountains and is the product of the Mediterranean climate and soil formation on hard limestone, this type of soil has a high iron content and low organic matter that make its’ color red. (Dudeen, 2000)

In addition to the “terra rossa” soils are not very fertile because of their poor water holding capacity and the high lime content. (Dudeen, Basim. 2000)

According to the master plan of Ramallah city the future use of the dumpsite is defined as trade exhibitions areas, but the current situation of the land use is landfill which is located about 200m far from a residential area (defined as A residential area) from the eastern side, which are one of the most best classification for residential areas, also in the eastern side of the dumpsite there are touristic area in which Ramallah Cultural center is located, in the western side of the dumpsite there are an industrial area about 95m far from the dumpsite, also there are in the northern side of the dumpsite classified as commercial area but are used as industrial area, and in the western side near the dumpsite classified as trade exhibitions areas which is used partially as exhibition area and industrial area. (Fig 6.5)

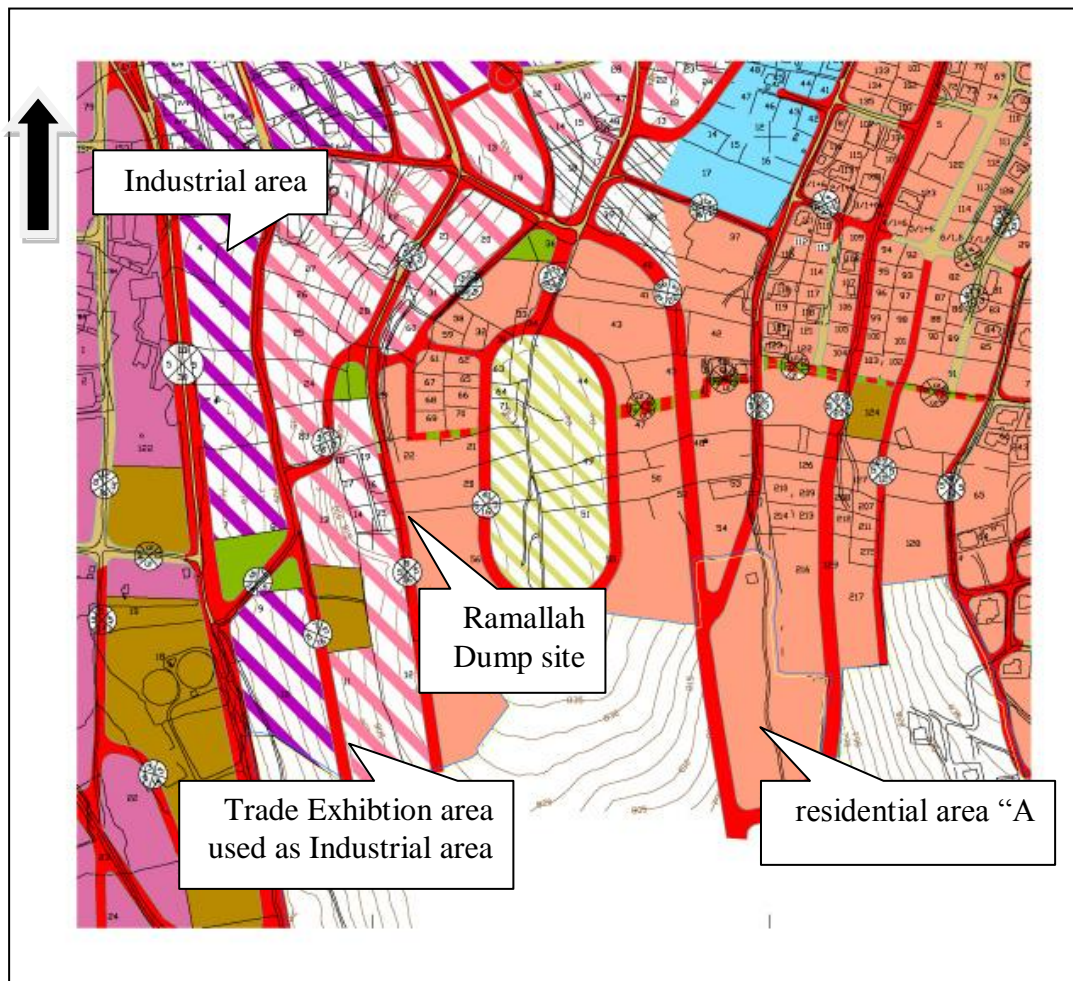


Fig 6.5: The Master Plan of the Dumpsite and its Surrounding.

6.3.4. Flora and fauna

Palestine is characterized by a rich variety of flora. An estimated 2,483 species of higher plants that belong to 700 genera and 114 families exists in the West Bank and Gaza Strip. Only 6 percent of the plants are endemic (ARIJ, 2006). As the below figure (Fig 6.6) shows that there are two rare or endangered plant species are in Ramallah city.

The flora of dumpsite location and area surrounded are mainly endemic plant such as Astragalus species see the figure below (Fig 6.7).

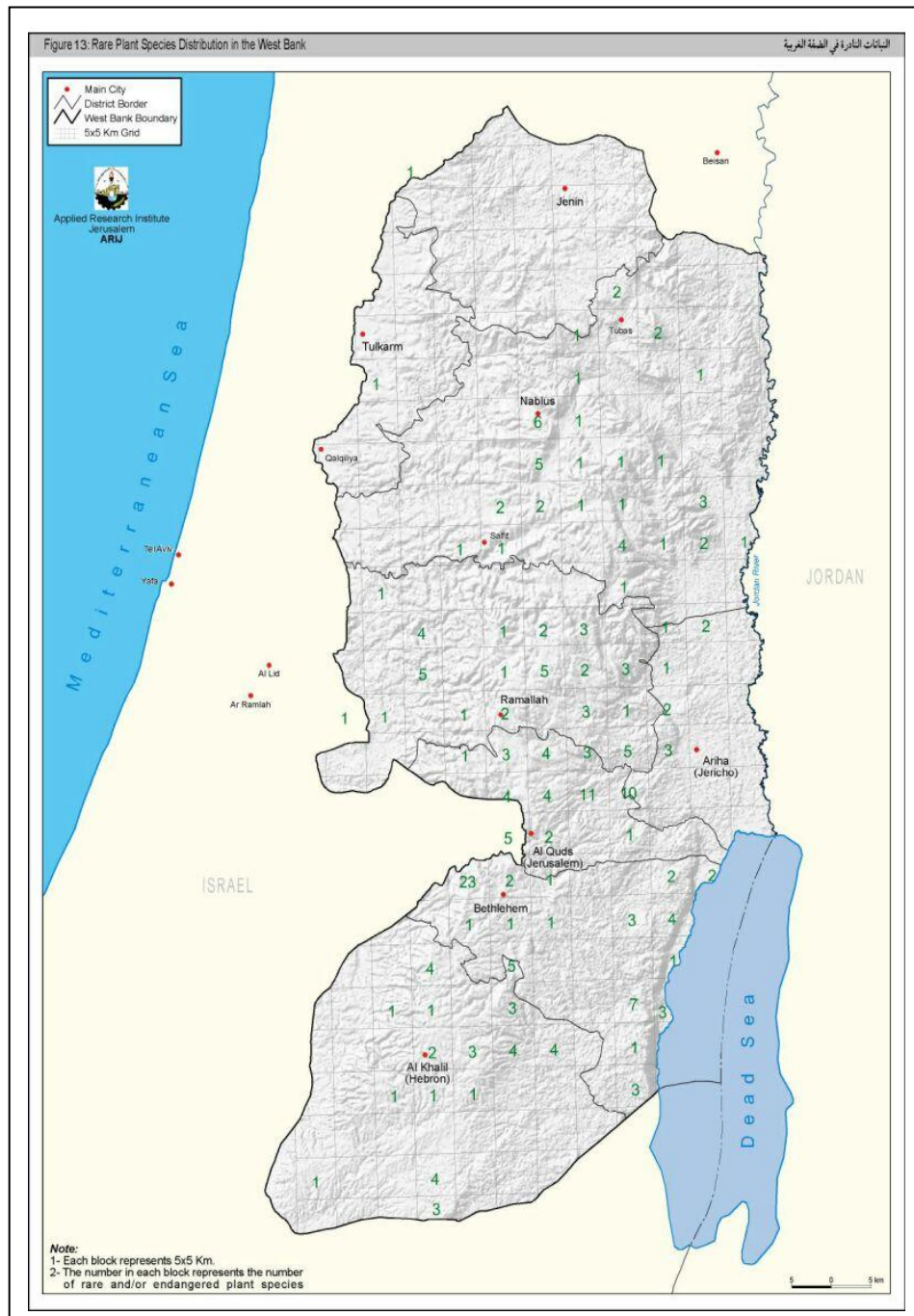


Fig 6.6: Map Of the Rare or Endangered Plant Species are in West Bank



Fig 6.7: Sample image of the existing flora in the dumpsite location

While the fauna in the existing dumpsite location need more field work and observation, but in general there are some kind of reptiles, birds and in the spring season deers could be seen around the dumpsite (according to the residents near the dumpsite).

6.4. Ramallah Landfill Impact Assessments Results and Discussion

In this section of this chapter the results of the site socio – environmental investigation (see the methodology) will be discussed, starting with presenting of the results of the investigations.

6.4.1. The results of the study

The results can be divided in to two parts:

- 1- The Environmental impact investigations.
- 2- The social impact investigations.

6.4.1.1. The Environmental Impact investigations

The Environmental investigations was done through laboratory examinations for ten samples of the runoff rain water over the dumpsite, and through a questioner and a site investigation of the of the odor, dust, and smoke, impact of the dumpsite on surrounding residential area which gives an indication of the air pollution that the dumpsite causes, also the noise pollution of the dump was investigated too. In additional to the previous other Environmental impacts where investigated through the questioner

A. Runoff Rain Water Analysis Results

The purpose of the runoff water analysis was to determine the level of pollution of water the dumpsite causes to the runoff water that will at the end pollute the soil then the ground water, Specially that Storm water harvesting has become an important water resource and the Continuous urbanization will result in more wastage of rainfall that could be used for replenishment of groundwater (Hamdan, et al., 2007).

The analysis included the chemical parameters (NH_4 , NO_3 , COD, CaCO_3 , TKN, Se, Cr, Mn, Cu, Pb), physical parameters (TSS,TDS), microbiological parameters (fecal and total coliforms).

The following tables are the results for laboratory examinations for the:

- **Chemical parameters**

Table 6.1: Concentrations of the NH_4 (Ammonium) in samples of the runoff water in Ramallah Dumpsite.

Sample #	NH_4 concentration (mg/l)	Sample #	NH_4 concentration (mg/l)
1	23.975	6	6.8775
2	12.1625	7	25.1000
3	18.4725	8	63.475
4	30.4825	9	17.7250
5	31.4900	10	11.8425

Table 6.2: Concentrations of the NO_3 (nitrate) in samples of the runoff water in Ramallah Dumpsite.

Sample #	NO_3 concentration (mg/l)	Sample #	NO_3 concentration (mg/l)
1	3.0	6	1.6
2	1.8	7	1.4
3	0.7	8	1.4
4	1.1	9	1.6
5	0.81	10	1.45

Table 6.3: Concentrations of the COD (chemical Oxygen Demands) in samples of the runoff water in Ramallah Dumpsite.

Sample #	COD concentration (mg/l)	Sample #	COD concentration (mg/l)
1	16.833	6	12.7667
2	54.6	7	42.0333
3	48.0667	8	275.3667
4	4.7	9	14.3
5	7.2333	10	8.7333

Table 6.4: Concentrations of the CaCO₃ (Calcium Carbonate) in samples of the runoff water in Ramallah Dumpsite.

Sample #	CaCO ₃ concentration (mg/l)	Sample #	CaCO ₃ concentration (mg/l)
1	156	6	120
2	164	7	280
3	540	8	440
4	200	9	90
5	60	10	80

Table 6.5: Concentrations of the TKN (Total Kjeldahl Nitrogen) in samples of the runoff water in Ramallah Dumpsite.

Sample #	CaCO ₃ concentration (mg/l)	Sample #	CaCO ₃ concentration (mg/l)
1	32.97	6	17.6
2	18.96	7	22.96
3	23.17	8	76.16
4	37.28	9	43.2
5	37.59	10	16.8

The concentration and existence of heavy metal such as (Se, Cr, Mn, Cu, Pb, Fe) was also analyzed for five different location samples of the runoff water in Ramallah Dumpsite, and the results was as the following table (6.6)

Table 6.6: Concentration of heavy metal in the rain runoff over the solid waste of Ramallah dumpsite analysis results

Sample #	Se ($\mu\text{g/l}$)	Cr ($\mu\text{g/l}$)	Mn ($\mu\text{g/l}$)	Cu ($\mu\text{g/l}$)	Pb ($\mu\text{g/l}$)	Fe ($\mu\text{g/l}$)
1	1.3405	15.86	126.4	151.3	57.43	3093
2	4.2134	125.9	95.33	1556.6	80.77	5649
3	0.7213	125.7	306.45	945.6	57.96	5090
4	0.4604	2.181	69.94	50.9	22.4	2360
5	0.8853	17.10	74.21	50.59	80.77	3363

- **The physical parameters** which are the total suspended solid and the total dissolved solid (TSS,TDS), were examined too. TSS is a water quality measurement measures the conventional pollutants (Olivia, 1980) by separating particles from a water sample using a filter, the material passed by a filter called the TDS, the following table (6.7) shows the results of TSS and TDS in ten different samples locations (See the methodology) of the runoff water in Ramallah Dumpsite.

Table 6.7: TSS and TDS in the samples of the runoff water in Ramallah
Dumpsite.

Sample #	TSS (mg/l)	TDS (mg/l)
1	29.7	209.3
2	27.5	26.3
3	41.3	28.8
4	32.2	3792
5	27	4.1
6	77	46
7	5.9	111.7
8	11.1	1057.3
9	9.7	16
10	9.9	12.1

- **Microbiological parameters** (fecal coliforms), five different location samples of the runoff water of Ramallah dumpsite were also analyzed for microbial existence (total coliform 'TC' and Fecal coliform 'FC'), to indicate the existences of bacteria, also the presence of fecal coliformsv serves as an indication of contamination by sewage, Animal wastes, and agricultural wastes (Cooper *et al.*, 1974).

The following table (6.8) shows the results of the rain Runoff water on the dumpsite of Ramallah Microbiological analysis.

Table 6.8: TC and FC in the samples of the runoff water in Ramallah Dumpsite.

Sample #	TC CFU/ml*10 ⁻⁶	FC CFU/ml*10 ⁻⁶
1	173	28
2	121	67
3	130	44
4	277	118
5	220	103

6.4.1.1.2. The Odor, Dust and smoke Emission from the dumpsite

One of the most common Environmental problems for the open dumpsites are the Odor, dust and Smoke emission that causes the air pollution, questioner and a site investigation of the of the odor, dust, and smoke, impact of Ramallah dumpsite on surrounding gave the following results (Table 6.9, 6.10).

Table 6.9: The most common problem the residential and industrial areas near the dumpsite suffer from.

The problem	Yes	Some time	No
Odor	77.4%	9.3%	13.3%
Dust	62.7%	25.3%	12.0%
Smoke	68.0%	12.0%	20.0%

Table 6.10: Source of the Dust, Odor and Smoke.

The problem	Source of the problem	The percentages %		
		As first priority	Second priority	Third priority
Odor	The dumpsite	69	40	0
	The WWTP	20	40	5.9
	Solid waste in the Containers	5.2	10	35.3
	Transportations	0	0	17.6
	Industrial activities	0	6.7	29.4
	others	5.2	3.3	11.8
Dust	The unpaved roads	15.4	10.5	0
	The dumpsite	15.4	21.1	37.5
	The industrial activities	13.5	5.3	12.5
	the construction activities	44.2	42.1	37.5
	others	9.6	10.5	0
Smoke	The burning activities in the dumpsite	90.2	9.5	12.5
	The industrial activities	3.9	28.6	25
	The burning of container solid waste	0	28.6	25
	the construction activities	0	23.8	12.5
	transprtations	5.9	9.5	25.5
	others	0	0	0

6.4.1.1.3. The Noise pollution

The results of the noise pollution investigation of Ramallah dumpsite, according to the residential areas near the dumpsite was as follows. (Table 6.11, 6.12)

Table 6.11: Noise pollution of Ramallah dumpsite.

The problem	Yes it exist	Some time	No
Noise pollution	45	28	26.7

Table 6.12: Source of the Noise pollution in the areas near the Dumpsite

Source of noise	The percentages %		
	As first priority	second priority	Third priority
The solid waste transfer activities	13.2	10.4	16.7
The traffic	34.2	26.3	16.7
The industrial activities	7.9	21.1	33.3
Construction activities	15.8	21.1	0
others	28.9	21.1	33.3

6.4.1.1.4. Other Environmental Impact Investigation

According to the Questioner the dumpsite caused the increase of crows, insects and dogs in the area (Table 6.13).

Table 6.13: Other Environmental problems, for the dumpsite.

Environment Problems	Percentage of agreed people
The increase of the crows	94.3%
The increase of insects	90.7%
The increase of wild dogs	92.0
others	26.7

6.4.1.2 The Social Impact investigations

In general the open dumpsites will affect the social activities and the health of the residences near it, Ramallah Dumpsite is So close to residential areas as it was mentioned in the previous sections, in this section the reason for living near by the dumpsite, the percentage of willingness to leave the area and live in other areas, percentage of people willingness to contribute financially to the waste management system improvement, the effect of the dumpsite on the social activity and the health will be presented, also the residents near the dumpsite opinions will be presented too.

The residence that were asked for their reasons to live near by the dumpsite where distributed in term of their ownership to the house was as the following chart (Fig 6.8).

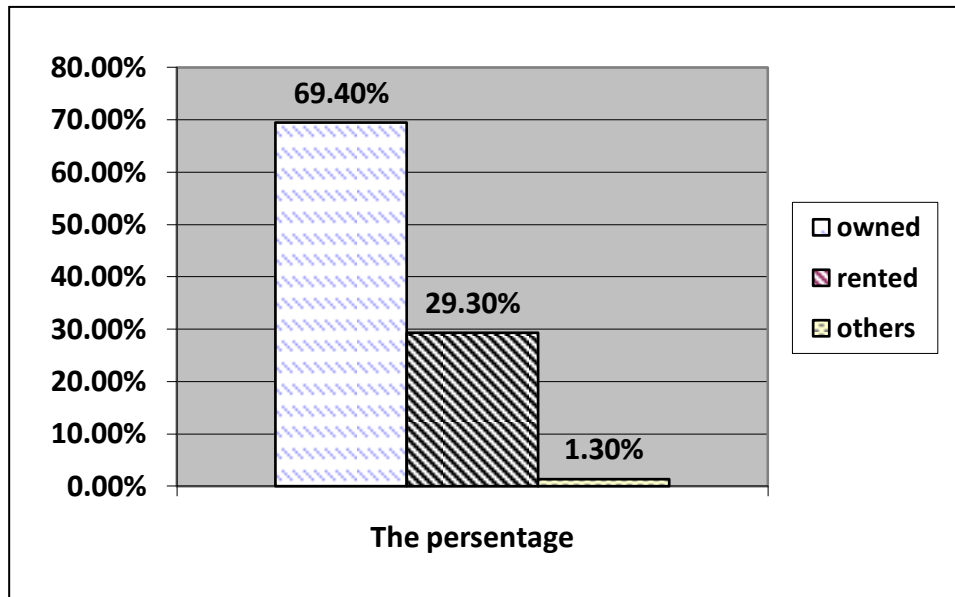


Fig 6.8: Family distribution according to their ownership of their houses

The value of the house rent in the area near by the dumpsite according to the residences were as the follow chart (Fig 6.9).

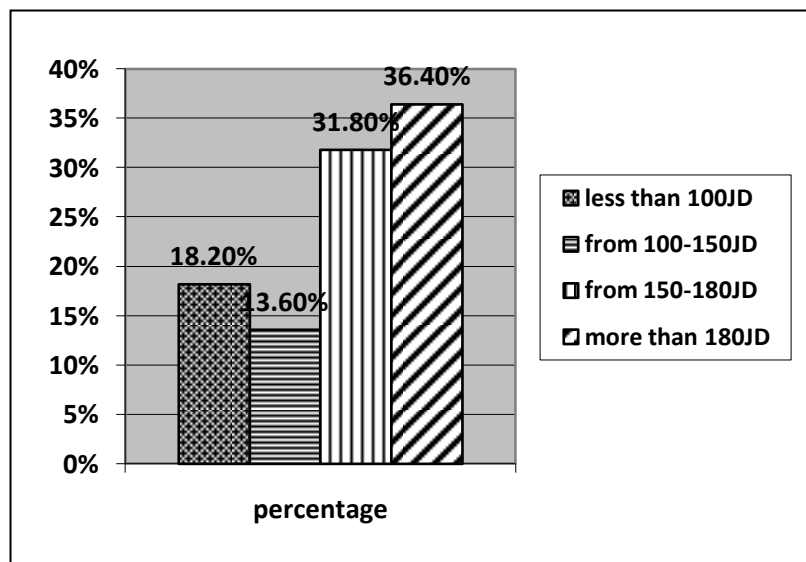


Fig 6.9: Value of house rents in JD in the areas near by the dumpsite.

- **The reason for living near by the dumpsite** according to the questioner was as following table (6.14):

Table 6.14: Reasons for living near by the dumpsite.

The reasons	Yes	No
The ownership of the house	69.3	29.3
The cheap rent values	12.0	84.0
The availability of houses	17.3	77.3
Closeness to work	30.7	65.3
others	10.7	80.0

- **The percentage of willingness to leave the area** and live in other areas because of the dumpsite closeness was as the following Chart (Fig 6.10).

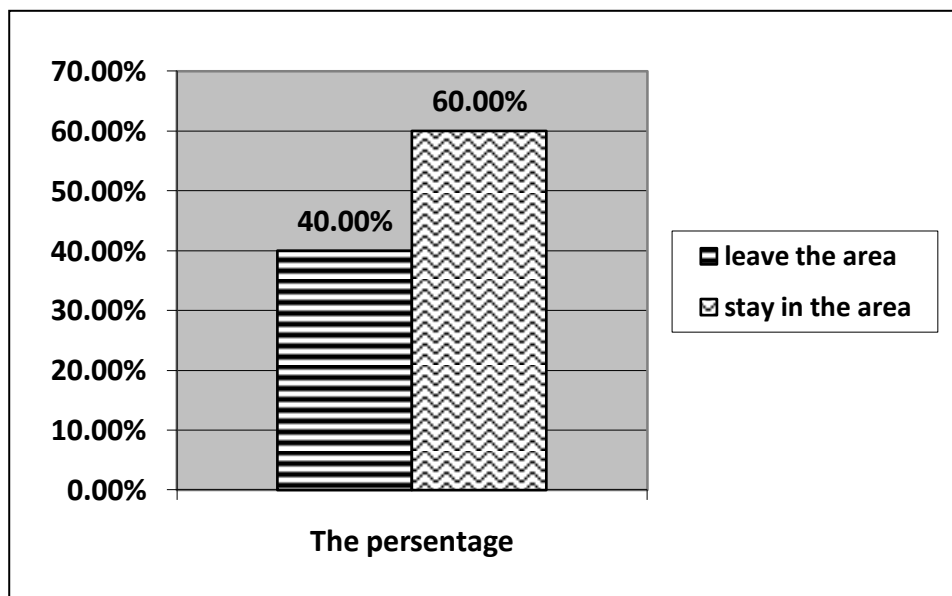


Fig 6.10: Family willingness to leave the area near Ramallah dumpsite.

As it shows in the previous chart 40% of the family that lives near by the dumpsite is willing to leave the area, and the reasons behind this are as the following table (6.15).

Table 6.15: Reasons for the willingness to leave the area near the dumpsite.

The Reasons	The percentages
Buying new house	20%
The availability of lower rented house in other area	26.7%
The availability of other house closer to work	23.3%
The health and environmental problem in the area	66.7%
The pollution conditions of the dumpsite	70%

Also 23% of the families that lives near by the dumpsite explained that one or more of the family members are suffering from breath diseases and allergies from the dust and smokes that are emerged from the dumpsite.

- **The Social Impact** of the dumpsite on the families living near by the dumpsite was also studied a, and the results was that 79.7% of the residences said that the dumpsite affected on their daily activities and was as follows:

1- 58.6% could not set in the back yards or the house gardens.

2- 95.2% closes the house windows all the day time.

3- 19.6% leave the house for few hours.

4- 12.5% the dumpsite caused few relative not to visit.

- **The people willingness to contribute financially** to the waste management system improvement was studied in the questioner specially that the solid waste management are paid as taxes fees for the municipality which is not feasible and any enhancing in the solid waste management system will need financial support to sustain.

The field survey showed that 59.7% only of the residences nearby Ramallah dumpsite are willing to pay while 40.3% are not, and that the families that are willing to pay for the increasing of the solid waste taxes agreed that the value of the taxes increase should be as the following table (6.16).

Table 6.16: the increase of the solid waste taxes

The increased money amount in Shakel /month	The percentages
Less than 10Shakel	41.8%
Between 10- 15 Shakel	16.3%
Between 16-20 Shakel	27.9%
others	14.0%

6.4.2. The Discussion

This part is the discussion of the previous results for the quantitative (Runoff Water results) and the qualitative (the Questioner results) survey

that were done to assess the impact of the Ramallah dumpsite on the socio-environmental aspects in the urban area.

6.4.2.1. The Environmental Impact

Three types of environmental issues were studied the pollution of the rain runoff water over the dumpsite in which will pollute in direct way or indirect way the soil and then the ground water, and the human health, then the air pollution from the odor, dust and smoke, and the noise pollution.

A. Storm Water Runoff

Ten runoff water samples were taken in different locations in the dumpsite to be analyzed, to assess the environmental pollution that it could carry in its trip to the ground water, specially that the dumpsite are located on terra rossa soil, which are mainly formed of hard limestone and in the previous chapter for the site selection criteria for landfill sitting the limestone rocks and soil type was described as fair to poor in term of suitability for landfill sitting.

In the following discussion the runoff water parameter analysis will be compared with the accepted drinking water parameters since it could not be classified as domestic wastewater.

- **Chemical parameters**

Chemical parameters tend to pose more of a chronic health risk through buildup of heavy metals although some components like nitrates/nitrites may have a more immediate impact (EPA, 2006).

The tested Chemical parameters are:

- 1- **Ammonium (NH_4):** The existence of ammonium in low level in water can be as a result of biological decay of plants and animal matter (Daghray, 2005), but a high concentration can indicate contamination from waste treatment facilities, and industrial effluent, also indicates the existence of fecal contamination. In our case the concentration of Ammonium was between 6.88 mg/l to 63.48 mg/l which is considered as high where the maximum allowable concentration for drinking water are 1.5mg/l according to the WHO. The sample(8) of NH_4 concentration of 63.48mg/l was taken in the middle of dumpsite at the steep slope (Fig 6.11), in which the leachate of the dumpsite could be uniform with the runoff water. The existence of such concentration will causes odor problems and results in nitrate formation (WHO, 2004).



Fig (6.11): Location of the sample number 8

2- **Nitrate (NO_3):** the nitrate is generally an indication of nitrogen pollution and the test of the existence of nitrate are used to determine the level of pollution and type of pollutants such as Sewage disposal system, animal manure and nitrogen fertilizers. (Daghray, 2005). The concentration of the nitrate in the runoff samples varied the lowest concentration was about 0.7mg/l and the highest concentration was about 3 mg/l. the maximum allowable concentration of NO_3 for drinking water are 50mg/l according to the Palestinian Standard Institution (PSI). as a result the concentration of NO_3 considered to be very low and the runoff water are not polluted with NO_3 .

- 3- **Chemical Oxygen Demand (COD):** the COD test is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in water, the maximum chemical oxygen demand allowed in wastewater before they can be returned to the environment should be between 200 and 1000 mg/L (EPA, 2006).

The COD values in the runoff water over Ramallah dumpsite varied where the lowest value was about 4.7mg/l and the highest was 275.37mg/l. Which means that the runoff water could be considered in term of COD not Harmful to the environment.

- 4- **Calcium Carbonate CaCO_3 :** the existence of CaCO_3 in water gives an indication of waster hardness, and The World Health Organization (WHO) says that "there does not appear to be any convincing evidence that water hardness causes adverse health effects in humans" (WHO, 2003).

But some studies have shown a weak inverse relationship between water hardness and cardiovascular disease in men, up to a level of 170 mg calcium carbonate per litre of water. The World Health Organization has reviewed the evidence and concluded the data were inadequate to allow for a recommendation for a level of hardness (WHO, 2003). Also National Institute of Public Health of

Czech Republic, unlike the WHO, sets some recommendations for the maximum and minimum levels of calcium (40-80 mg/L) (NIPH, 2005).

In general a high concentration of CaCO_3 could be hazardous, in the runoff water the concentration varied between 60mg/l to 540mg/l, in this case and according to National Institute of Public Health of Czech Republic, the runoff water in all cases are hard and polluted with CaCO_3

- 5- **Total Kjeldah Nitrogen (TKN):** TKN is the sum of organic nitrogen; ammonia (NH_3) and ammonium (NH_4^+) in a wastewater. The runoff water examination showed that there are various concentration of TKN in different locations in the dumpsite carried by the storm water runoff and the lowest concentration was 16.8 mg/l and the highest concentration was 76.16 mg/l for sample (8).

- 6- **Heavy metals:** high concentration of heavy metal in water could have a toxic effect under a certain concentration, Toxicity levels depend on the type of metal, it's biological role, and the type of organisms that are exposed to it. Increased urbanization and industrialization are to blame for an increased level of trace metals, especially heavy metals, in waterways to the aquifers. (EPA, 2006).

The following table (6.17) shows a comparison between the high level of concentration of heavy metal in the runoff sample and the maximum allowable concentration of heavy metal for drinking water.

As illustrated in Table (6.17), the storm water runoff over Ramallah dumpsite carries a high concentration of Cr, Mn, Cu, Pb, and Fe, while the Se Concentration are not pollutant, the presence of high concentration of trace elements in water means that the water are polluted, toxic and hazards to human health (EPA, 2006).

Table 6.17: the heavy metal concentration of the runoff water and allowed concentration

Heavy metal	Runoff samples Maximum concentration of heavy metal (mg/l)	Maximum allowable concentration of heavy metal for drinking water. (mg/l)
Se	0.0042	0.01 (PSI)
Cr	0.1259	0.05 (PSI)
Mn	0.3065	0.1 (WHO)
Cu	1.5566	1 (PSI)
Pb	0.0808	0.01 (PSI)
Fe	5.649	1 (PSI)

- **Physical parameters:** The physical parameters are TSS and TDS as mentioned in the previous sections. The results of the TSS in the runoff water samples over Ramallah dumpsite varied, the maximum value was about 77mg/l, while the minimum value was 5.9mg/l which indicates that the runoff water carries a solid waste particles from the dumpsite but this could be considered not a problem because the water trip to the ground water will face any filtration process from the soil and the rocks. Unlike the TDS that comprise the inorganic salts. (Daghrah, 2005).

Although TDS is generally considered not as a primary pollutant (e.g. it is not deemed to be associated with health effects), but it is rather used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of presence of a broad array of chemical contaminants, also high TDS levels generally indicate hard water.

The high TDS measures value gives an indication of that the water can be salty or brackish taste (Daghrah, 2005). In our case of study the TDS values varied, the lowest value was 4.1mg/l and the highest value was 1057.3mg/l. The Highest value indicates that the water are generally classified as Brackish according to the following classification of water with respect to TDS (Daghrah, 2005):

- 1- Fresh water when TDS are between 0-1000mg/l.
- 2- Brackish when TDS are between 1000-10000mg/l.

3- Saline when TDS are between 10000-100000mg/l.

4- Brine when TDS are more than 100000mg/l.

- **Microbiological parameters (TC, FC):** the test for the TC and FC of the runoff water over Ramallah dumpsite showed that there are a presence of coliform bacteria in the runoff. the values of TC and FC varied depending on the type of wastes near the sample location but in general highest values for the TC and FC was 277×10^{-6} CFU/ml and 118×10^{-6} CFU/ml respectively.

The presence of fecal coliform bacteria in aquatic environments may indicate that the water has been contaminated with the fecal material of man or other animals and birds. Large quantities of fecal coliform bacteria in water may indicate a higher risk of pathogens being present in the water which causes diseases. Also fecal coliform can be harmful to the environment, where fecal bacteria also kill bacteria essential to the proper balance of the aquatic environment, endangering the survival of species dependent on those bacteria (Cooper *et al.*, 1974).

B. Odor, Dust and Smoke Emission from the dumpsite

The air quality issues will normally be raised at the environmental assessment of any open dumpsite, but in the case of Ramallah dumpsite the problem of the dust, odor and smoke emission from the dumpsite are effecting on the residential areas near by the dumpsite specially the areas in the eastern side of

the dumpsite since the major wind direction are from the western side to eastern side and this became a major problem specially that there are no natural or any sort of barriers to prevent the emission of the dust, smoke and odor toward the residential areas (Fig 6.12).

The investigation of the most common problem the residents are suffering from in the areas surrounding the dumpsite showed that 77.4% of the families are suffering from odor problems, 62.7% are suffering from dust emission in the area, and 68.0% are suffering from the smoke emission. More investigation needed to insure the source of dust, odor and smoke specially that there an industrial area close to the dumpsite and residential area, the results showed that the main source of the odor was from the dumpsite where 69% of the family agreed on that the main source of the odor are the dumpsite, also 37.5 % agreed on that the dumpsite causes dust but as a third main source while the first main source was the construction activity, and 90.2 % agreed on that the main source of the smoke are the burning.

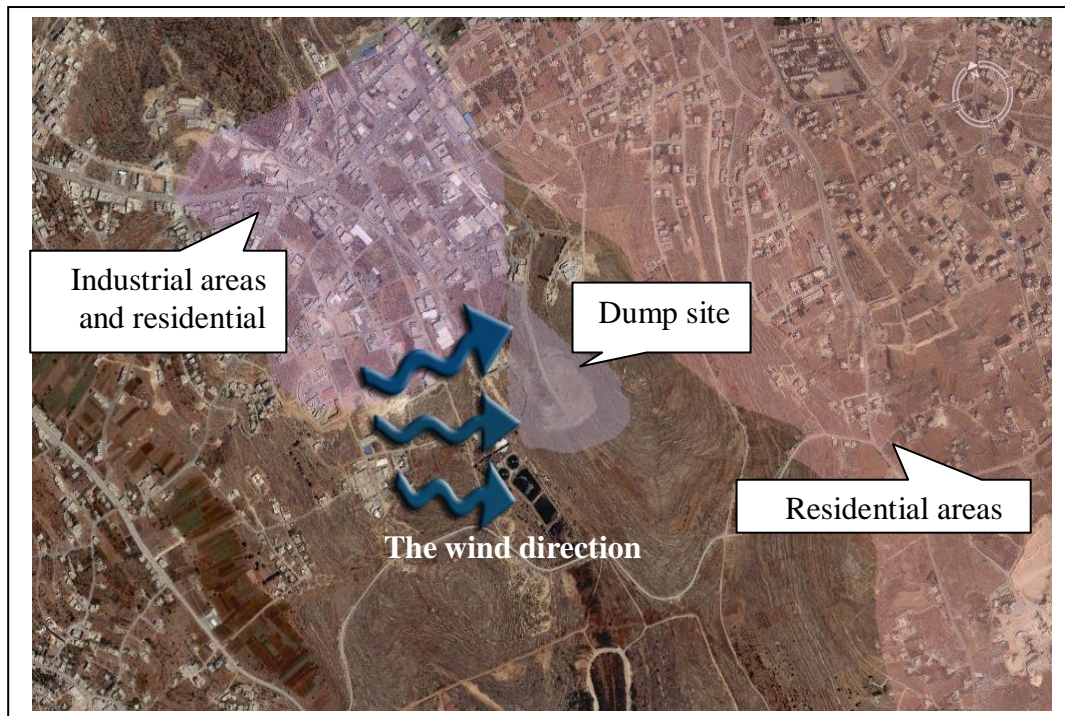


Fig 6.12: the wind direction in the dumpsite.

C. Noise Pollution

The operation of large waste management facilities can produce noise, and intermittent and sustain operating noise may be a problem if not kept in acceptable level. The solid waste collection and disposal in Ramallah city are daily continuous work that last for late time in the day time which causes noise pollution where 45% of the family survey samples said that the dumpsite are source of noise pollution and 13.2% of them agreed on that the solid waste transfer activity are noise source of the dumpsite, and 28.9 % said that the filling operation activities inside the dumpsite are the source of the noise pollution in the area. In general the dumpsite is a source of noise pollution too.

D. Other Environmental Impact Investigations:

The existence of crows, insects and dogs in the dumpsite and the area nearby forms a problem for the families living nearby Ramallah dumpsite and to the industrial area too, where 94.3% of the survey sample considered the increase of the crows in the area are annoying, also 90.7% of them also suffering from the increase of insects in the area, and 92.1% agreed that the dumpsite are the reason for the increase of wandering dogs.

In general waste disposal semi controllers open landfills as Ramallah dumpsite case, can attract insects, birds and dogs, and they may be major nuisance to people living nearby, and spread hazard and germs in the area.

6.4.2.2. The Social Impact:

Urban expansion toward the landfill of Ramallah city can be caused by many fences such as the lack of land, specially that Ramallah city are surrounded by other cities that are surrounded by Israeli settlements, which limits the urban expansion. In addition, Ramallah are considered a long with Al Bireh city the administrator and economical capital of the OPT, and a major urban area, which causes the rabid urban expansion. Most of the living nearby the dumpsite families lived in the area between the years 1994 -2004, where 54.7 % of them moved to the area after the year 2000.

The major reason for living in that area was the owning of the land, or the house, where 69.3% of the surveying sample own their living houses,

also the location of the dumpsite are not far from the city commercial center and so 30.7% of the families living nearby the dumpsite lives they because the location is close to their work either in the industrial area or the commercial center. It is worth to mention, that the rent value of the houses nearby Ramallah dumpsite are mainly more than 180JD which is not cheap according to the economic situation in OPT, and that the rent value was not the cause of the living by the dumpsite.

The results of the survey also showed that 60% of the families living nearby the dumpsite are not willing to leave the area because of the ownership of the living house, while 40% of the families that lives nearby the dumpsite are willing to leave the area, where 66.7% of them say that the reason of willingness to leave the area because of the polluted environment, and 70% agreed on that the main reason for the pollution are the dumpsite location. Furthermore 23% of the families explained that one or more family member suffers from breath diseases and allergies due to the air pollution from the dust and smoke released from the dumpsite.

The most negative social impact of Ramallah dumpsite was that the dust, smoke and odor emission of the dumpsite causes the whole day closure of the house windows and not allow the people to site in their house garden specially that disposing process stay for long day time. And so 79.7% of the people agreed on that the dumpsite affect their daily social activities not only the health.

- **People Willingness to Financial Contribution:**

The solid waste management requires a high public acceptance to participate in relevant activities, also it involves financial contributions in the form of waste management fees from citizens in order to assist the municipality in recovering the cost of running the waste management system effectively (ARIJ, 2005)

In according to the interviews perceptions, around 59.7% of people only stated that they are willing to pay higher fees or waste taxes in case of the improvement of the solid waste management. And 41.8% of them stated that the fees that they are willing to pay are not less than 10skakels/month. The acceptance of financially contribution depends on the public awareness of the importance of the solid waste management system, and the impact of less effective solid waste management system.

CHAPTER 7

CONCLUSIONS AND RECOMENDATIONS

The field survey and the examination of runoff water over Ramallah dumpsite indicated that the dumpsite is source of socio – environmental pollution, which on the long run will cause ground water pollution risk, soil pollution and public health problems.

Also the location of the dumpsite on a high natural point increases the emission of the dust, odor and smoke toward the areas surrounded, causing increase in the air pollution and decreases the environmental solutions. In Ramallah dumpsite the risk are not only on the environment quality and social activities, but also on the safety matter since the inclinations of the disposal site toward the valley sides are generally very steep, this poses the danger of mass movements of wastes, which threatens the buildings.

7.1. Conclusions

- As first, in chapter five the analysis of the master plan of Ramallah city showed that the site selection of the dumpsite was not according to environmental sound but according to the location with the existing residential area at that time and according to the land ownership as it was mentioned previously.

- The previous point indicates that the existing dumpsite was not selected according to future urban planning. The first master plan of Ramallah city was done without taking into consideration defining land as dumpsite, also in the second master plan of 1998 was done considering that the dumpsite will be closed and a new one will be opened but outside the city borders, and this encouraged the residential extension toward the existing dumpsite and the municipality of Ramallah gave permits for building around the dumpsite according to the master plan and land use division.
- The period between 1963 and 1998 Ramallah city was developing outside the master plan without any approved master plan, and so the municipality of Ramallah city could not stop the developing and expanding toward the dumpsite especially after the peace process. Also after the developing of the master plan in 1998 the expansion areas was previously built up and the land use division was made according to the existing built up areas use, which did not give many choices to the planner.
- In the Environmental analysis which was based on quantitative data obtained from the lab analysis of samples of storm water over the landfill, to determine the quantity of pollution the water carries showed that:
 - There are a high concentration in chemical parameter, such as the Ammonium (NH_4) which reached in some samples about 63.48mg/l causing an odor problems, also the storm water over the dumpsite

carries a high concentration of Cr, Mn, Cu and Pb which means that the water are polluted, toxic and hazards to human health.

- The analysis results of the physical parameter (TSS, TDS) of the storm water showed that the water are Brackish with TDS concentration about 1057.3mg/l.
- The analysis of the microbiological parameter showed that there are a presence of coliform bacteria in the runoff water, where the TC and TF reached about 277×10^{-6} CFU/ml and 118×10^{-6} CFU/ml respectively.
- The qualitative data that obtained from the analysis of the questionnaire that was distributed in the area around the landfill, showed that:
 - The dumpsite is a source of air pollution and the residents around the dumpsite are suffering from it which is formed in dust, odor and smoke, specially that the location of the dumpsite is in the eastern direction of the residential area in the way of the general wind, also
 - The filling operation activities inside the dumpsite are source of noise pollution in the area around it.
 - The dumpsite are a source of attraction to the insects, birds and dogs, and they may be major nuisance to people living nearby, and spread hazard and germs in the area

- The environmental pollution of the dumpsite are affecting on the social daily behaviors and health where about 23% of the families living nearby the dumpsite explained that one or more family member suffers from breath diseases and allergies due to the air pollution that the dumpsite causes.
- The lack of land and unpredicted rapid population increasing through the planning stages caused the mixed use of urban land use in negative way; also the random site selection of the dumpsite location increases the environmental impact of the dumpsite.
- The lack of public awareness toward environmental issues could cause the deterioration of the environment.
- As a summary, Ramallah dumpsite present location and situation are inadequate in both urban planning matter and in environmental matter. Also the method of solid waste disposal in the dumpsite are not suitable, and there are need for more advanced studies for different methods for solid waste disposal if the dumpsite will keep on running for longer time.

7.2. Recommendations:

- To hurry in the closure of the existing dumpsite and the construction of the sanitary landfill. Especially if the dumpsite is kept as it is and the methods that are used to get rid of solid waste in the dumpsite stayed the same.

- Prevent the open solid waste burning at the dumpsite, which means the enhancing of the control of the dumpsite since that the burning caused by individuals.
- Immediate actions should be taken to minimize the social-environmental negative impacts are:
 - i. Construct a barrier between the dumpsite and the area surround it. the barrier could be greenery as trees or fences, but trees are more likely since it also prevent the dust and smoke from emission.
 - ii. Construct a drainage channel around the dumpsite. To prevent the continuous pollution that could be resulted from the runoff water and leachate.
 - iii. Daily coverage to stop the emission of odor and the increase of crow, insects and dogs.
 - iv. Compact the wastes that arrive the dumpsite to minimize the size of it.
 - v. Avoid the disposal of waste in the southern western side of the dumpsite (the steep side) to avoid any slippage risk of the waste body.

- Increase the public awareness and information about the dangerous burning waste and guide them to the ways to contribute in the improvement of waste management.(the municipality, and the educational role)
- Increase the awareness of solids waste minimization system and solid waste separation.
- In urban planning terms, the sitting of solid waste disposal site should follows many investigations and Environmental Impact Assessment (EIA) processes. Also Land use planning should aim at avoiding land use conflicts and environmental and health deterioration.
- Regulations should be sated solid waste management processes.
- Recommendation for farther future studies for recent or new methods to be applied for solid waste disposal at the same location of the dump site which could be more feasible than construction of new sanitary landfill, and not harmful on Environment, public health, normal social life activities, and minimize the existing socio- environmental deterioration from the dumpsite.

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Appendix 1

صفحة الغلاف
COVER

استبيان بحثي خاص برسالة ماجستير

جميع المعلومات في هذه الاستمارة هي لأغراض أكاديمية فقط ويتم التعامل معها بسرية تامة

اختي المواطنة، اخي المواطن
تم صياغة هذا الاستبيان كأداة لبحث تقييم آثار مكب النفايات التابع لبلدية رام الله على المنطقة المحيطة
من نواحي مختلفة، هذه الدراسة هي لأغراض أكاديمية، وسيتم الاستفادة من بياناتها دون الإشارة الى
الاسماء او دلالات البيانات الفردية.
شاكرين لكم مساهمتكم لانجاح هذا البحث.

البيانات التعريفية

رقم الاستمارة:	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	Q01
اسم الحي:	1. المنطقة الصناعية 2. الماصيون 3. بيتونيا 4. عين منجد 5. أخرى/.....	Q02
اسم رب الأسرة:		Q03
موقع الاسرة من مكب النفايات التابع لبلدية رام الله؟	1. شرق 2. غرب 3. شمال 4. جنوب	Q04
مجموع أفراد الأسرة:	عدد الذكور: <input type="text"/> <input type="text"/>	Q05
	عدد الإناث: <input type="text"/> <input type="text"/>	Q06
		Q07

<input type="checkbox"/>	<p>Q 09 ما حيازة المسكن؟ 1. ملك 2. مستأجر 3. أخرى</p>
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<p>Q10 اذا كان المسكن مستأجراً، كم تبلغ قيمة الإيجار الشهري للمسكن بالدينار</p>
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<p>Q ما هي سنة الإقامة في هذا المسكن؟</p>
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<p>Q كم تبلغ مساحة مسطح المسكن بالمتر المربع؟</p>
<input type="checkbox"/>	<p>Q 13 كم يبعد مسكن الأسرة عن مكب النفايات التابع لبلدية رام الله؟ 1. اقل من 500 متر 2. من 500-1000 متر 3. اكثر من 1 كيلو متر</p>
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<p>Q 14 تسكنون في هذا المسكن وفي هذه المنطقة، بسبب : 1. ملكية الارض/المسكن 2. قيمة الايجار المنخفضة نسبياً 3. توفر مسكن شاغر اكثر من غيرها من 4. قرب المسكن من موقع العمل 5. أخرى/حدد.....</p>
<input type="checkbox"/>	<p>Q 15 هل ترغبون في الانتقال من هذا المسكن؟ 1. نعم، 2. لا</p>
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<p>Q 16 في حال الاجابة نعم على السؤال السابق، ذلك بسبب: 1. نعم، 2. لا 1. شراء/بناء مسكن 2. توفر مسكن اقل تكلفة 3. توفر مسكن أقرب على مكان العمل 4. المشاكل الصحية والبيئية في محيط 5. ظروف التلوث بسبب مكب النفايات 6. نرغب ولكن لا تتوفر الامكانيات 7. أخرى/ حدد.....</p>
<input type="checkbox"/>	<p>Q 17 كيف تصنفون إجمالي دخل أسرتم الشهرية من مختلف المصادر، بالشيكل؟ 1. اقل من 2000 شيكل 2. 2000-3000 شيكل 3. 3000-5000 شيكل 4. اكثر من 5000 شيكل</p>

Q 20		Q 19		Q 18	
ما هما أهم ثلاث (على الأكثر) مصادر للمشكلة ؟		اكثر الأوقات تعرضا لهذه المشكلة		هل تشكل أي من التالية مشكلة جدية في محيط المنزل؟	
الإجابة				<p>1. لا ، .. السطر التالي</p> <p>2. نعم، 3. احيانا ...</p> <p>السؤال التالي</p>	
1. حركة سيارات نقل	2. حركة المرور				
النفائيات لمكب البلدية	3. محاجر				
4. مصانع/ورش	5. أعمال	<input type="checkbox"/>	1. الأول	<input type="checkbox"/>	1. الضجيج
صناعية	بناء/حفريات	<input type="checkbox"/>	2. الثاني	<input type="checkbox"/>	
6. أخرى/	حدد.....	<input type="checkbox"/>	3. الثالث		
1. مكب نفائيات البلدية	2. مياه عادمة.				
3. نفائيات	4. موصلات	<input type="checkbox"/>	1. الأول	<input type="checkbox"/>	2. الروائح
الحاويات/طرق	5. أنشطة صناعية	<input type="checkbox"/>	2. الثاني	<input type="checkbox"/>	
6. أخرى/ حدد		<input type="checkbox"/>	3. الثالث		
1. طرق غير معبدة	2. مكب نفائيات البلدية				
3. مصانع/ورش	4. محاجر	<input type="checkbox"/>	1. الأول	<input type="checkbox"/>	3. الغبار
صناعية	5. أعمال بناء/حفريات	<input type="checkbox"/>	2. الثاني	<input type="checkbox"/>	
6. أخرى/ حدد		<input type="checkbox"/>			
1. حرق مكب نفائيات البلدية	4. أعمال				
2. مصانع/ورش	بناء/حفريات	<input type="checkbox"/>	1. الأول	<input type="checkbox"/>	4. الدخان
صناعية	5. موصلات	<input type="checkbox"/>	2. الثاني	<input type="checkbox"/>	
3. حرق نفائيات	أخرى/ حدد	<input type="checkbox"/>			
الحاويات/					

<input type="checkbox"/>	<p>هل سبق او ما زال يعاني أي من افراد الاسرة مشاكل صحية بسبب اي من المشاكل المذكورة في السؤال السابق: (الضجيج، الروائح، الغبار، الدخان).</p> <p>نعم 2. لاانتقل الى السؤال التالي</p>	Q 21
	<p>برجاء تحديد طبيعة المشكلة:</p> <p>.....</p> <p>.....</p> <p>.....</p>	Q 22
<input type="checkbox"/>	<p>هل تسببت مشاكل (الضجيج، الروائح، الغبار، الدخان) في التأثير على أنشطة الاسرة الاعتيادية.</p> <p>1. نعم 2. لاانتقل الى السؤال التالي</p>	Q 23
	<p>ما هي التأثيرات / المشاكل التي تسببت فيها (الضجيج، الروائح، الغبار، الدخان)</p> <p>1. نعم، 2. لا (أكثر من خيار)</p> <p>1. عدم الجلوس في حديقة المنزل</p> <p>2. الاضطرار لاغلاق النوافذ في المنزل</p> <p>3. الاضطرار الخروج لساعات من المنزل</p> <p>4. قلة زيارات الاقارب</p> <p>5. اخرى/حدد....</p>	Q 24
<input type="checkbox"/>	<p>هل تعتقدون بان مكب نفايات البلدية يشكل مشكلة "صحية، بيئية..". لكم.</p> <p>1. نعم 2. لا</p>	Q 25
	<p>ما هي اهم النتائج التي يؤدي اليها وجود المكب.</p> <p>1. نعم 2. لا</p>	Q 26
<input type="checkbox"/>	<p>1. وجود الغربان</p>	
<input type="checkbox"/>	<p>2. زيادة وجود الحشرات</p>	
<input type="checkbox"/>	<p>3. وجود الكلاب الشاردة</p>	
<input type="checkbox"/>	<p>4. اخرى/حدد....</p>	

	اذا كان وجود مكب النفايات مشكلة، برأيكم ما هو الحل: 1. نعم 2. لا	Q 27
<input type="checkbox"/>	1. اغلاق المكب نهائيا	
<input type="checkbox"/>	2. الابقاء على المكب ولكن دون عملية الحرق	
<input type="checkbox"/>	3. الابقاء على المكب مع معالجة موضوع الروائح	
<input type="checkbox"/>	4. استخدام المكب كمحطة لفصل النفايات تمهيدا لمعالجتها	
<input type="checkbox"/>	5. استخدام المكب للمنطقة المحيطة فقط "المنطقة الصناعي والجوار"	
<input type="checkbox"/>	6. اغلاق منطقة المكب بسور وعزلها	
<input type="checkbox"/>	7. اخرى/حدد...	
<input type="checkbox"/>	8. اخرى/حدد...	

انتهى الاستبيان

نشكر تعاونكم