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Sanitary and Social Effects of Dear El Balah Landfill

(Gaza Strip-Palestine)

الآثار الصحيه و الاجتماعيه لمكب نفايات دير البلح (قطاع غزه – فلسطين)

By

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Dedicated to:

My Dear Family.

My Dear Friends.

My Dear Colleagues.

A cknowledgements

First of all praise Allah for blessings and guidance in fulfilling this research.

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Acronyms and abbreviation

Biochemical Oxygen Demand	BOD
Chloride	Cl
.Chemical Oxygen Demand	COD
Electrical Conductivity	EC
German Technical Cooperation	GTZ
Ministry of Environmental affairs	MEnA
Municipal Solid Waste	MSW
Nitrate	NO3
Palestinian Meteorological Office	PMO
United Nations Environment Programme	UNEP
United States Environmental Protection Agency	US EPA
World Health Organization	WHO
Cubic meters	M^3
Environment Quality Authority	EQA
Gaza Meteorological Station	GMS
Milligrams per Liter	mg/l
Millimeter	Mm
Total Dissolved Solids	TDS
Solid Wastes Management	SWM
Solid Wastes Management Council	SWMC
volatile organic compounds	VOC

Abstract

This research aims to study sanitary and social effect of Dear El Balah Landfill which designed by a linear system for protection groundwater from pollution. Questionnaire was prepared for farmers and people living near landfill, water samples were collected from private wells surrounding landfill and analyzed (private wells).

Chemical parameters of Leachate such as ammonium NH_4, BOD, COD indicates reducing of organic wastes or presence of toxic materials that inhibit activity of microorganisms. Therefore landfill is in a final age and must be closed. On other side these of landfill parameters may indicate that using the second phase after first phase is filled. Chloride and electrical conductivity (EC) at sampling wells are high .On 2003 and 2005 the data showed the same elevation values of Cl and EC. On other side values of EC and Cl on 2008 and 2009 at all wells in middle area of Gaza Strip were also high. We are not sure that elevation is due to landfill, because no historical data to compare.

Nitrate concentration are relatively acceptable to WHO standards except for well (7) is high due to agriculture practical in Dear Al Balah area.

It has been noticed that 25% of olive farms surrounding the study area showed fungal spots on leaves, fruits and/or all the plant parts. The study indicated that milk production and poultry production were reduced by 12% as consequences of the landfill in the study area. The results showed that farmers bothering of presence of landfill especially the effect of insects and rodents on their agriculture crops. Also unpleasant smell especially that produced from fires that took place inside landfill, in addition floods of Leachate at their lands.

الملخص

يهدف البحث إلى دراسة التأثيرات الصحية والإجتماعية لمكب نفايات دير البلح ، وهو الوحيد في القطاع المصمم بطريقة النظام الخطى لجمع العصارة بحيث تحمي المياه الجوفية من التلوث

اشتملت الدراسه على جمع المعلومات ودلك من خلال تصميم إستبيان للسكان ومقابلة المزارعين بجوار منطقة المكب ، وكذلك تم عمل تحاليل للآبار المجاورة للمكب (آبار خاصة) ، وأظهرت النتائج أن عمق المياه الجوفية وخصائص التربة في المنطقة تقلل من حدوث التلوث للمياه الجوفية .

بينما نتائج تحاليل المياه (الكلورايد و الموصلية الكهربائية و مجموع ألأملاح الذائبة) كانت عالية اما تحاليل النترات كانت مناسبة للمعايير العالمية ما عدا بئرآ واحدآ وربما يرجع ذلك الى النشاط الزراعي في المنطقة. لقد تم جمع تحاليل لجميع آبار المنطقة الوسطى في قطاع غزة لسنة 2008 ،2009 وهي بعيدة نسبيآ عن المكب وأظهرت النتائج أنها أيضآ عالية .

أظهرت النتائج أيضآ انزعاج المزارعين والسكان من وجود المكب وخاصة تأثير الحشرات والقوارض على المحاصيل الزراعية والحيوانات وأيضآ الرائحة الكريهة ولاسيما الناتجة عن الحرائق المتكررة التي تحدث داخل المكب ، بالإضافة إلى فيضان العصارة على الأراضي الزراعية ،كما أظهرت نتائج الاستبيان أن 25 % من أشجار الزيتون قد أصيبت بالفطريات بينما انخفضت نسبة حليب الأغنام فى منطقة الدراسة بنسبة 12% و كذلك انخفضت نسبة انتاج لحوم الدواجن بنفس النسبة

لايمكن الجزم بأن ذلك سببه وجود المكب ، حيث لاتوجد تحاليل سابقة لمقارنتها.

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CHAPTER (1)

INTRODUCTION

1.1 Introduction:

Groundwater resources are critical to the Palestinian population and are susceptible to contamination if human activities are not carefully managed. Inadequate management of waste disposal sites is a prime potential cause of contaminated groundwater. Other negative impacts that may be associated with waste disposal sites have serious consequences for public health and for economicdevelopment. Therefore, it is highly important that all waste disposal sites are properly rehabilitated in order to protect environment, public health and economic development aspirations.

1.2 Problem identification:

Landfills are one option for municipal organic wastes disposable system. The uses of landfills have generated leachate. This leachate may contain harmful pathogens and chemical compounds which may be toxic to the human beings and the eco-system. Furthermore, the biodegradation of wastes may produce ammonia, hydrogen sulfide and particulate matter which are considered as indicators pollutants according to the US-EPA. These materials may have harmful effects to the local community. An example of this landfill is Deir El Balah.

1.3Objectives

1- Evaluate social and health impacts of the land fill on the people live

2- Evaluating the current social and sanitary effects of Deir Al-Balah Landfill.

3- Identify the effect of land fill on quality of groundwater, air, soil, and agriculture.

1.4 Methodology:

To achieve the objectives of the study, the following methodology has been applied:

1 - Literature collection of the study area.

2 - sampling collection including landfill samples, water samples and soil samples.

3 - analyzing the collected samples.

4 – Questionnaire for the target group of people living near the study area.

5 – Data presentation using statistics, graphs, maps, etc….

1.5 Thesis outlines:

The thesis consists of six chapters as follows:

Chapter (1): Introduction.

Chapter (2): Literature review.

Chapter (3): Description of the study area.

Chapter (4): Methodology.

Chapter (5): Results and discussion.

Chapter (6): Recommendation.

CHAPTER (2)

LITERATURE REVIEW

2.1 General Introduction:

The environmental problems and the general state of the environment in Gaza Strip have received much attention for the international donors and local researchers.

Part Two of the Environmental Profile (1995) describes the interactions between man and environment. It presents the problems resulting from man's intervention in the environment and from his exploitation of natural resources. One of these problems related with integrated solid wastes managements such as collection, disposal.

One of the most common waste disposal methods is landfilling. Landfill refers to an engineered facility for disposal municipal solid waste and is used to minimize public health problems and adverse environmental impact.

Few sites are naturally ideal for landfill. Those sites have suitable soil permeability for waste dumping. The infiltration of rainfall and surface water into a landfill coupled leachat.

Landfill site is the final disposal option for solid waste in Gaza Strip. The other alternatives such as incineration, composting and others were not tried or very limited due to lack of finance in Gaza Strip .There are three landfills in Gaza strip: in Rafah, Dear el Balah and Gaza city. They

are well located, but all are close to 1967 occupied Palestinian lands that cause problems for landfill operation.

Emergency Action Plan for Solid Wastes at Gaza Strip prepared by Sha'at and Jouda in (1995) assessed needs for future development of the sector as donor funded projects.

Desk Study on the Environments in the OccupiedPalestinianTerritories prepared by United Nations Environment Program (2003) identifies critical environmental issues that despite the current political difficulties in order to preserve natural resources and establish safe environment for future generation. This study discussed solid wastes and dumpsites on West Bank and Gaza Strip.

Japan International Cooperation Agency (JICA) and in cooperation with Environment Quality Authority (EQA) funded a project for assessment of solid waste dumpsites in Gaza Strip (2007)

Studies and researches on solid wastes management on Gaza Strip are still rare, but few published researches have been done such as: Solid Wastes Management in Gaza Strip: Problems and Solutions by Abu El (Qomboz 2003). An Investigation into Geotechnical Aspects of landfill " A case Study of Gaza (Mortaja, 1998), and Evaluating the Impact of Landfill Leachate on Groundwater Aquifer in Gaza Strip Using Modeling Approach (Al Slaibi, 2009). Analysis Report on the current status of solid waste management in Palestine (Ministry of Planning and International Cooperation, 1997).

2.2 Landfill sitting:

To achieve a good sitting process, several significant political and environmental obstacles have to be overcome (Wells and Crooks, 1987), those are:

1. Required capacity: It depends on the generation rate, rate of population growth, density and waste compacted at land fill and maximum place elevation.

2. Residents concerns: Including health, environmental risk, negative impact on aesthetics in the area, increased traffic, noise and dust.
3. Hydrogeology: Landfills should not be sited in wetlands, and in flood plains, also depth to water table must be deep.
4. Coast: Capital costs determine the type of facility that can be constructed and operating.
5. Geology : Topography, fault, rocks and seismic activity
6. Soil: Grain size, fracture in the clay layer, thickness, natural moisture content, degree of saturation, soil stratification and permeability of soil site.
7. Climatic conditions: Include rain fall and wind.
8. Different cover material: Such as vegetation, soil, composite cap system (sand or gravel or a thick plastic mesh) and compacted clay.

2.3 Typical Anatomy of Sanitary Landfill:

A typical schematic cross section in sanitary landfill is illustrated in Figure (2.1).

To design a sanitary landfills the following criteria requiring attention:

1. Daily cover of soil: reduces odors, keeps litter from scattering. Grasses are planted to prevents erosion, also a thick plastic are placed to protect cover soil
to enhance stability and help to prevent infiltration of rain water through the land fill cap.
2. Compacted the waste: to reduce the volume of wastes (Mortaja, 1998).
3. Both surface and subsurface hydrology must be considered
4. Leachate collection system: (Kavanagh, 1984)

The leachate collection system collects the leachate so that it can be removed from the landfill. Thick plastic layer of polyethylene is located over compacted clay forms a linear that prevent

leachate from leaving the landfill towards groundwater. Liners may be described as single or double or multiple (Hughes et al, 2008)

Single – lined landfills:

Figure (2.2 a , and b) shows cross section of a typical single lined landfill (Bagchi, 1994)
Either clay or synthetic membrane may be used : Synthetic materials allow less leakage but are difficult to protect from damage, where clay liners are not easily damaged . Sometimes drag lines are used which may damage the top portion of the liner. In such cases a combination of clay and synthetic lining may be used.

Leakage through a properly constructed clay liner is not high. , leakage through a clay liner reduces over time (probably due to a decrease in permeability of the linear.

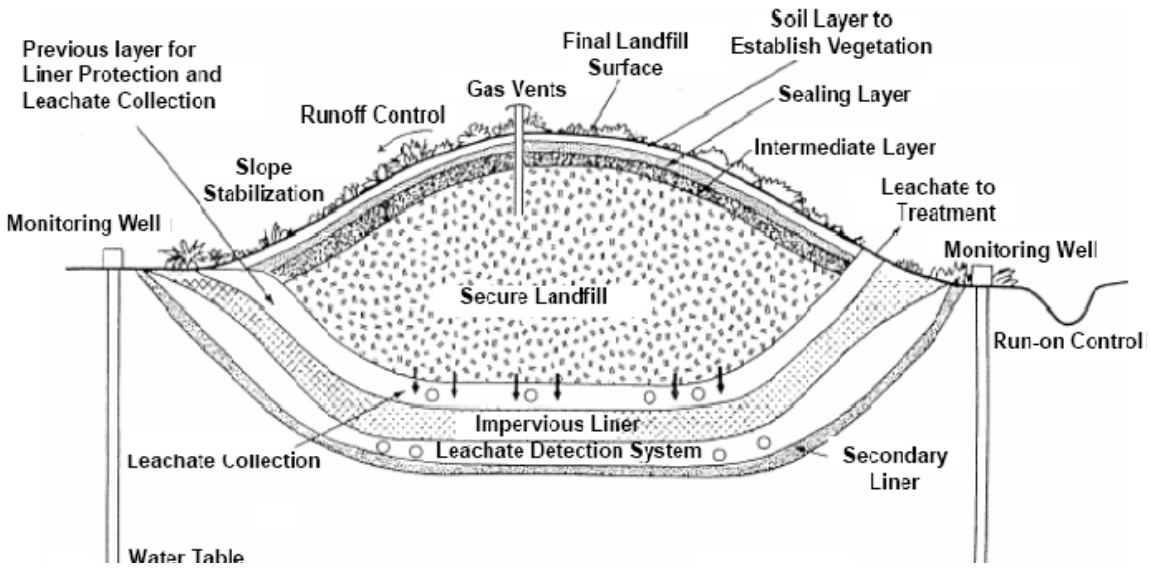

Figure 2.1: Schematic Cross Section in Sanitary Landfill (EQA, 2007)

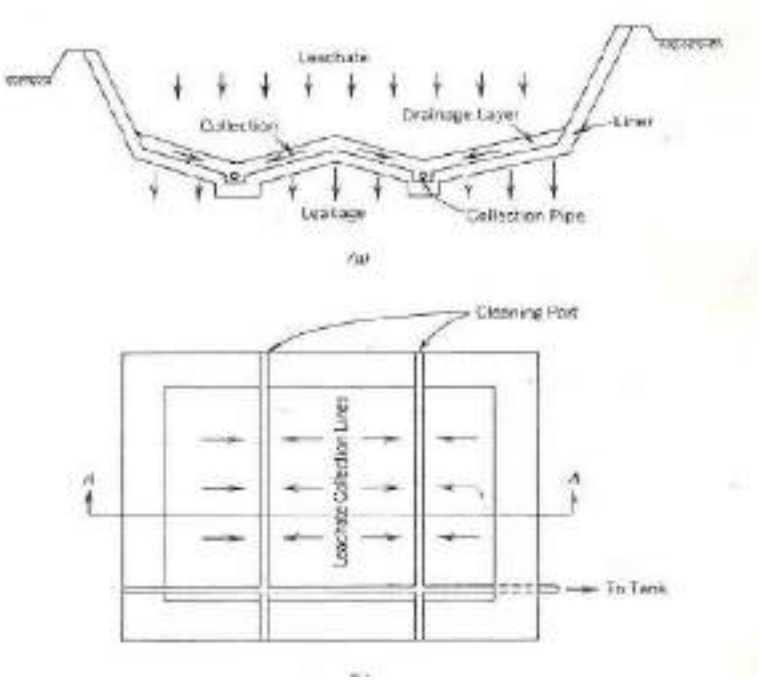

Figure (2.2): single lined landfill (Bagchi, 1994)

Double or multiple lined landfills:

This design has two or more leachate collection systems (Figure 2.3). Double liner system is used in some municipal solid wastes landfills and in all hazardous waste landfill.

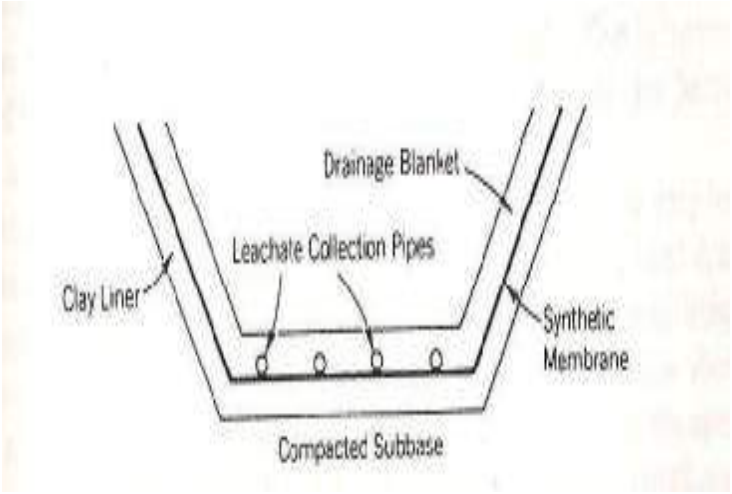

Figure (2.3): Double linear landfill (Bagchi, 1994)

2.4. Sanitary landfill compared with other methods:

According to Jabber and Nassar (2007), landfills will continue to be the most attractive disposal route for solid waste and will remain as an integral part of most solid waste management plans. Table (2.1) shows comprise sanitary landfill with other methods that used for disposing solid wastes.

Under normal condition, sanitary landfills will be the least expensive disposal method followed by (low-tech) composting. Incineration and advanced central sorting are the most expensive. Furthermore, all treatment and disposal methods have a clear economy of scale.

Table (2,1): Criteria for sanitary landfills (UNEP, 2003)

Aspect	Sanitary landfill	incineration	Composting	Advanced central sorting
Environmental impact	Acceptable (assessing proper operation)	Good to very good	acceptable to good	Good to very good (high % reject)
Resource recovery	Acceptable (landfill gas)	Good to very good	Barely acceptable (soil conditioner)	Good
Local operation and maintenance capacity	Good to very good (appropriate technology)	Not or barely acceptable	Good (assuming low-tech solution)	Acceptable
Need/market for end product	Good to very good (LFG electricity + reclaimed land)	Very good (electricity)	Good (compost as soil conditioner)	Acceptable to good (difficult market for recycled materials)
Efficiency (% of total municipal solid waste stream handed	Very good (100%)	good (70-80%)	good (60-70%)	Acceptable to good (30-40%)

2.5 Landfill leachate:

Leachate is formed when water passes through the waste in the landfill cell. The precipitation can be from rain, melted snow or the waste itself. As the liquid moves through the landfill, many organic and inorganic compounds, like heavy metals, are transported in the leachate.

The amount of leachate produced is directly linked to the amount of precipitation around the landfill. The amount of liquid waste in the landfill also affects the quantity of leachate produced. A large landfill site will produce greater amount of leachate than a smaller site (Monroe, 2001).

2.5.1 Factor affecting the composition of landfill leachate:

- The type of waste material.
- Landfill conditions include the pH, temperature, moisture, age and climate.
- Characteristics of precipitation entering the landfill.
- Final cover design. (Crawford and Smith, 1985).

2.5.2 Collection of leachate:

Leachate is collected from the bottom of modern landfills by a series of collection pipes installed into the base of the landfill. The leachate percolates through the waste and into the pipes where it collects. The leachate can then be recycled or pumped out of the landfill and placed in storage areas or directly into the leachate treatment plant.

2.5.3 Extraction of leachate:

Two different methods are commonly used to extract the leachate (Eden, 1994)). These are:

Borehole pumps: These pump extracted leachate only to the point of collection. Borehole pumps only run when leachate are present so there is a low energy demand. Individual sensors are required in wells to switch the pumps on and off.

Educators: These function no matter whether liquid is present or not. Educators are part of a circuit collection system. They are simple and reliable but use more energy. However, this is still within acceptable limits as it is not necessary to run the educator for 24 hours a day. This makes this option the favored choice for leachate extraction.

2.5.4 Treatment of leachate:

Studies have shown that discharge of raw municipal leachate into streams impacts aquatic life and causes degradation of water quality (Bagchi, 1994)). The following traditional teqnique used for waste water systems are also used for treating landfill leachate: biological treatment (aerobic and anaerobic biological stabilization) and physical / chemical treatment (precipitation, adsorption, coagulation, chemical oxidation, and reverse osmosis.

2.6 Factors determine contamination by leachate:

Here are several factors determined the contamination by leach ate **(**O'Leary and Walsh, 1997). It is believed that the most factorsare follows:

1. Water table: If the water table is low (far below the ground surface), water will become partially filtered as it percolated downward through the soil so contamination is less. If the water table is high (close to the ground surface), contaminants can enter the groundwater directly without filtration by soil.

2. Concentration of leachate: The higher the concentration of contaminants in the leachate the higher the likelihood of groundwater pollution.

3. Soil type and structure: Permeability of the ground below the landfill affects the rate of leachate escape. Sand has large pore size and so it allows greater groundwater flow. Clay is tightly packed and so prevents the movement of groundwater and it is also more effective in adsorbing out contaminants.

4. Leachate characteristics: Depending on characteristics of the landfill and the waste it contains, the leachate may be relatively harmless or extremely toxic. Generally leachate has a high biochemical oxygen demand (BOD) and high concentrations of organic solvents, and heavy metals. Many other chemicals may be present, including pesticides, solvents, and heavy metals.

2.7 Landfill gas:

Gas generation from waste should be studies carefully. The quality of gas depends mainly on the waste type(Crawfordand Smith,1985). As with leachate, the quantity and quality of gas vary with time.. Most landfill gas is produced by bacterial decomposition, which occurs when organic waste is broken down by bacteria. Bacteria decompose landfill waste in four phases. Landfills often accept waste over a 20 to 30 year period, so waste in landfill may be undergoing several phases of decomposition at once (Jabber and Nasser, 2007). The phases of landfill gas generation are shown in Figure (2.4), while Table (2.2) outlines a typical landfill gas composition.

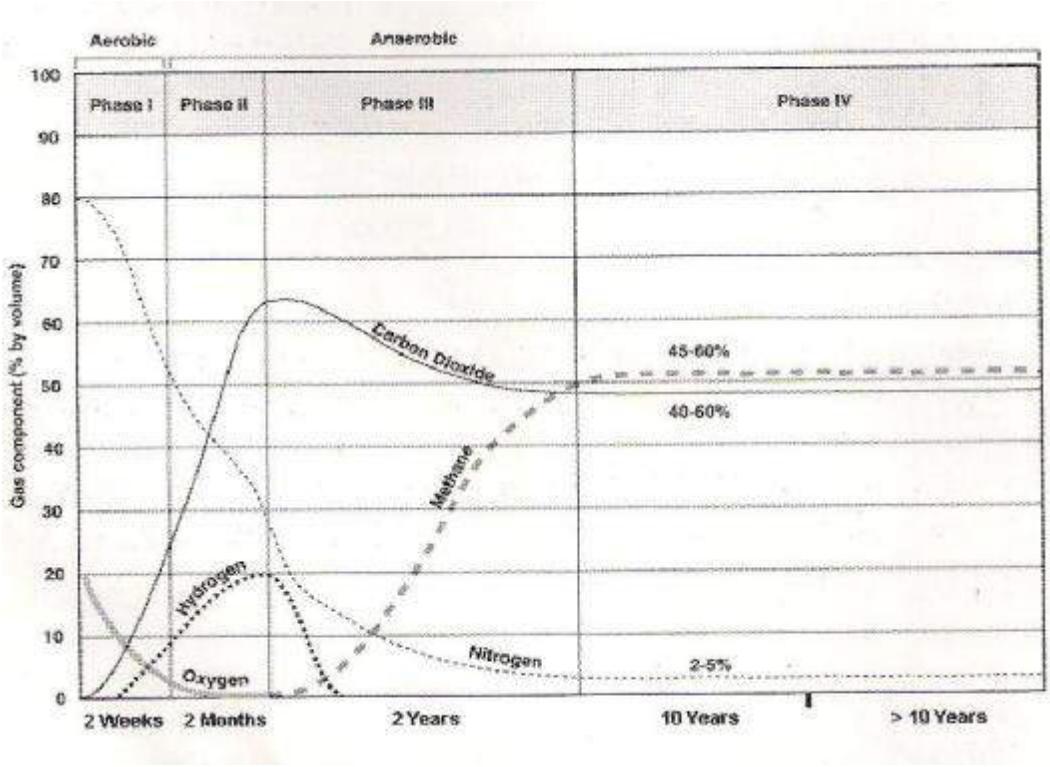

Figure (2.4) Gas generated in typical sanitary landfill (Jaber &Nassar, 2007)

Table (2.2) Typical landfill Gas composition

Gas	% concentration range	
	Lower limit	Upper limit
Methane	40	70
Carbon dioxide	30	60
Carbon monoxide	0	3
Oxygen	0	5
Nitrogen	0	3
Hydrogen	0	5
Hydrogen sulfide	0	2
Trace Gases	0	1

2.8 Impacts of Gas Generatedin Landfills:

2.8.1 Health Impacts:

In some cases, these gases found their way in to basements of houses and building and deaths and injuries have asphyxiation, poisoning of from detonation of explosions of air methane mixtures. Possible pathways of landfill gas are illustrated in Figure (2, 5).

2.8.2 Global Warming:

Methane has received recent attention as a contributor to global warming because on a molecular basis, it has a relative effect 20 to 25 times greater than carbon dioxide.

2.8.3 Fires and Explosions:

Methane has the tendency to migrate away from the landfill boundaries by diffusion and advection. The migrating gas finds its way into buildings and underground facilities erected on or near to a landfill site where it forms gas pockets and creates potential explosive hazards. Numerous incidents of fires and explosions due to lateral gas migration away from landfills have been reported in the literature.

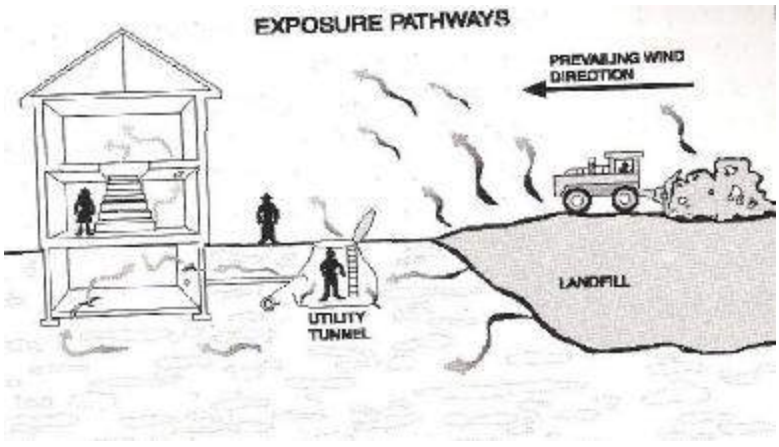

Figure (2.5) exposure pathway to landfill gas (EQA, 2007)

Onsite fires are common and many occur in the subsurface due to air entrainment into the landfill and the formation of a mixture of methane and oxygen that can sustain a fire.

2.8.4 Unpleasant Odors:

The odorous nature of landfill gas may vary widely from relatively sweet to bitter and acid depending on the concentration of the odorous constituents within the gas. These concentrations will vary with waste composition and age. The extent to which odors spread away from the landfill boundaries depends primarily on weather conditions; wind, temperature, pressure and humidity.

2.8.5 Vegetation Damage:

Vegetation damage at or nearby to such sites is well documented in the literature.

The damage occurs primarily due to oxygen deficiency in the root zone resulting from a direct displacement of oxygen by landfill gas. Roots are exposed to high concentrations of methane and carbon dioxide; gas asphyxia. Methane oxidation near the surface by methane consuming bacteria is factor that contributes to oxygen deficiency.

Heat release during methane oxidation increases the soil temperature creating a potential for plant asphyxia. Other commonly reported factors that may affect growth of plants at landfill sites include the presence of trace toxic compounds in landfill gas and cover soil characteristics such as thickness, composition, compaction and moisture.

2.8.6 Air pollution:

Emissions of volatile organic compounds (VOCs) from landfills can be attributed to regular household, co-disposal of light industrial wastes. The emission of VOCs is believed to have the potential to increase cancer risks in local communities and contribute to ambient ozone formation (Jouda, 1984).

CHAPTER (3)

STUDY AREA DESCRIPTION

3.1 Location of the study area:

The study site located in Deir Al-Balah zone which situated in the middle area of Gaza Strip (Figure3, 1) Furthermore, Gaza Strip constitutes the south west part of Palestinian coastal plain of Mediterranean sea the strip is confines between the Mediterranean sea in the west, Sinai of Egypt in the south, Negev desert in the east and green line in the north .The Gaza strip area is about 365 km ² (MOPIC, 1994). The length is about 41 km on the western Mediterranean cost and the width varying from 7 to 12 km. Gaza Strip is located in an arid to semi-arid region. It is located on a latitude of 31º 16″ to 31º 45″ North and 34º 20 to 34º 25 East. The study area in Dear El Balah city and the landfill is located closer to green line boundaries (Figure3.1).

3.2 Climate of the study area:

The climate in Gaza strip has characteristically semi-arid climate , and is located in a transitional zone between a temperature Mediterranean climate to the west and north , and arid Negev and Sinai deserts to the east and south .There are two well-defined season : the wet season starting in October and extend through April , and the dry season from April to September .

The average daily temperature in the Gaza strip range from 26 ^{o}C in the summer to 12 ^{o}C in winter with the average daily maximum temperature range from 29 ^{o}C to 17 ^{o}C , and the minimum temperature range from 21 ^{o}C to 9 ^{o}C in the summer and winter respectively (GMS, 2009)

Mean daily evaporation ranges between (21-6.3) mm per day in July and December respectively. The high potential evaporation is induced by high solar radiation incident over the Gaza Strip at 190 kg – calories / cm2 / year (US. National Academy of Science, 1999). The actual amount of evaporated water greatly depends on the nature of the soil , the vegetation and the availability ground water table. Rainfall occurs in the winter period which is between October to March. The period for June to September is dry with no rainfall. The average rainfall varies between 200-400 mm(PMO, 2008).Table (3.1) and figure (3.2) represents the rainfall amounts in the study area.

Figure (3.1): The study area location
(UNEP, 2003)

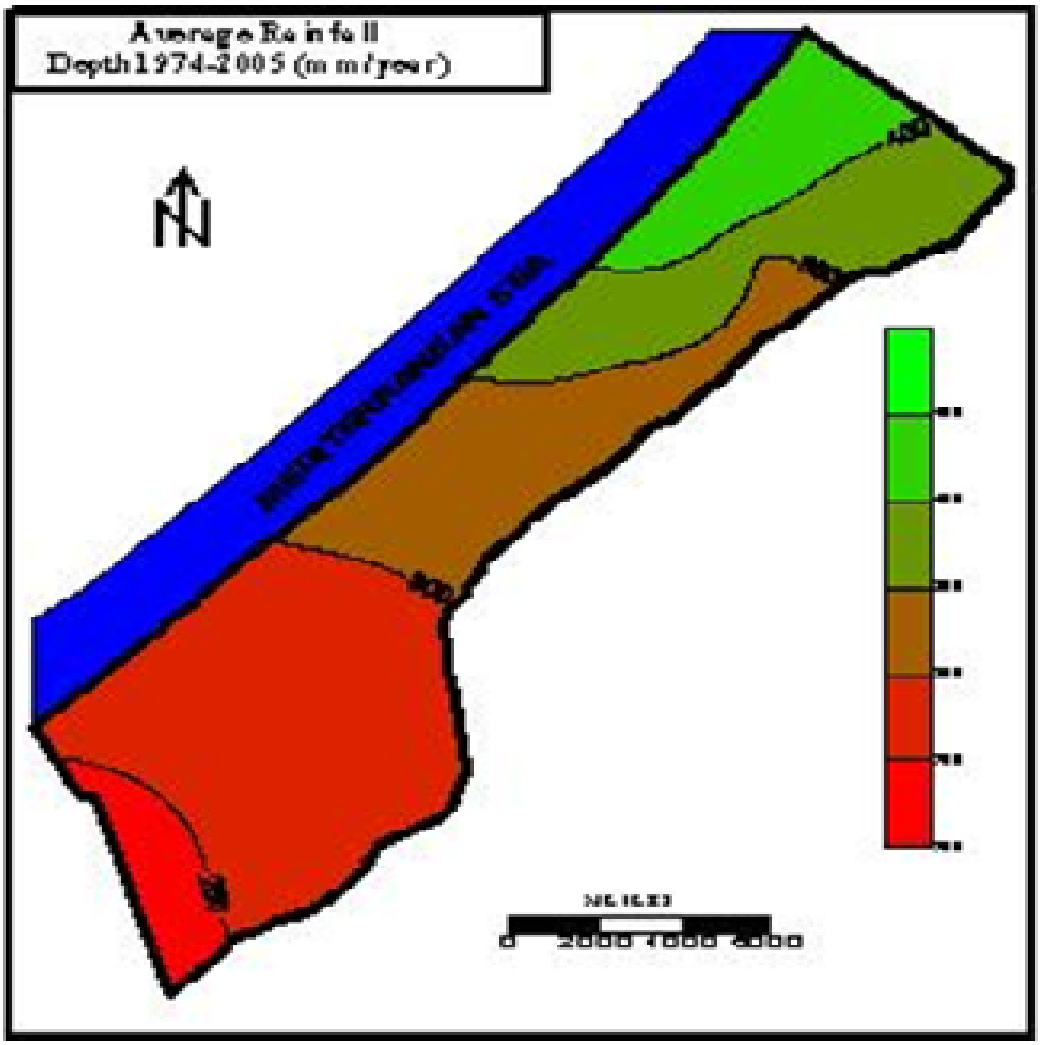

Figure (3,2): Average rainfall depth (1974-2005).

Table (3.1): Average rainfall (mm) and quantities of rains (Mm3) for Gaza Strip

.Station Name	Rain 02/03 (mm)	Rain 03/04 (mm)	Rain 04/05 (mm)	Quantities in 02/03 (Mm3)	Quantities in 03/04 (Mm3)	Quantities in 04/05 (Mm3)	Avg. Annual Rain (mm)	Avg. annual Quantities (Mm3)
Beit-Hanoun	801.5	349.9	358.7	23.2	10.1	10.4	393	11.4
Beit-Lahia	724	383.0	320.6	10.3	5.5	4.6	414	5.9
Shati	627	334.9	296.6	11.1	5.9	5.3	376	6.7
Gaza-City	599	374.4	316	7.8	4.9	4.1	439	5.7
Tuffah	653.5	421.3	345	15.2	9.8	8.0	343	8.0
Moghraqa	790.7	493.6	323.5	27.7	17.3	11.3	355	12.4
Nusseirat	446.2	318.0	405	13.2	9.4	11.9	336	9.9
Deir El Balah	372.6	312.9	345.5	14.3	12.0	13.3	310	11.9
Khanyunis	298	203.7	369.5	24.9	17.0	30.9	283	23.6
Khuzaa	261.2	184.5	365.7	11.1	7.8	15.5	267.5	11.4
Rafah	220.8	172.0	358.2	8.6	6.7	13.9	228	8.8
Total				167.4	106.4	129.2	317	115.8

3.3. Geology of the study area:

Geology of Gaza strip is a part of geology of Palestine. Several authors have described geology of Palestine. Abed and Wishahi (1999) summarized the geology of Palestine in his titled book (Geology of Palestine). Gaza Strip is a south west part of the coastal aquifer of Palestine. Summary of Gaza Strip geology is given below.

The coastal aquifer of the Gaza Strip consists of the Pleistocene age Kurkar and recent (Holocene age) sand dunes. The Kurkar Group consists of marine and Aeolian calcareous sandstone ("Kurkar"), reddish silty sandstone, silts, clays, unconsolidated sands, and conglomerates.

Regionally, the Kurkar Group is distributed in a belt parallel to the coastline, from north of Haifa to the Sinai in the south. Near the Gaza Strip, the belt extends about 15-20 km inland, where it un-conformably overlies Eocene age chalks and limestone, or the Miocene-Pliocene age Saqiye Group, a 400-1000 m thick sequence of marls, marine shale, and claystones. The transition from the Kurkar Group to the Saqiye Group is sometimes obscured by the presence of a thin, basal conglomerate. Figure (3.3) presents typical hydrogeological cross-section of the coastal aquifer (PWA, 2000).

The Kurkar Group consists of a complex sequence of coastal, near-shore and marine sediments. Marine calcareous sandstone forms the base of each transgressive sequence, and marine clays form the end of regressions.

Cycles of deposition may be incomplete, depending on location; hence sedimentary sequences may be truncated and rest unconformable on one another. The calcareous sandstone are interbedded with irregular layers and pockets of uncemented sand, thin red-brown sands and silty sands, and especially at greater depth, marine silts and clays.

Within the Gaza Strip, the thickness of the Kurkar Group increases from east to west, and ranges from about 70 m near the Gaza border to approximately 200 m near the coast. Israeli literature suggests that the Kurkar Group becomes more clastic towards the east. The distinct 'layering' of sedimentary cycles becomes less obvious, and the presence of red silty-clayey sandstone becomes more dominant. In addition, alluvial clays and soils become more evident along the courses of major drainage features such as Wadi Gaza.

Clay formations or units within the Gaza Strip, and the coastal aquifer in general, are of two types: marine and fluvial. Marine clays are present along the coast, at various depths within the formation. They pinch out about 5 km from present coastline, and based on existing data, appear to become more important towards the base of the Kurkar Group.

Three major clay layers were defined that can be correlated between boreholes from north to south in Gaza. They extend inland about 2 to 5 km, depending on location and depth. Limnic and fluvial clays near ground surface are present along Wadi Gaza, in the middle area along the Gaza border, and in the Beit Hanoun area. Where cemented sandstone are present near the surface, they form distinctive topographic ridges with vertical relief up to 60 m. These "Kurkar" ridges, from which the coastal aquifer has obtained its name, typically extend in a NE-SW direction.

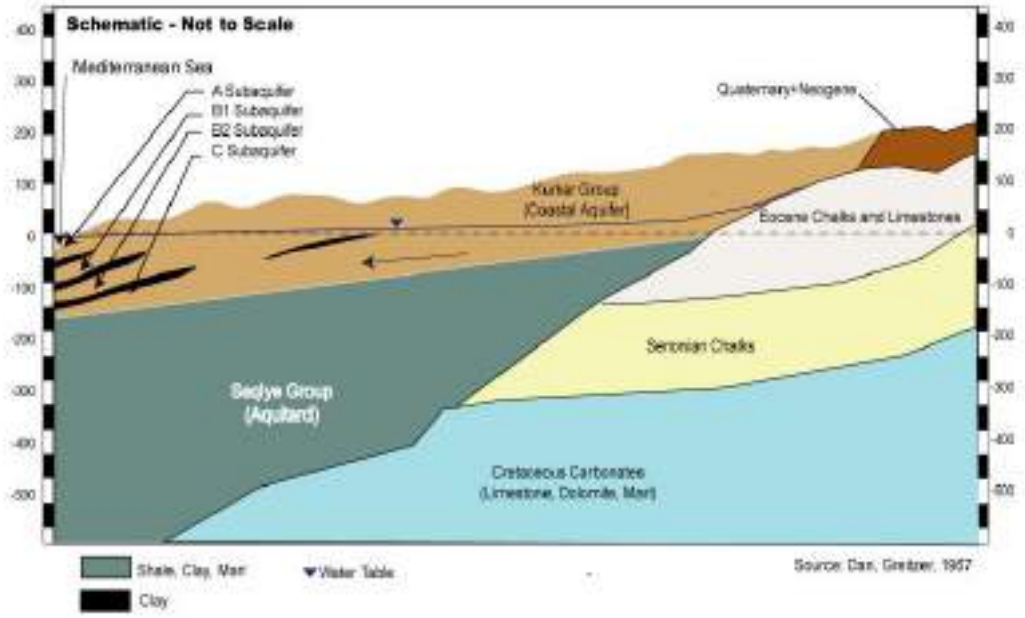

Figure (3.3): Typical hydrogeological cross section of Gaza Strip (PWA, 2000)

The dune sands (and loess soils) which overlie the Kurkar Formation consist of mostly fine, well-sorted sands of Aeolian origin. They are predominantly present in the north and along the Mawasi area in the southwest. Thickness of these sands and loess range from a few meters to 15 m. In addition, alluvial sediments, consisting of sand, loess and gravel beds, are present along Wadi courses. In Wadi Gaza, the reported thickness of alluvial sediments is between 30 to 40 m.

3.4 Hydrogeology:

Gaza's water resources are essentially limited to that part of the coastal aquifer that underlies its 365 km2 area. The coastal aquifer is the only aquifer in the Gaza Strip and is composed of Pleistocene marine sand and sandstone, intercalated with clayey layers. The maximum thickness of the different bearing horizons occurs in the northwest along the coast (150 m) and decreasing gradually toward the east and southeast along the eastern border of Gaza Strip to less that10 m. The base of coastal aquifer system is formed of impervious clay shade rocks of Neogene age

(Saqiyah formation. Depth to water level of the coastal aquifer varies between few meters in the low land area along the shoreline and about 70m along the eastern border.

The coastal aquifer holds approximately 5x109 m3 of groundwater of different quality. However, only 1.4 x109 m3 of this is “freshwater”, with chloride content of less than 500mg/ (Al Jamal & Al Yaqubi, 2002) This fresh groundwater typically occurs in the form of lenses that float on the top of the brackish and/or saline ground water. That means that approximately 70% of the aquifer is brackish or saline water and only 30% is fresh water.

The major source of renewable groundwater to the aquifer is rainfall. Rainfall is sporadic across Gaza and generally varies from 400mm/yr in the North to about 200 mm/yr in the south (figure 3.4 and table 3.1). The total rainfall recharge to the aquifer is estimated to be approximately 45Mm3/yr (PMO, 2008). The remaining rainwater evaporates or dissipates as run-off during the short periods of heavy rainstorms.

The layered stratigraphy of the Kurkar Group within the Gaza Strip subdivides the coastal aquifer into 4 separate sub aquifers near the coast. Further east, the marine clays pinch out and the coastal aquifer can be regarded as one hydrogeological unit. The upper sub aquifer “A” is unconfined, whereas sub aquifers “B1, B2, and C” become increasingly confined towards the sea.

The thickness of the entire coastal aquifer sequence at the coastline is on average about 120 m. At the eastern Gaza border, the saturated thickness is about 60 m in the north, and only 5-10 m in the south near Rafah. Localized perched conditions may exist in the unsaturated zone throughout the Gaza Strip, due to the presence of shallow fluvial and limnic clays.

The transmissivity values of the upper 20-30m tested saturated part interval of the aquifer are ranging between 700 and 5,000 m2/d. The corresponding values of hydraulic conductivity (K)

are within a relatively narrow range, 20-80 m/d, with a few outliers greater than 100 m/d. Based on lithology and information from studies carried out in Israel, the specific yield of the unconfined coastal aquifer is in the 0.15-0.3 range.

3.5 Soil types:

The Gaza Strip is 365 km2 and has several major soil types (Figure 3.4).Shomaret. al (2005) described in details these soil types. Arenosolic, Calcaric, Rhegosolic, and CalcaricFluvisolic soils are examples of these soils. Arenosolic (sandy) soils of dune accumulations are Regosols without a marked profile. The soils are moderately calcareous (5–8% CaCO3), with low organic matter.

CalcaricArenosols (loessy sandy soils) can be found some 5 km inland in the central and southern part of the Strip, in a zone along Khan Yunes toward Rafah, parallel to the coast. This belt forms a transitional zone between the Arenosolic soils and the Calcaric (loess) soils. Typical Calcaric soils are found in the area between the city of Gaza and the Wadi Gaza and contain 8–12% CaCO3. ArenosolicCalcaric (sandy loess) soils are transitional soils, characterized by a lighter texture. These soils can be found in the depression between the Calcareous (Kurkar) ridges of Deir El Balah. Apparently, windblown sands have been mixed with Calcareous deposits. Deposition of these two types of windblown materials originating from different sources has occurred over time and more or less simultaneously. These soils have a rather uniform texture. Another transitional form is the Arenosols over Calcaric soils. These are loess or loessial soils (sandy clay loam) that have been covered by a layer (0.20–0.50 m) of dune sand. These soils can be found east of Rafah and Khan Yunis.

Fluvisols (alluvial) and Vertisols (grumosolic), which are dominated by loamy clay textures, are found on the slopes of the northern depressions between Beit Hanoun and Wadi Gaza. Borings

east of El Montar ridge have revealed that alluvial deposits of about 25m in thickness occur. At some depth, calcareous concentrations are present. The CaCO3 content can be approximately 15–20%. Some of the soils have been strongly eroded, and the reddish-brown subsoil may be exposed on the tops of ridges and along slopes. The alluvial sediments are underlain by a calcareous layer.

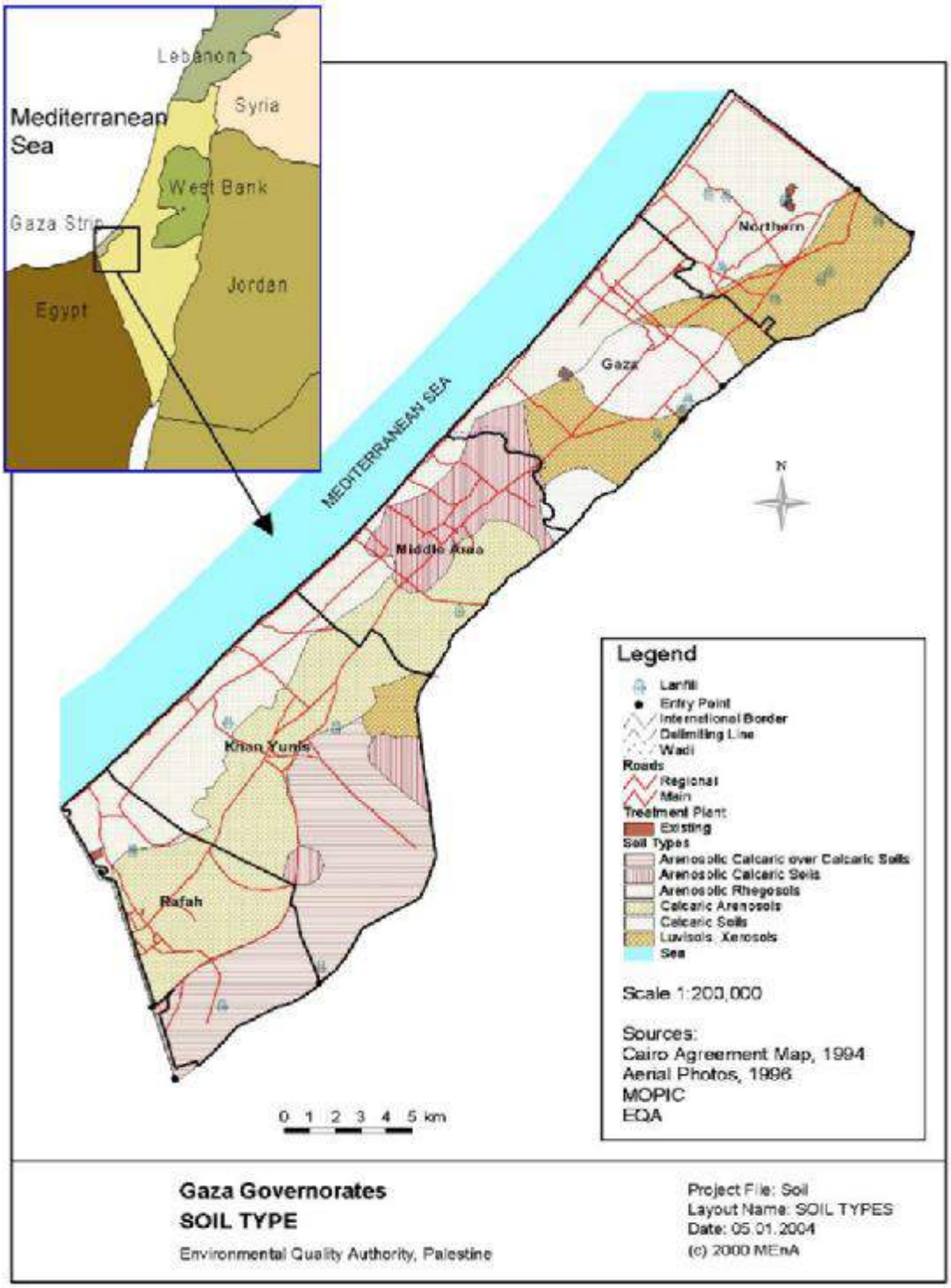

Figure (3.4): Main soil types with associated land forms and dominant land use.

(EQA, 2004)

3.6 Solid waste dumpsites in Gaza governorates

3.6.1 Solid waste management in the Northern governorates :

The four municipalities (Jabalia, Beitlahia, BeitHanon, and Om Al Naser) are working together and sharing most of the activities of the solid waste management council in the north (SWMCN). Beit Hanon dump site is the only open dump site located on the north border which is located on the top of a good water aquifer. This site was closed officially in the year 2002. So after the formation of the north council all the waste is transferred to the official dump site in Gaza city. Different open random dump sites are available in the northern governorate which is as follow:

1. A Nada Random Dump site
2. Al Manshia Dump site.
3. Om Al Nser Dump site.
4. Wade BeitHanon Dump site.
5. BeitHanon Dump site.
6. Jabalia Dump site

3.6.2 Solid waste management in Gaza City:

Johor Al dick official Dump site:

The area of this dump site is approximately 140 dunums. Its located in the eastern part of Gaza City (Figure 3.5). The ground water depth is estimated to be more than 100 m. Part of this dump site is designed and constructed to the disposal of hazardous waste. This site serving the whole municipalities of the Gaza governorate as well as the northern governorate in addition to UNWRA.

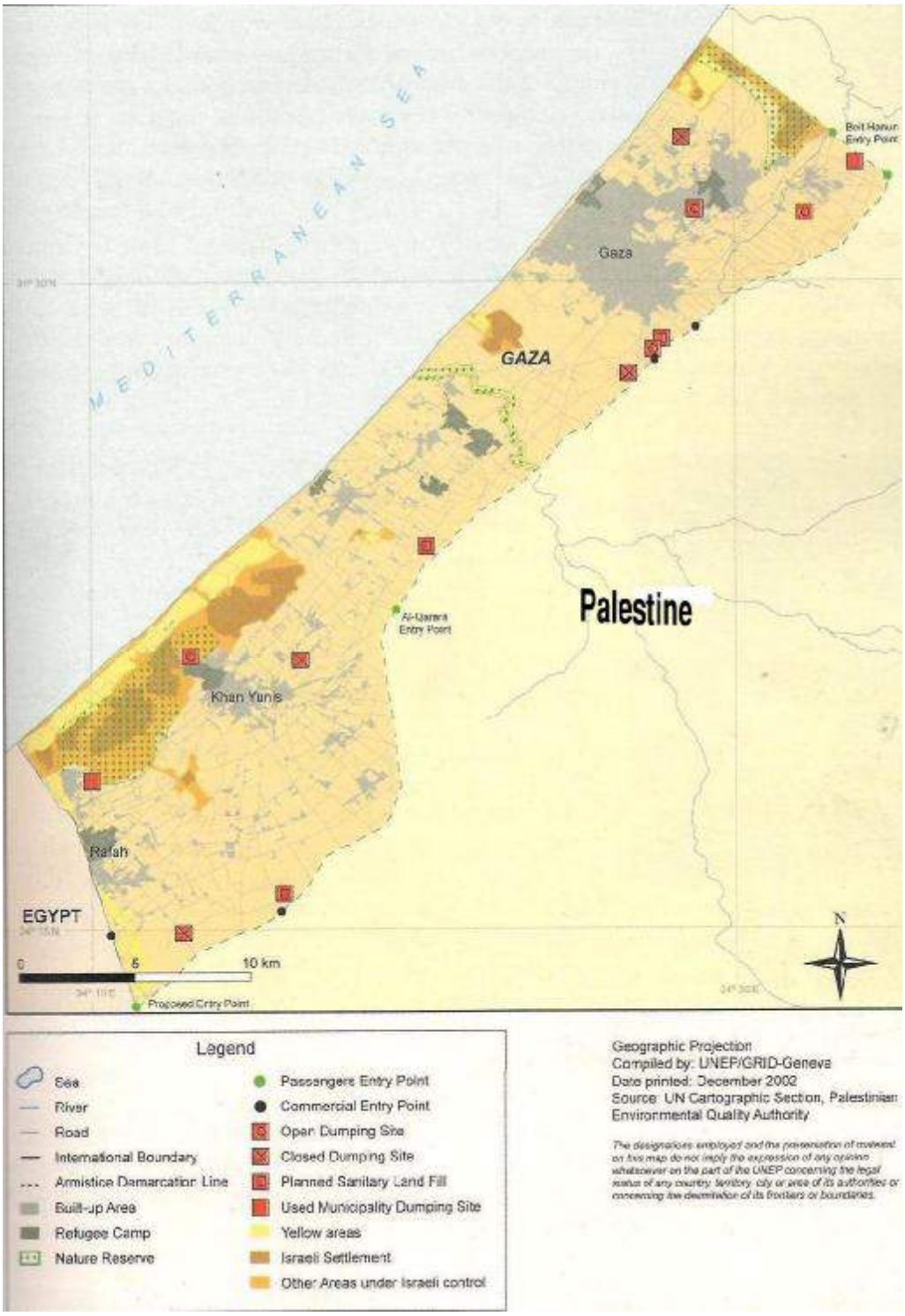

Figure (3.5): Location of solid waste dumping sites in Gaza Governorates

(UNEP, 2003)

3.6.3 Solid Waste Management in the Middle area Governorate:

The municipalities of Khan Younis, Deir El Balah, Nuseirate, Maghazi, Zawida, Buerij, AbasanKabira, AbasanSaghira, Banisuhila, Khuzaa, Qarara, Wadi salqa and Al mosadar have formed a solid wastes management council (SWMC) to operate, maintains and own a SWM transportation and disposal system (Figure 3.6). The council was established in 1996 and was founded by German and Implemented by GTZ. Collection of solid wastes will remain the responsibility of municipalities, while payments will be made to the council based on tonnage transported to the sanitary land fill operated by council at Deir El Balah. The council has own management system and has two garages and the official dump site in the Deir Al Balah city (Figure 3.5). The quantities of solid wastes reached the landfill on 2006 ,2007 and 2008 are shown on the Table (3.2).

3.6.3.1 Deir El Balah Official Landfill:

The land fill is located on the eastern part of Deir Al Balah city closed to green line boundaries .This landfill has a leachate collection system in a separate ponds where the leachate is re-circulated again on the landfill surface. Leachate are collected in two ponds, the first one has an area of 1000 m^2 and volume 2400 m^3,whereas the second bond has 1500 m^2 and 3600 m^3 volume (Fig 3.7).

The area of the landfill is 60000 m^2. The depth of ground water is around 70 meter , Height of waste is 17 meters. Quantity of solid wastes received were about 9000-10000 ton/year as shown in Table(3.2). The landfill is far from high residential area , only 30 house are found at a distance 1500 m. The wind direction is form west to east, the landfill is serves about 500,000 resident, Monitoring boreholes for ground water at the site have been prepared.

It can be seen that the waste generated ranges between 6059-9651 ton/month. The differences in the amount received may be due to the current situation in Gaza. This suggests that some waste quantities did not reach the sites due to the security reasons.

Table (3.2): Amounts of solid wastes received landfill (ton/month) on 2006--2008 (SWMC):

Year	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2006	8631	8105	9220	9651	9325	9357	9018	8984	7725	8632	8723	7808
2007	9069	8044	8901	8666	9048	8577	9153	7717	7771	7671	7105	7661
2008	7005	7274	8485	6396	6059	6918	7642	8611	7121	7919	8098	6847

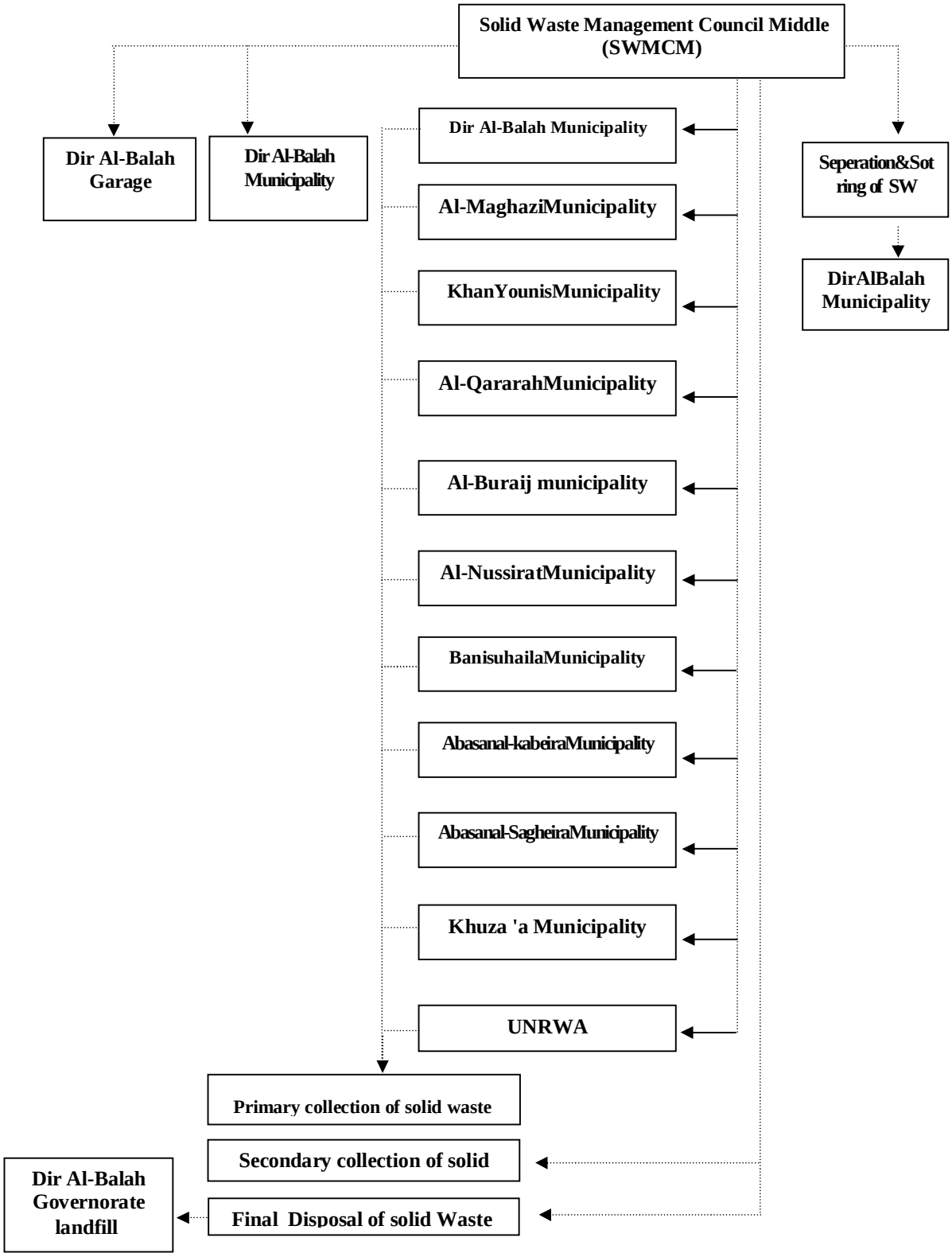

Figure (3.6): The existing system of SWMCM.

Figure (3.7): Engineering design of Deir Al Balah landfill (GTZ, 2002))

3.6.3.1.1 Construction of the Basal Sealing System :

A summary of engineering and technical specification of Deir El Balah landfill is given below:

Construction of asphalt sealing system at Deir El Balah land fill:

The basal sealing system consists of the following layers:

1. Base course 20 cm is placed on the sub base to increase the bearing capacity

2. Bitumen spraying.

3. Asphalt liner 1.

4. Bitumen spraying (1.5 kg/ m2).

5. Asphalt liner 2.

6. Bitumen spraying (1.5 kg/ m2) at the drainage pipes .

The detailed requirement to the component of the liner system are described in the Technical Specification.

Sealing layers have to comply with the following specification :

Asphalt liner 1 being a binding layer on the base course

Grain size 0 to 3/4”

Bitumen content 5.5%

Bitumen B60-70

Thickness 5 cm

Void ratio <=5 %

Asphalt liner 2 being the sealing layer on asphalt liner 1 :

Grain size 0 to 3/8”

Bitumen content 6%

Thickness 4 cm

Bitumen B60-70

Void ratio <=3%

The materials and characteristics of the asphalt liners correspond to conventional road construction. A layer of hot bitumen (bitumen spraying) is applied between the two asphalt liners which provides an impermeable connection of the two layers .(SWMC)

3.6.4 Solid waste management in Khan Yunes Governorate:

There are two open illegal dump site :

1. Al Hai Al Namsawi dump site .

2. Al mawassi dump site.

3.6.5 Rafah Governorate : Rafah Municipality landfill is located near sofa with an area of 27000 m. Four municipalities are sharing this site. There is no leachate collection and the height of the waste reach more than 15 meter.

CHAPTER (4)

METHODOLOGY

4.1 Introduction

The study covered Deir El Balah landfill in Gaza Strip which has a linear system. The first purpose of this study was to identify the effect of landfill on quality of groundwater, air, soil and agriculture.

Analysis of water for wells surrounding landfill are made, historical data from previous monitoring wells were collected to deduce the trend of past and current system operation and ground water quality. The second purpose to study social and health impacts of the landfill on the people live, questionnaire for target group are made.

4.2 Data Collection:

The data and information used in this thesis have been collected as follows:

4.2.1 Available Data in the Study Area:

Historical data for well surrounding landfill are not found because wells are not recorded and drilled by farmers. Recorded wells are found far from landfill, therefore historical information for groundwater quality around landfill are poor.

Only two wells (Mohna well and Ben Said well) have records. Sampling and analysis were made by German Technical Cooperation (GTZ) on 2003 and 2005. Data of most recorded wells in middle area in Gaza Strip were analyzed in Public Health laboratory on 2007 and 2008.

No historical data for analysis of leachate except for on 1988, 1999, 2001 and 2005. Only these data were obtained from GTZ and SWMC.

4.2.2 Field visitation:

several visits has been done to German Technical Cooperation (GTZ) in Gaza Strip and Solid Waste Management Council (SWMC) to obtain information about landfill such as composition of linear system, volumes of solid wastes, problems that facing SWMC and municipalities related gathering and dumping solid wastes.

4.3 Questionnaire: The study area is located very closed to the Green Line. Technical regulations for the establishment of a landfill should be considered: to be far from major population centers and location must be suitable in terms of wind directions.

The social effects of the Leachate on the local community were collected through questionnaire. The questionnaire consists of 30 questions related to the soil type, irrigation system, agricultural activity, water well information, such as distance from the Leachate site, depth of water table, rainwater type, ammonia emission, hydrogen sulfide smells, intensity of smells, health status of the farmers, insects and birds. More details are shown in (Annex 1). However, data collection includes available data in the study area, and data collected by field visits to target landfill area office of solid wastes management council (SWMC) also from German technical cooperation (GTZ).

The surrounding area of Deir El Balah Landfills considered agricultural area. It is not highly populated. Field survey for the houses surrounding the landfill classified the area as follows:

Zone 1: including the houses at a radius of about 300 m from the landfill (3 houses).

Zone 2: including the houses at a radius of about 500 m from the landfill (6 houses).

Zone 3: including the houses at a radius of about 700 m from the landfill (8 houses).

Zone 4: including the houses at a radius of about 1000 m from the landfill (about 120 houses).

About of 25 questionnaire samples have been conducted in the study as follows:

3 questionnaires for zone1 (12%).

3 questionnaires for zone 2 (12%).

5 questionnaires for zone 3 (20%).

14 questionnaires for zone 4 (56%).

4.4 Sampling program:

On September 2008 groundwater samples were collected from 8 selected wells surrounding Deir Al Balah landfill and analyzed in laboratories of Islamic University of Gaza.

The wells located in the west side of the landfill represented the downstream side as the lateral flow direction of Gaza Strip is form east to west. The wells distance from the landfill are varying between about 200-500m.

4. 5 Tested Parameters:

A group of physical and chemical parameters were tested in groundwater samples. The physical parameters including:

- Temperature
- pH
- electrical conductivity (EC)
- Total dissolved solids (T.D.S).

The chemical parameters include:

- Nitrate (NO3)
- Ammonia (NH4), and
- Chloride (Cl).

4. 5.1 Physical analysis:

1- Temperature

Temperature was taken synchronously with pH value using the device

(Hanna 8424) by selection of their modes

2- pH Combined portable meter(Hanna 8424) was used for measuring PH and temperature.

3- Electrical conductivity (EC).

Measuring conductivity was carried out using EC meter (Hanna, TH-2400) Voltage is Applied between the two electrodes immersed in the solution, and the voltage drop caused by the resistance of the solution is used to calculate conductivity. The display of the EC value is also automatically compensated for temperature. The basic unit of measuring conductivity is micro Siemens (Mslcm).

4- Total dissolved solids (T.D.S):

Measuring T.D.S was carried out using T.D.S meter.

4. 5.2 Chemical analysis:

1- Nitrate (NO3): was measured with Spectrophotometer device. Nitrate measuring process is achieved by taking samples of a known concentrations and using the resulted calibration curve, and then by matching technique.

2- Chloride determination (Cl):

After the sample was diluted 1ml, potassium chromate solution added. The mixture is then titrated with silver nitrate solution until the color changes form yellow to reddish brown.

3- Ammonia (NH4):

Sufficient amount of sodium hydroxide - thiosulfate reagent was added to the flask (pink layer is formed) . The flask is then connected to distillation apparatus, mixed thoroughly and 200 ml was distilled into boric acid absorbing solution. Aliquot of the distillate was titrated with 0.02 N standard sulfuric acid until the indicator turned pale lavender. The following formula was used to calculate the ammonia as total Kjeldahl Nitrogen :

Mg/L ammonia = ((A-B).280)/ml sample.

A = Volume of sulfuric acid titrated for the sample.

B = Volume of sulfuric acid titrated for the blank.

4.6 Leachate Collection:

Leachate samples were collected directly from the landfill site in Deir Al-Balah. The land fill collection system was designed from a concrete structure and has a pipeline that collect the Leachate in a separate room. The Leachate were re-added to the new solid waste that will come in the next day to enhance the biodegradation. Samples of these Leachate were collected manually using glass bottles and were sent to the laboratory in the Islamic University of Gaza for chemical analysis.

4.7 Data Analysis:

Data analysis has been done software programs involving the use of :

1- Excel for drawing graphs, and tables.

2- SPSS program to analysis questionnaire.

CHAPTER (5)

RESULTS AND DISCUSSIONS

The results of the study represents the effect of the landfill on population live, social and health impacts, and the effect of landfill on quality of groundwater, air, soil and agriculture.

Table (5.1) presents the results of the leachate re-circulation performance during years 2005-2008.

It is clear that leachate reaching the pond decreased in 2008 to reach 18112 m^3 whereas the value was 68905 m^3 in 2007. The explanation of these results is that is that rainfall reach the pond contribute to the biodegradation and reduce waste volume.

5.1 Leachate water quantity:

As shown in the Table (5.1) filling ratio of leachate pond increases in 2006 to 70% and decrease in 2007 to 40% then to 30% on 2008. It has been shown that annual evaporation lost from the pond reached 2500 mm whereas annual evaporation form the area was 1000 mm. It can be seen that liquids remained in the pond on 2006 was the highest among all years although hours of pumping leachate is increasing. Furthermore, leachate reaching the pond increased from year 2005 to 2007, whereas in the year 2008, the volume was the lowest among all). In 2005, 2006 percolated rainfall increasing due to low of height of solids on second stage at second part of landfill, also due to pumping and recirculation leachate is very difficult because pumping system are damaged by Israeli bombardment and workers are prevented to arrive the region, therefore leachate sometimes runs to another places such as sides of landfill and agriculture lands, where parts of fences are destroyed. It is easy to

conclude that high evaporation of liquids on the surface is faster than percolation through wastes, 10 month of the year high evaporation due to solar radiation, also increasing area and hours of pumping leachate through wastes helps by decreasing of leachate. In addition plastic cover through winter decreasing of water reaching the pond and decreasing of operating pumps.

Another pond are built 1500 m² in area and 3600 m³ volume ,in addition to original pond 1000m ² in area and 2400 m³ in volume Tow ponds also have a good linear system and cleaning for ponds are made one time on 2004. The collection and treatment of landfill gas were not regarded to be a priority for the time being, reasons for this included the fact that the landfill is relatively small and that the utilization of gas would be uneconomical.

Table (5.1): Recirculation performance of leachate (SWMC)

Item	2005	2006	2007	2008
Average rainfall (mm)	197	367.9	158.6	275
Rainfall reaching the pond (m^3)	492	920	391.5	687.5
Annual evaporation (mm)	1000	1000	1000	1000
Annual evaporation lost form the pond (mm)	2500	2500	2500	2500
Leachate lost form the pond (m^3)	43585	44476	64402	14500
Hours of pumping leachate (hr)	1353	1511	1841	524.5
Liquids lost form the pond (m^3)	46085	46976	66902	17000
Leachate reaching the pond (m^3)	49273	50274	68905	18112
Liquids reaching the pond (m^3)	49765	51194	69296	18800
Liquids remained in the pond (m^3)	3680	4218	2394	1800

Percentage of filling pond of liquids (%)	61%	70%	40%	30%

5.2 Leachate water quality:

Leachate has elevated concentrations of numerous organic and inorganic pollutants. Landfill accept waste since about 15 year, so waste in landfill may be undergoing several phases of decomposition at once (Jabber and Nasser, 2007), and leachate varies in its chemical composition.

5.2.1 Leachate characterization:

The physical and chemical parameters leachate samples collected from Deir AL Balah landfill are shown in Table (5.2).

It can be seen that the color of the leachate varies from dark green olive to very dark green, whereas the turbidity remains dark in all years of investigation, the smell was also the same as well.

It is also appears that pH values range between 8-8.7 indicating the alkaline reaction of the leachate. The EC range was 29.9-55.4 ms. indication high salinity.

The values of BOD and COD were extremely high in all years of measurements, indicating high pollution. The value of total organic carbon (TOC) range between 1.5-10 g/l indicating low fraction of TOC. However, the dissolved organic carbon ranges between 2.3-9.5 g/l indicating high fraction of DOC. Furthermore, the value of DOC may indicate high fraction of low molecule weight of organic compounds. These data are due to possible biodegradation of the solid waste.

Table (5.2): Physical and chemical properties of the leached water obtained from the landfill site Deir EL-Balah in 1998-2005. (GTZ).

Parameter	March 1998	July 1999	January 2001	2005
Color	DGO	DGO	V. Dark Green	-
Turbidity	Dark	Dark	Dark	-
Temp. ^{o}C	13.8	35	12.8	-
Smell	SAA	SAA	SAA	-
pH	8.7	8.2	8.0	8
EC ms	35.5	55.4	29.9	40
TS g/l	26.3	55	24.78	37
BOD mg/l	3700	12500	4400	5330
COD mg/l	12840	28350	24580	14000
TOC g/l	3.5	10.0	1.5	7
DOC g/l	2.2	7.5	2.5	9.5
NH4 g/l	1.86	5.1	2.3	1.6
Cl g/l	6.9	10.5	5.6	9.33
Sulfate g/l	0.21	0.38	0.200	-

DGO= Dark Green Olive

SAA= Sharp after ammonia

The ammonia concentration range between 1.86-5.1 g/l indicating high content of nitrogen compounds in the wastes. Chloride concentration ranged between 5.6-10.5 g/l. This may indicate high fraction of chlorinated compounds. Sulfate concentration was the lowest among all, indicating low sulfur containing compounds.

These data are gathered from German Technical cooperation GTZ. After 2005 no data or samples of leachate were tested by GTZ or SWMC.

Furthermore we present year variations of NH4, COD and BOD values in Figure (5.1) shown below.

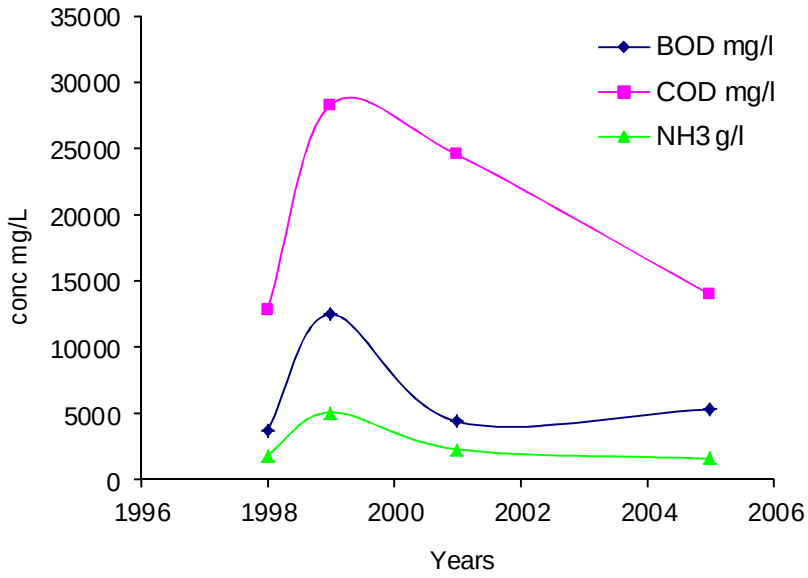

Figure (5.1): BOD, COD and NH4 dynamics during 4 years of study.

It is obvious that the most interesting point is that the increase of the values from year 1998 and reached the maximum in year 1999 then decreased again. The explanation of these results is that biodegradation increased in year 1999 to the highest level. Then probably some toxic materials were produced by the bacterial degradation. These toxic materials may stand behind the reduction of the values in the following year.

These results are in accord with the data in Table (5.3) which contains nearly high fraction of heavy metals which may have some toxicity to aerobic bacteria.

Figure (5.1) shows the variation of Ammonia concentration with time which increase on 1999 and start to decrease in years 2001, 2005, due to the anaerobic conditions which in return contributed to nitrate reduction towards ammonia gas phase .These concentrations are very toxic to the microorganisms that responsible for the anaerobic processes.

The variation of BOD and COD concentration with time have the same behavior which increase on 1999 comparative to 1998 value then decrease on 2001 ,and then start to increase on 2005 .

The BOD/COD ratio was around 0.29 in year 1998 and reach to about 0.44 at year 1999 deceases to 0.16 on 2001 after that return to increase to 0.38 in year 2005 as shown in Figure (5.2).

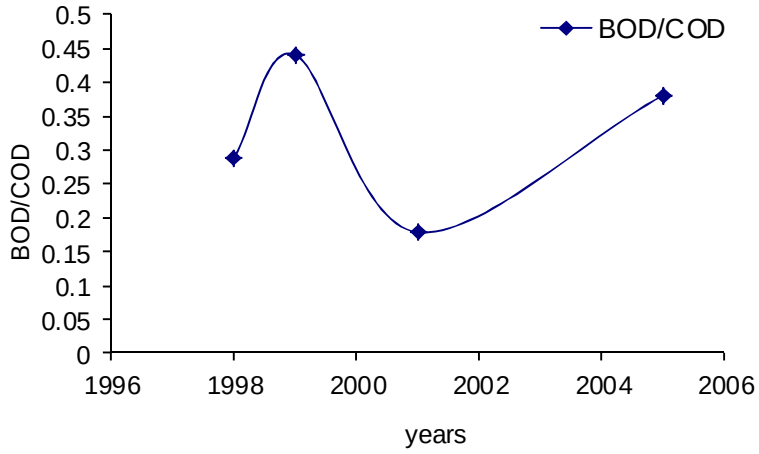

Figure (5.2): Change of (BOD/COD) ratio with time.

Decreasing of BOD/COD ratio for the year 1999 to the year 2001 (from 0.44 to 0.16) is believed to a decrease in biodegradation processes occurring in the landfill. This result in a good a agreement with the ratio obtained by others (Frascari et al.,2004)

The increase of BOD/COD ratio on 2005 to 0.38 can be described as a result to use the second stage of land fill (25 dunums) by SWMC with a new solid wastes after stage one (35danums) was completely filled. In addition, increasing volume of wastes arriving land fill after occupation Israeli are left Gaza Strip on 2005, as roads to landfill are opened, therefore the volume of solid wastes, that arrived the landfill was increased to 91000 ton.

Table (5.3) presents the concentration of heavy metals that were detected in the leachate samples obtained from the landfill. It can be seen that there were various concentrations of heavy metals (hazardous chemicals). These chemicals tend to be harmful to various living organisms. These materials may stand behind reduction of BOD and or COD values in years 2001-2005.

Table (5.3): Heavy metal concentration of leached water obtained from the landfill site deir EL-Balah in during from 2001 and 2005 (GTZ)

Heavy metals mg/l	2001	2005
Pb	0.004	>0.1
Cd	>0.10	0.08
Cu	<0.01	0.5
Ni	1	1.5
Zn	<0.01	1.1
Hg	<0.01	0.006
Bo	<0.01	1.5
Cr	<0.01	2

5.2.2 Effects on ground water quality:

The chemical properties of water samples collected from the selected wells of ground water in Deer Al-Balah are shown in Table (5.4).

It can be seen that pH values of all the sampling wells around Deir AL Balah land fill were in the normal of the range 7.28-7.6 whereas, the EC values were high in all monitoring wells and have a range between 1475-3600 ms/cm. The EC values were above WHO suggested levels (900 ms/cm) at all samples. However, according to (Abu-Rukah and AL-kofahi, 2001), EC value within 1000 ms/cm is suitable for irrigation purpose. We are not sure that high values of EC is due to presence of the landfill. All values of EC in middle area of Gaza strip are high. Furthermore, C1 values around Deir AL Balah landfill have averages between 322 and 900 mg/l (Table 5.4) .The highest values measured were in wells W2, W5, W6 and W7 are not acceptable

to Palestinian Standards (600mg/l). Water wells. W1, W3, W4 and W8 are not acceptable to W.H.O Standards (250 mg/l). In addition, Nitrate concentrations are relativity acceptable to WHO Standards (50 mg/L)., except for W7 is higher than WHO standard. The agriculture practical (fertilizers, manure) in Deir EL Balah area could be the source of nitrate.

Table (5.4): Groundwater characteristics for sampling well at Dear Al Balah on 2008

Parameter	W1	W2	W3	W4	W5	W6	W7	W8
EC(MS)	1475	3600	2225	2310	3430	2650	3100	2300
T.D.S(mg/l)	826	2480	1460	1480	2220	1700	1970	1440
CL(mg/l)	322	900	470	540	845	615	717	522
pH	7.6	7.5	7.4	7.33	7.38	7.34	7.28	7.4
NO3 (mg/l)	32	20	50	55	52	46	85	44
NH4 mg/l	-	-	-	-	-	-	-	-

At Dear EL Balah landfill there is no historical data of ground water samples. There are two wells very closed to landfill: Ben Said well and Mhana well, where SWMC and GTZ are used them as monitoring wells. No analysis was made after 2005 because these two wells are very closed to green line and dangerous to go there. The results of samples at these two wells only on 2003 and 2005 are shown in Table (5.5). The results show high values of EC , acceptable values of Nitrate , and no ammonia (zero).

Table (5.5): Physicochemical properties of water sample of monitoring well on 2003-2005 (SWMC)

Test	Ben Said **well**		Mhana well	
	2003	2005	2003	2005
Color	>5	5	>5	5
Turgidity	>5	5	>5	5
Ph	7.53	7.8	7.55	7.89
EC	3370	3320	4310	4110
TDS	2089	2058	2672	2548
NO3 ppm	40.5	38.91	43.8	52.73
Cl (ppm)	772.6	821.7	488.3	1006
SO4 (ppm)	357	275.8	462,8	410
Alkalinity (ppm)	238	252	252	259.2
Hardness (ppm)	378	311.8	469	470.1
Ca (ppm)	55.4	53.67	71.1	69.83
Mg (ppm)	57.9	43.1	70.6	71.73
K (ppm)	3.2	3.7	4.6	4.6
Na (ppm)	620	567	800	760

It can be seen that parameters have high values except pH, NO3, Ca, Mg, and K. This suggests that those parameters lay in the acceptable level, but infact we have to consider the other parameters together. Accordingly, it would be difficult to lay them in the acceptable level of WHO standards.

Table (5.6): properties of drinking water samples in Deir El Balah area

(Ministry of Health, 2009)

Code no	2008				2009			
	pH	EC	NO3	Cl	pH	EC	NO3	Cl
S/69 حسن سعيد	7.5	2310	41.8	523.5	7.96	2300	48	516
k-21	6.88	2370	107.6	502	7.72	1628	99	279
k-20	7.11	2370	124.3	537.8	7.1	2310	124	423
j-32	7.48	5230	184.6	1276	6.92	5390	186	1255
j/146	7.63	3003	66.9	697.7	8.1	3120	33.4	702
EL-Sahel 4	6.51	1547	68.3	272.5	7.76	1323	142	208
EL-Sahel5	6.49	1566	64.6	265.3	7.81	1544	39.5	179.3
EL-Sahel3	6.93	2560	68.9	595.2	7.64	1992	72.8	358.6
EL-Sahel 2	7.5	4990	114.6	1269	7.55	3840	136.5	839
s/82	6.48	1014	46.7	186.4	7.84	1069	46.9	211.7
s/80	7.49	3180	50.1	747.2	7.45	2980	36.21	717
s/71	7.46	2570	43.9	556.5	7.67	2600	33.42	589.9
H-95	7.11	3760	117	860.5	7.25	3530	77.83	860.5
H-60	7.21	5030	195	1190	7.25	4940	114.8	1262
G/49	7.19	4680	130	1113	7.63	4550	64.8	1112
G/45	7.37	4860	171.7	1155	7.55	4800	101	1183
G/30	7.34	4160	191.2	1133	7.69	4006	41.6	1004
F/208 الزهراء	7.32	2610	62.3	567.9	8.74	2290	65.8	473.3
F/203	7.21	2140	55	467.5	8.42	1735	38.6	351.4
S-72	7.45	4240	40	1036	7.32	4399	55.1	1076

In addition, some properties of drinking water samples collected from 20 wells around the landfill and analyzed in year 2008 and 2009 are shown in Table (5.6).

5.3 Social Data

Influence of landfill in the human health and social parameters are discussed below.

About 25 persons living close by the landfill were interviewed using a special questionnaire designed for this study (Annex 1). The interviewed persons were farmers (60%), workers (20%) and governmental employee (20%).The agricultural section of the collected data are shown in Table (5.7).

Table (5.7): Type of farms and effects of landfill in the quality and quantity of products.

Item	V (%)	O (%)	Oseat (%)	G (%)	No farm (%)	V&O (%)	G&O (%)
Type of farm	40	12	8	4	20	8	8
Changed quality	8	12	0	0	0	20	0
Changed quantity	8	8	0	8	0	56	0

V, O, G, are vegetable, olives, and grains respectively.

It can be seen (Table 5.7) that the agricultural activities around the landfill includes vegetables, olive trees, Oseat, grains, no farm land, vegetable and olive tree together in one farm, and grain and olives. The percentage of each farm varies between 8-40%. The % of changed quality and quantity of the products in each farm are shown in Table (5.7), which includes variations based on the type of the crop land. This suggests the impact of the landfill on the agricultural quality and quantity is based on the sensitivity of the agricultural crops.

Furthermore, it has been noticed that 25% of olive farms showed fungal spots on leaves, fruits and/or all the plant parts. An interesting notice is that 75% of the olive farms were free from any fungal spots.

In addition, the collected data indicated that the soil texture of the farm lands are sand, clay and sand clay with the following percentage 60%, 24% and 8% respectively. Furthermore, 56% of those farms used organic manure and only 12% from the whole farms used chemical fertilizers. In addition, only 64% of the farms applied pesticides to protect the crops from pest infestation.

It was also noticed that water wells around the landfill area have different depths. Water wells with 50 meters depth and/or below represent 32% from the wells whereas those with depths above 50 meters are 48%. It was also appeared that 48% of the wells belong to private sectors whereas 16% of the wells belong to governmental organization. Only 12% of the wells were used for rain collection.

Only, 40% of the interviewed population noticed the arrival of rain water from the landfill to their farms, whereas 54% of the interviewed population noticed a flooding of leachate pools occurred several times.

About 12% of the interviewed population indicated that they bread sheep and 40% of them indicated that they bread poultry. They also indicated that milk production from their sheep reduced by 12% and poultry production reduced by 12% as consequences of the landfill.

Furthermore, 44% of the interviewed population indicated that their home lay within the distance of 700 m away from the landfill whereas 56% of the homes lay within 1500 m away from the landfill. About 80% of those population indicated that they have unpleasant smell during day and night, whereas 20% of them reported that they have the unpleasant smell not usually.

In addition, 80% of the interviewed population noticed insects (flies, mosquitoes) and only 8% of them noticed some rodents. Furthermore, 56% of the interviewed population indicated that they noticed a municipal body spraying insecticides.

Regarding solid waste collection, 40% of the interviewed population noticed waste scattered along the way. This suggests improper waste transport.

In addition about 100% of the interviewed population noticed a fire within the landfill, 60% of the population indicated that the Israeli Shells stand behind thos fire. Furthermore, 60% of them indicated that fire put under control within 7-10 days.

About 36% of the interviewed population indicated that only 25% of the landfill area is covered by sand or plastic cover.

In addition 20% the interviewed population indicated that farmers used leachate as a fertilizer, whereas 60% of the interviewed population indicated that an overflow of the leachate cover Wadi Al salqa and some farms.

CHAPTER (6)

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions:

Landfill is an option of waste disposal method. It based on dumping the controlled wastes into dump or engineered landfill. The appropriate design and operation aspects such as Deir El Balah landfill is well considered to protect the aquifer from contaminated by leachate. The design includes double lined landfills, but its large part is covered. Covers are placed only when the stage of landfill is filled where bed of soil is placed and grassy. In winter time the landfill may be covered with a plastic layer to protect it from rainwater.

Leachate is collected in two ponds 60 m^3 in volume and with area 2500 m^2 by a series of collection pipes. The leachate can be recycled or pumped to landfill. Water depth in study area is not too deep, about 50-70 m, so water will become partially filtered through the sandy soil or loamy soil. Permeability for soils below the landfill is low due to clay lenses through sand aquifer , so contamination is less, In addition the down steam side as the lateral flow direction of Gaza Strip is from east to west dilution may took place.

On other hand leachate is flood to agricultures area and Wadi El Salqa on winter where many of trees are died. Also Israeli rockets and pumps damaged recirculation pipes and fence of landfill, therefore large amount of leachate runs through slopes of land fill to agriculture area.

Due to calculation of SWMC the percentage of fully Leachate ponds is reduced from 70% on 2005 to 30% on 2008 because increasing height of wastes that effect on rainfall that percolated, in addition runoff due to slop of wastes, also plastic cover in parts of landfill.

Chemical parameters of Leachate such as NH4, BOD, COD indicates reducing of organic wastes or presence of toxic materials that prevent action of microorganisms. Therefore landfill is in a final age and must be closed. On other hand the mentioned chemical parameters may indicate that using the second phase after first phase is filled.

Chloride and electrical parameters at sampling wells are high, we are not sure that elevation is due to landfill.

In 2003 and 2005 the data showed the same elevation values of Cl and EC. On other side values of EC and CL on 2008 and 2009 at all wells in middle area of Gaza Strip are high.

Nitrate concentration values are relatively acceptable to WHO standards except for well 7.

The interviewed persons were farmers (60%), workers (20%) and governmental employee (20%). The agricultural activities around the landfill includes vegetables, olive trees, Oseat, grains, no farm land, vegetable and olive tree together in one farm, and grain and olives. The percentage of each farm varies between 8-40%.

An interesting notice is that 75% of the olive farms were free from any fungal spots.

The collected data indicated that the soil texture of the farm lands are sand, clay and sand clay with the following percentage 60%, 24% and 8% respectively. Only small percentage (12%) of farms used chemical fertilizers . In contrast high percentage (64%) of farms applied pesticides to protect the crops from pest infestation , and 80% of the interviewed population noticed insects (flies, mosquitoes) and only 8% of them noticed some rodents. Furthermore, 56% of the interviewed population noticed a municipal body spraying insecticides.

The study indicated that milk and poultry production reduced by 12% as consequences of the landfill in the study area. In addition about 100% of the interviewed population noticed a fire within the landfill, 60% of the population indicated that the Israeli Shells stand behind that fire.

6.2 Recommendations:

1- In Gaza Strip, the three official waste disposal sites are approaching their capacity and plans have not been made for future disposal of waste. In the absence of such plans and their subsequent implementation, it is likely that existing sites will continue to be used in ways that are unsustainable from both public health and environmental perspectives.

2- In Gaza Strip the close proximity of official waste disposal sites to major population centers and important groundwater resources suggests that site rehabilitation should be carefully considered and applied.

3- Recycling and composting initiatives are to be supported and encouraged so this would increase the life span of the sanitary landfill.

4- Clear plan should be developed to start as soon as possible for the rehabilitation of the Dear El Balah Landfill and to the scattered dumpsites all over Gaza Strip.

5- Upgrading of the existing disposal sites to controlled disposal sites taking into consideration that rehabilitation works and after-care measures will be designed and undertaken to allow desired future uses and which address risks to public health and environment in ways that are locally appropriate in technical, financial and social terms.

6- Analysis of groundwater samples for wells adjacent to landfills must be done continuously.

7- Landfill must be covered especially in winter.

8- Development and implementation of public awareness programs to the peoples near and around the landfill areas.

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Annex 1: Questionnaire

1 - What are your profession
(A) Employee (b) Farmer(c) worker
2 What are the types of crops that you grow?
(A) Vegetables, (b) Olive (c) Oseat (D) grain (h) No farm (g) Vegetables and Olive (f) grain and olive

3 - What are the crops, which noted the change in quality?
(A) vegetables, (b) Olive (c) Oseat (D) grain (h) No farm (g) does not note the change

4 – What are the crops, which noted the change of agricultural production
(A) vegetables, (b) Olive (c) Oseat (D) grain (h) No farm (g) does not note the change

5 - What are you noticed on the olive trees
(A) spots on olive leaves and flowers (b) spots on the fruits of the olive (C) fungi and patches on the leaves of olive (d) All of the above (h) None of the above

6 - What kind of soil: (A) sand (b) clay (C) sandy clay (d) Do not know

7 - What kind of fertilizers used in agriculture (A) Organic (b) chemical (c) none (d) No farm
8 - Do you use pesticides (A) Yes (b)no (c) sometimes (d) I'm not a farmer
9 – What are the depth of agricultural wells (approximately) (A) 50 meters (b) 60 meters (c) 70 meters (d) Do not know
10 - What are the sources of irrigation in the region (A) private wells (b) wells-governmental organizations (c) rain water (d) Do not know

11 - Have you noticed the arrival of rain water from the landfill to agricultural land (A) Yes, in winter (b) sometimes (c) does not note
12 - How many times a flood was occurred by leachate pools to agricultural land (A) much (b) three times (c) 4 times (d) does not notice it
13 - What are livestock that you rear (A) sheep (b) Poultry (c) birds (d) None of the
14 - Is livestock production was affected (A) Affected by less production of milk (b) affected poultry (C) not affected by something (d) does not raise Pets
15 - Are you or any other do examination of water (A) I do it (b) others (c) None of the
16 - What are the animals and birds, which suffer from the presence in the region (A) stray dogs (b) birds of prey (c) dogs and birds (d) None of the above

17 - Do you are bother of presence birds of prey (A) Yes, they hurt the poultry farmers (B) Yes, because they tear nylon used in agriculture (C) does not hurt because I am relatively free of the landfill

18 - Do you suffer from the following diseases?

(A) Shortness of breath (b) the psychological impact because of the smell and mosquitoes And (c) itching of the skin (d), vomiting and diarrhea in infants
(H) does not suffer from these diseases
19 - How far is your place of residence for the landfill?
(A) about 300 meters (b) 500 m (C) about 700 meters (d) about 1500 meters
20 - What are the times that you feel the presence of an unpleasant smell (A) on day (b) at night (C) always (d) sometimes?
21 - What are the insects and rodents that suffer from deployment (A) rats (b) flies (c) mosquito (D) flies and mosquitoes (e) All of (f) is not something which stated

22 - How many times used the municipal body spray (insects) (A) only once (b) twice (C) more than that (D) Do not know
23 - What do you think of the performance of vehicles transporting waste to landfill
(A) waste scattered along the way (b) to assume the appropriate load (C) None of the d) Do not know

24 - Have you noticed a fire within the landfill (A) Yes, this happened several times (b) Yes, and this year twice (c) did not occur
25 - What is the cause of afire in the landfill in your mind (A) Israeli shells (b) waste residues are burned in containers (C) Do not know (d) All of the above
26 - When the fire under control within the landfill (A) quickly (b) After a week (C) more than ten days (d) Do not know

27 - What is the area of the landfill that is covered (A) 0.25 Area (b) 0.5Area (C)all space (d) Do not know
28 - When do covering a waste in the landfill (A) sometimes in winter (b) only when the full part of the landfill (c) Do not know

29 - Have you seen people use leachate as a fertilizer (A) Yes, a few farmers (b) I did not see (c) do not know because I live away from leachate pools

30 - Where is leachate overflowing (A) to Wadi al Salqa (b) to some agricultural land (c) I don't know
31 - Have you noticed random dumps (A) Yes (b) no (C) a little (d) Do not Know

Arabic version of the questionnaire

1- ما هي المهنة
(أ) موظف (ب) مزارع (ج) عامل
2 ما هي أنواع المحاصيل الزراعية التي تزرع :
(أ)خضروات (ب) زيتون (ج) لوزيات
(د) حبوب (ح) لا أزرع (ز) خضروات وزيتون (و) حبوب وزيتون
3- ما هي المحاصيل الزراعية التي لاحظت فيها تغير في نوعيتها :
(أ)خضروات (ب) زيتون (ج) لوزيات
(د) حبوب (ح) لا أزرع (ز) لا ألاحظ تغير
4- في أي من المحاصيل الزراعية تغير في الانتاج الزراعي
(أ)خضروات (ب) زيتون (ج) لوزيات
(د) حبوب (ح) لا أزرع (ز) لا ألاحظ تغير
5- ماذا لاحظت على أشجار الزيتون
(أ) بقع على أوراق وأزهار الزيتون (ب) بقع على ثمار الزيتون
(ج) فطريات وبقع على أوراق الزيتون (د) جميع ما سبق (ح) لا شيء مما سبق
6- ما نوع التربة الزراعية :
(أ)رملية (ب) طينية (ج) طينية رملية (د) لا أعرف
7- ما نوع الأسمده المستعملة في الزراعة
(أ)عضوية (ب) كيماوية (ج) لا شيء (د) لا أزرع
8- هل تستعمل المبيدات الزراعية
(أ)نعم (ب) لا (ج) أحيانا (د) لست مزارعاً
9- كم عمق الآبار الزراعية
(أ)50 متر تقريبا (ب) 60 متر تقريبا (ج) 70 متر تقريبا (د) لا أعرف
10- ما هي مصادر الري في المنطقة
(أ)أبار خاصة (ب) أبار حكومية (ج) مياه الأمطار (د) لا أعرف
11- هل لاحظت وصول مياه الأمطار من جهة المكب إلى الأراضي الزراعية
(أ) نعم في فصل الشتاء (ب) أحياناً (ج) لا ألاحظ
12- كم مرة حدث فيضان للعصارة من بركة تجميع العصارة إلى الأراضي الزراعية
(أ) كثيرا (ب) ثلاث مرات (ج) 4 مرات (د) لا ألاحظ ذلك

13 - ما هي الأحياء التي تربيها
(أ)أغنام (ب) دواجن (ج) طيور (د) لا شيء مما ذكر
14- هل تأثر الإنتاج الحيواني
(أ) تأثر حيث قل إنتاج الحليب (ب) تأثرت تربية الدواجن
(ج) لم يتأثر شيء (د) لا أربي حيوانات أليفة
15- هل تقوم أنت أو أي جهة أخرى بفحص المياه
(أ) أنا أقوم بذلك (ب) جهات أخرى (ج) لا شيء مما ذكر
16- ما هي الحيوانات والطيور التي تعاني من وجودها في المنطقة
(أ) كلاب ضالة (ب) طيور جارحة (ج) لا شيء مما ذكر
17- هل تزعجك وجود الطيور الجارحة

(أ) نعم لأنها تؤذي طيور المزارعين
(ب) نعم لأنها تمزق النايلون المستعمل في الزراعة
(ج) لا تؤذي لأنني بعيد نسبياً عن المكب

18- هل تعاني من الأمراض الآتية :

(أ) ضيق في التنفس (ب) تأثير نفسي بسبب الرائحة والبعوض
(ج) حكة في الجلد (د) قيء وإسهال عند الأطفال الرضع
(ح) لا أعاني من هذه الأمراض

19- كم يبعد مكان سكنك عن المكب :

(أ) حوالي 300 متر (ب) 500 متر
(ج) حوالي 700 متر (د) حوالي 1500 متر

20- ما هي الأوقات التي تشعر فيها بوجود رائحة كريهة

(أ) في النهار (ب) في الليل
(ج) دائماً (د) أحياناً

21- ما هي الحشرات والقوارض التي تعاني من انتشارها

(أ) فئران (ب) ذباب (ج) بعوض
(د) ذباب وبعوض (هـ) جميع ما ذكر (و) لا شي مما ذكر

22- كم مرة استعملت البلدية جهاز الرش (الحشرات)

(أ) مرة واحدة فقط (ب) مرتين
(ج) أكثر من ذلك (د) لا أعرف

23- ما رأيك في أداء سيارات نقل النفايات إلى المكب

(أ) تبعثر النفايات على طول الطريق (ب) تحمل حمولتها المناسبة
(ج) لا شيء مما ذكر (د) لا أعرف

24- هل لاحظت حدوث حريق في داخل المكب

(أ) نعم حدث ذلك عدة مرات (ب) نعم وفي هذا العام مرتين (ج) لم يحدث

25- ما سبب الحريق في داخل المكب في رأيك

(أ) القذائف الإسرائيلية (ب) بقايا نفايات محروقة في الحاويات
(ج) لا أعرف (د) جميع ما سبق

26- متى يتم السيطرة على الحريق داخل المكب

(أ) بسرعة (ب) بعد أسبوع
(ج) أكثر من عشرة أيام (د) لا أعرف

27- ما هي مساحة المكب المغطاة تقريباً

(أ) 1\4 المساحة (ب) 1\2 المساحة
(ج) كل المساحة (د) لااعرف

28- متى يتم تعطيه النفايات في المكب

(أ) أحياناً في فصل الشتاء (ب) فقط عند امتلاء جزء من المكب (ج) لا أعرف

29- هل شاهدت أناساً يستعملون العصارة كسماد زراعي

(أ) نعم قليل من المزارعين (ب) لم أشاهد (ج) لا أعرف لأنني أسكن بعيداً عن بركة العصارة

30- أين تفيض العصارة

(أ) إلى وادي السلقا (ب) إلى بعض الأراضي الزراعية (ج) لا أعراف

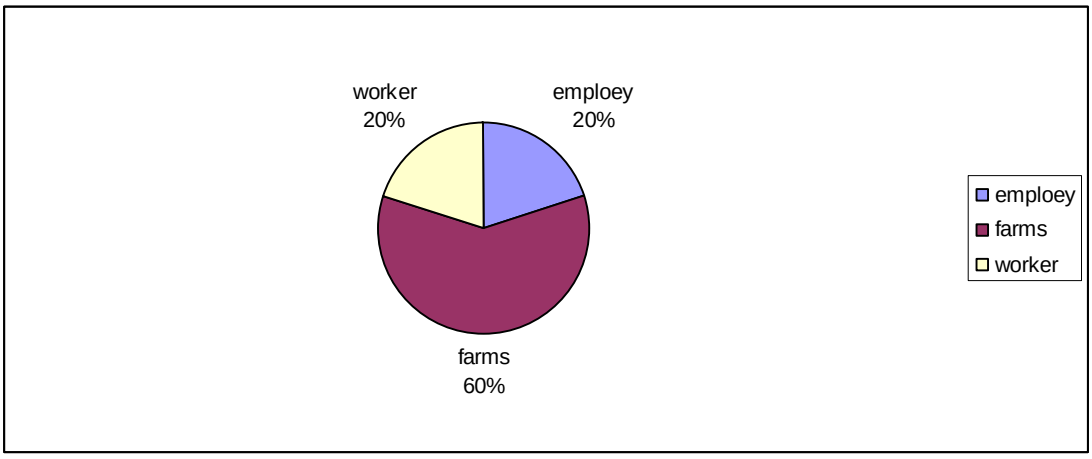
31- هل لاحظت وجود مكبات عشوائية

(أ) نعم (ب) لا
(ج) قليلاً (د) لا أعرف

Annex 2: Questionnaire results

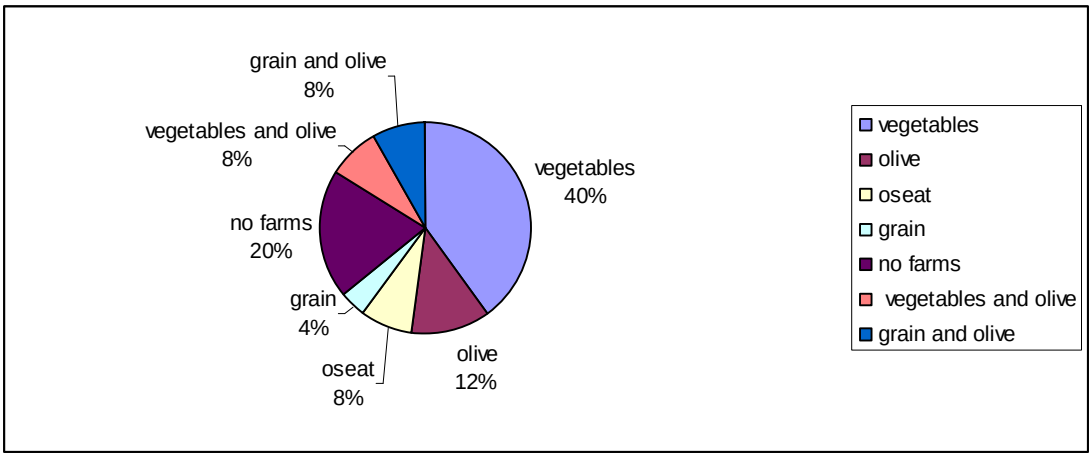
1 – What are your profession?
(A) Employee (b) Farmer (c) worker

	number	percent
employee	5	20%
farmer	15	60%
worker	5	20%
sum	25	100%



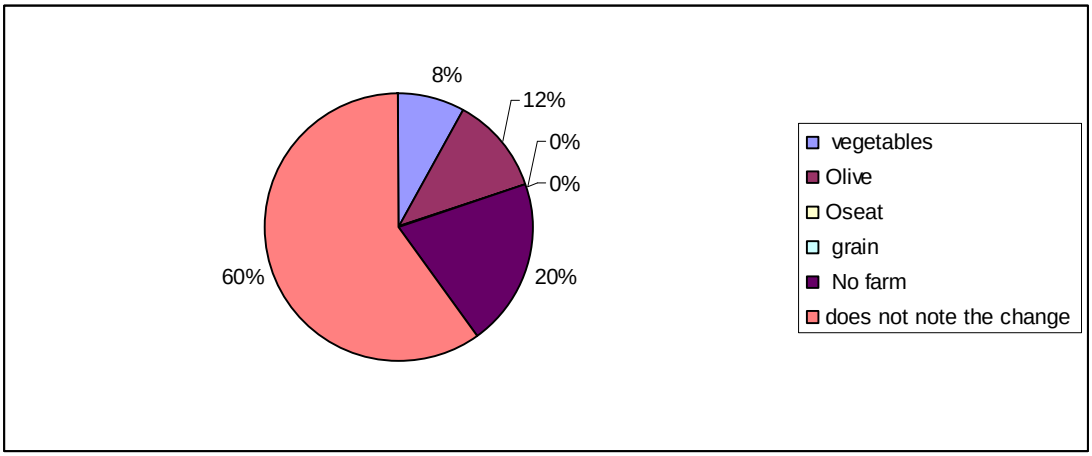
2 What are the types of crops that you grow:
(A) vegetables, (b) Olive (c) Oseat
(D) grain (h) No farm (g) Vegetables and Olive (f) grain and olive

	number	percent
vegetables	10	40%
olive	3	12%
oseat	2	8%
grain	1	4%
no farms	5	20%
vegetables and olive	2	8%
grain and olive	2	8%
sum	25	100%



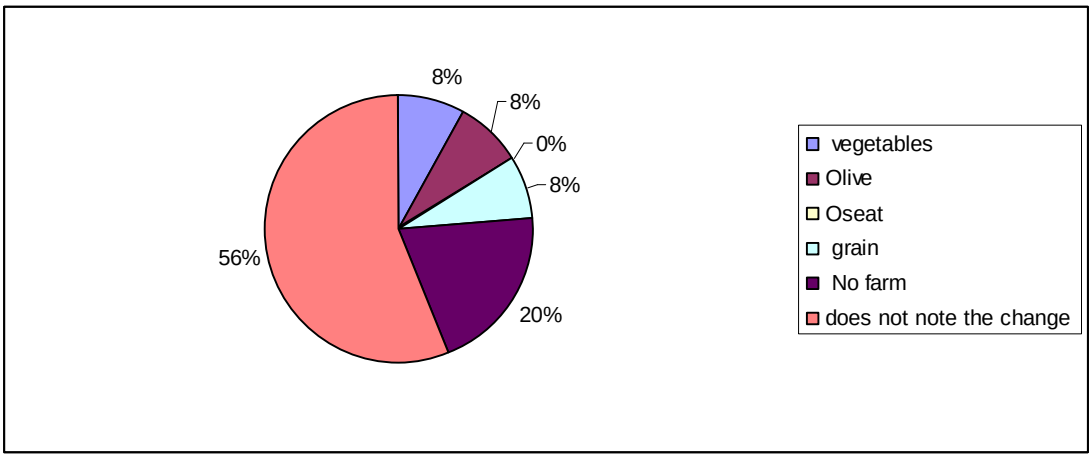
3 - What are the crops, which noted the change in quality:
(A) vegetables, (b) Olive (c) Oseat
(D) grain (h) No farm (g) does not note the change

	number	percent
vegetables	2	8%
Olive	3	12%
Oseat	0	0%
grain	0	0%
No farm	5	20%
does not note the change	15	60%
sum	25	100%



4 – What are the crops, which noted the change of agricultural production
(A) vegetables, (b) Olive (c) Oseat
(D) grain (h) No farm (g) does not note the change

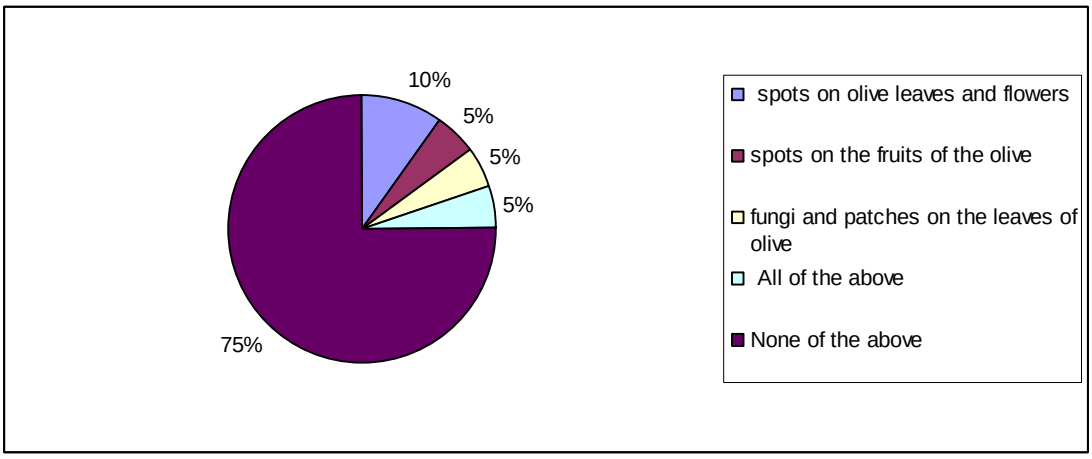
	number	percent
vegetables	2	8%
Olive	2	8%
Oseat	0	0%
grain	2	8%
No farm	5	20%
does not note the change	14	56%
sum	25	100%



5 - What are you noticed on the olive trees

(A) spots on olive leaves and flowers (b) spots on the fruits of the olive (C) fungi and patches on the leaves of olive (d) All of the above (h) None of the above

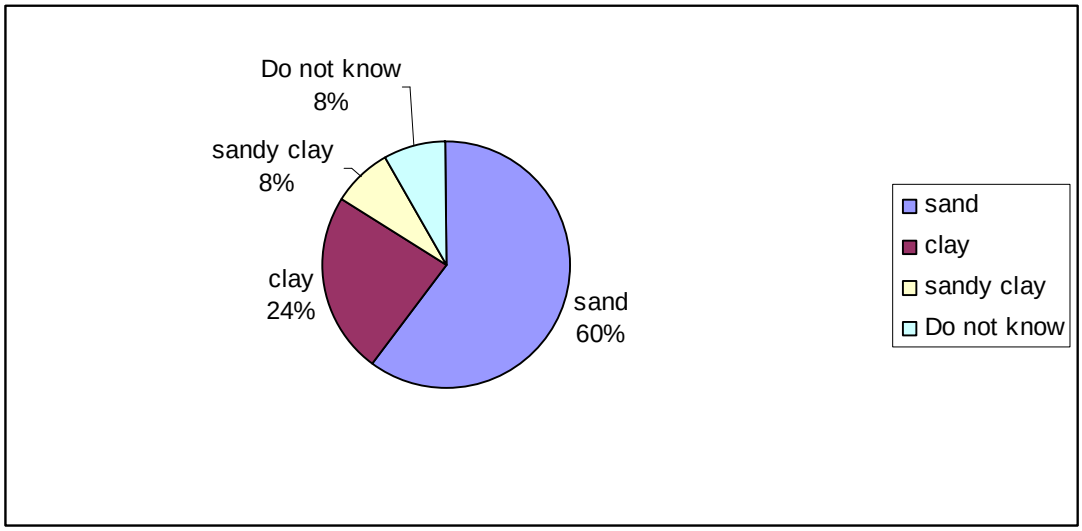
	number	percent
spots on olive leaves and flowers	2	10%
spots on the fruits of the olive	1	5%
fungi and patches on the leaves of olive	1	5%
All of the above	1	5%
None of the above	15	75%
Sum	25	100%



6 - What kind of soil:

(A) sand (b) clay (C) sandy clay (d) Do not know

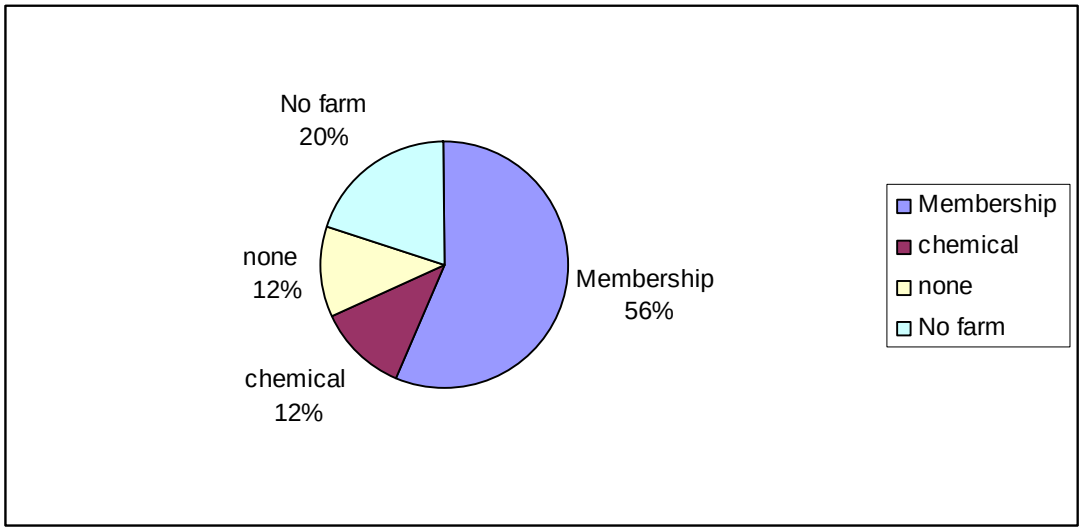
	number	percent
sand	15	60%
clay	6	24%
sandy clay	2	8%
Do not know	2	8%
sum	25	100%



7 - What kind of fertilizers used in agriculture

(A) Organic (b) chemical (c) none (d) No farm

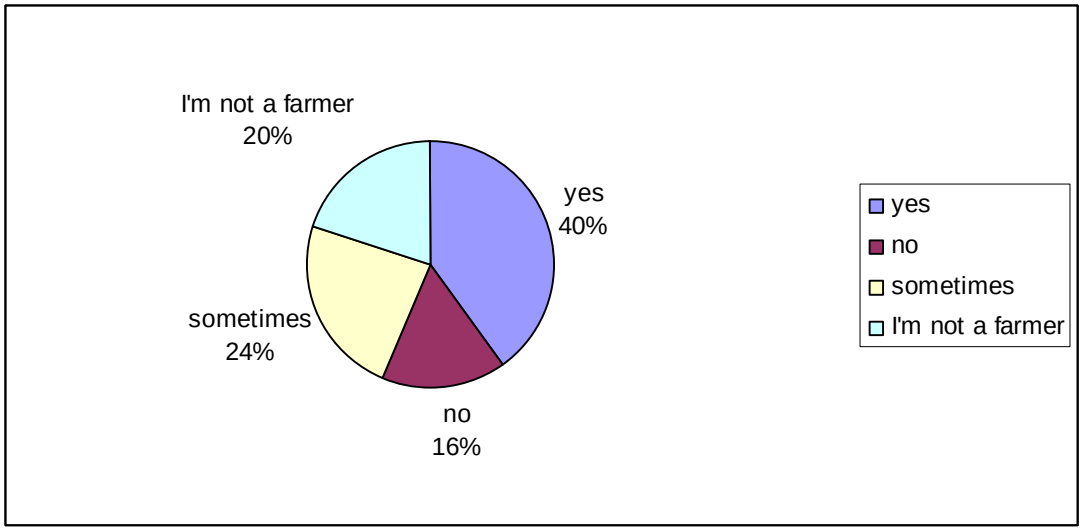
	number	percent
Organic	14	56%
chemical	3	12%
none	3	12%
No farm	5	20%
Sum	25	100%



8 - Do you use pesticides

(A) Yes (b) no (c) sometimes (d) I'm not a farmer

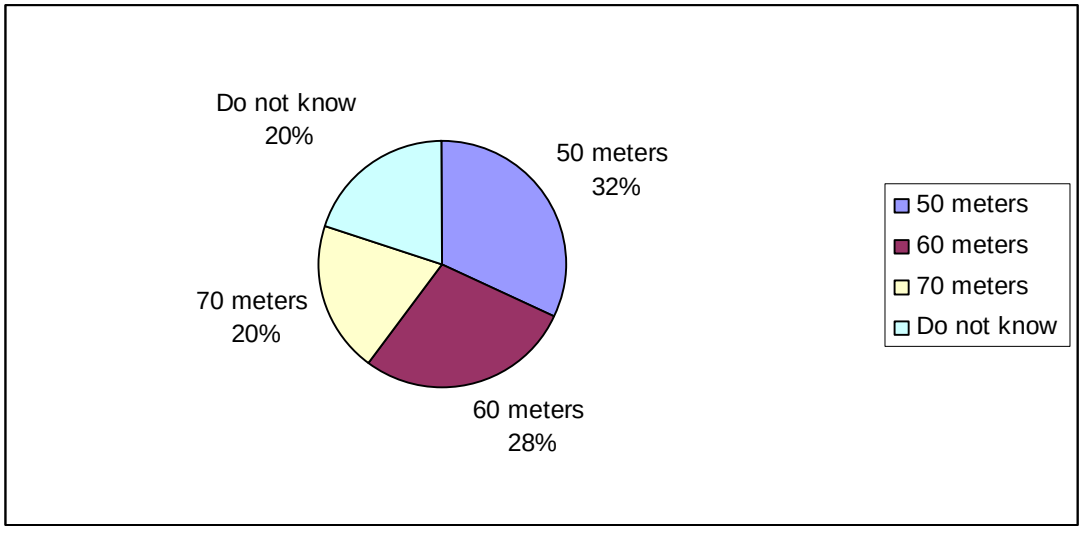
	number	percent
Yes	10	40%
No	4	16%
sometimes	6	24%
I'm not a farmer	5	20%
Sum	25	100%



9 – What is the depth of agricultural wells (approximately?)

(A) 50 meters (b) 60 meters (c) 70 meters (d) Do not know

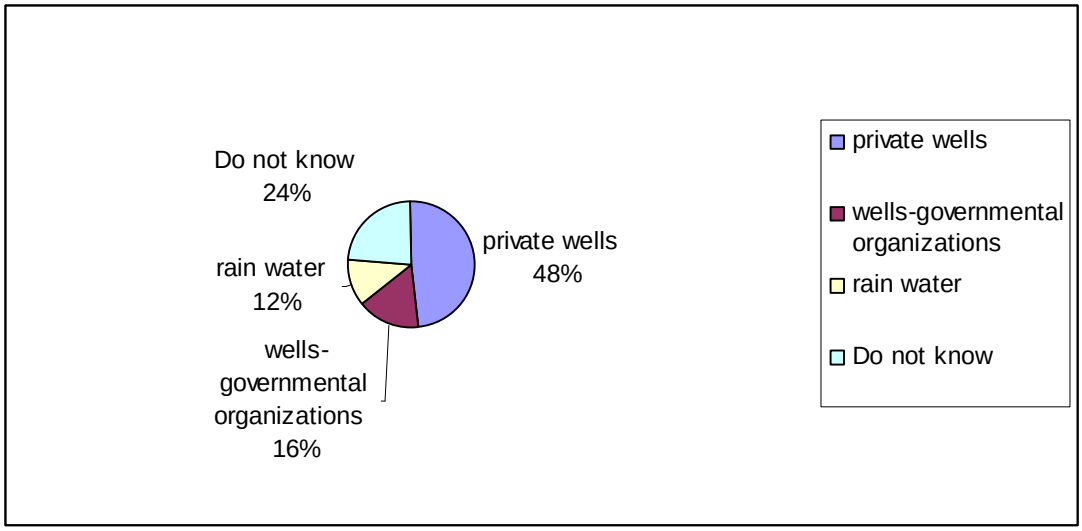
	number	percent
50 meters	8	32%
60 meters	7	28%
70 meters	5	20%
Do not know	5	20%
sum	25	100%



10 - What are the sources of irrigation in the region

(A) private wells (b) wells-governmental organizations (c) rain water (d) Do not know

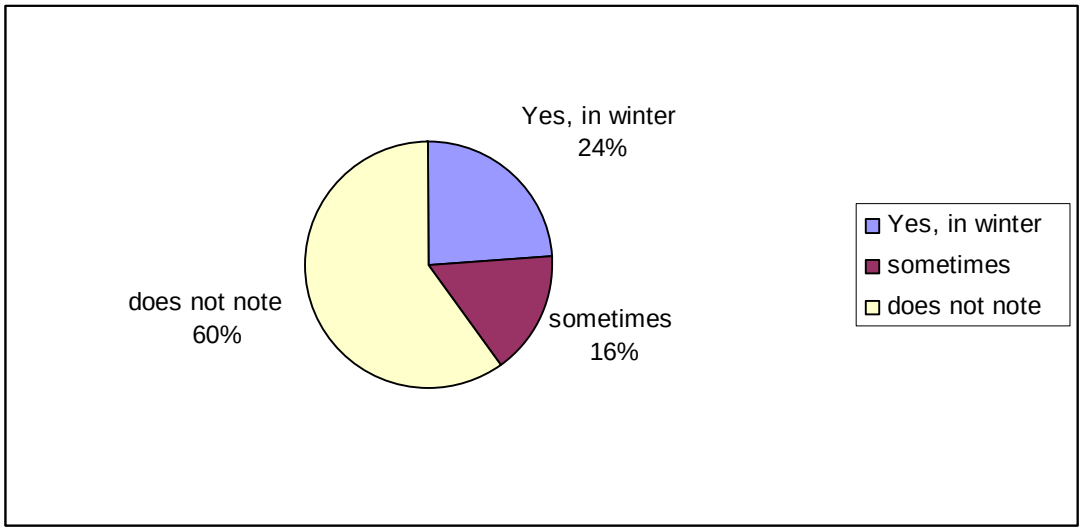
	number	percent
private wells	12	48%
wells-governmental organizations	4	16%
rain water	3	12%
Do not know	6	24%
sum	25	100%



11 - Have you noticed the arrival of rain water from the landfill to agricultural land

(A) Yes, in winter (b) sometimes (c) does not note

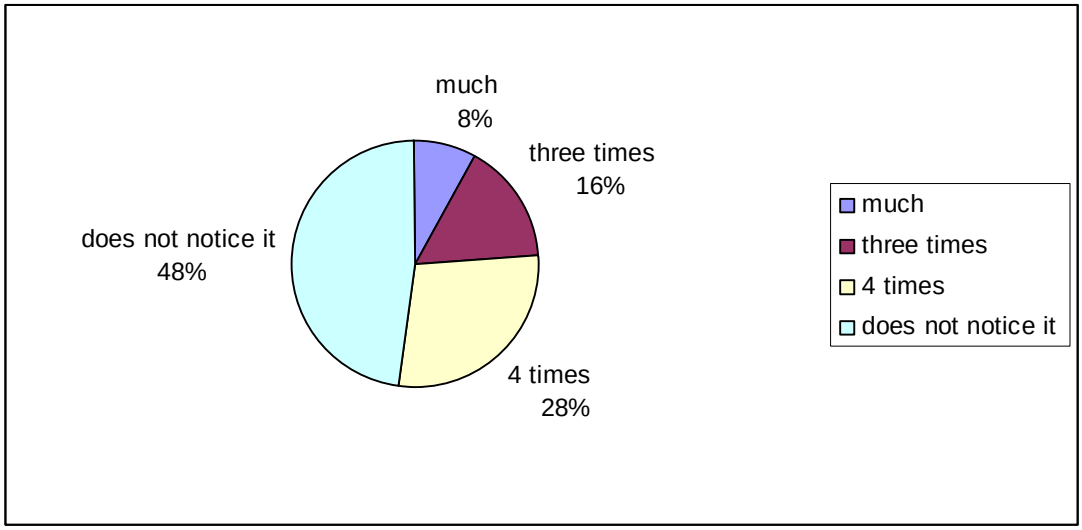
	number	percent
Yes, in winter	6	24%
sometimes	4	16%
does not note	15	60%
sum	25	100%



12 - How many times a flood was occurred by leachate pools to agricultural land

(A) much (b) three times (c) 4 times (d) does not notice it

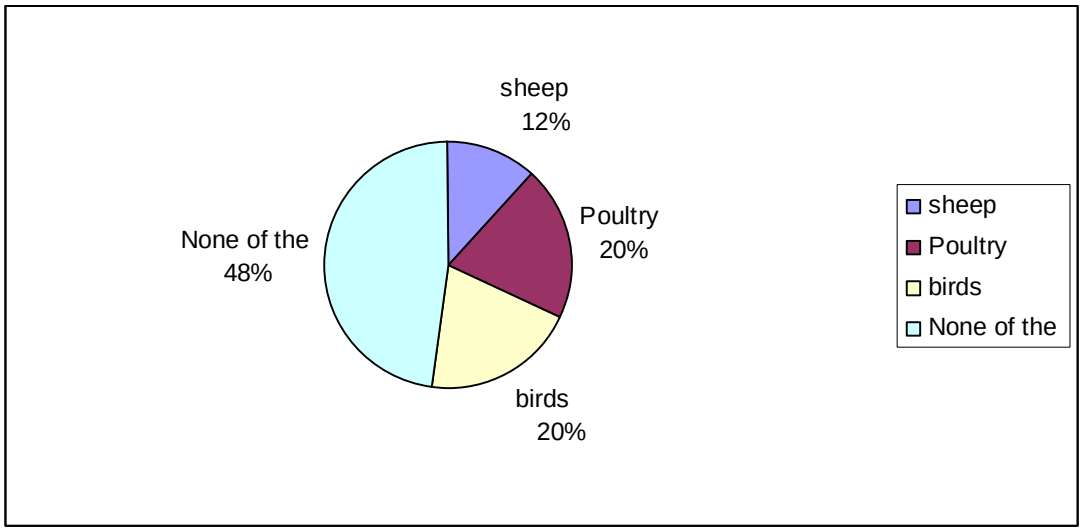
	number	percent
much	2	8%
three times	4	16%
4 times	7	28%
does not notice it	12	48%
sum	25	100%



13 - What are livestock that you rear

(A) sheep (b) Poultry (c) birds (d) None of the

	number	percent
sheep	3	12%
Poultry	5	20%
birds	5	20%
None of the	12	48%
sum	25	100%

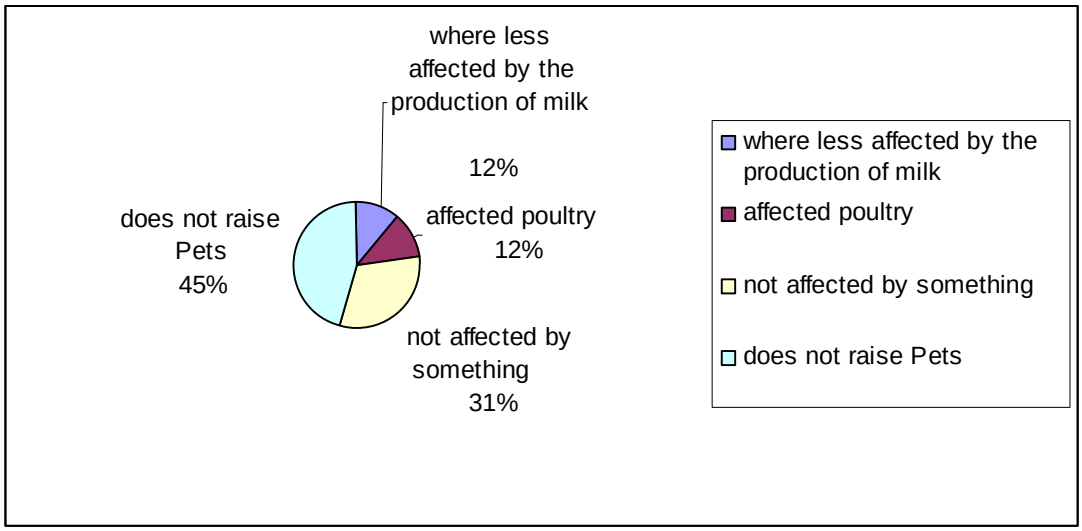


14 - Is livestock production was affected

(A) Affected by less production of milk (b) affected poultry

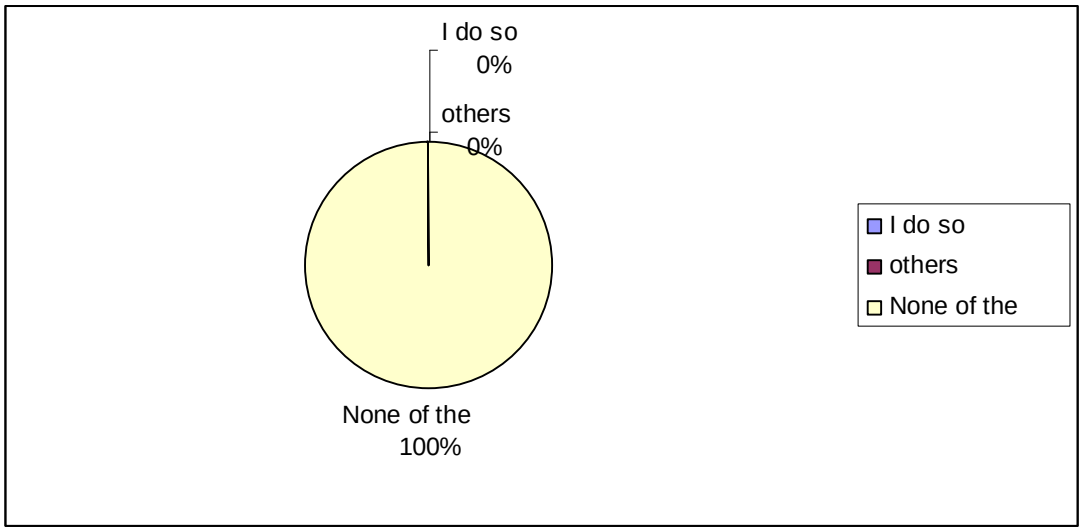
(C) not affected by something (d) does not raise Pets

	number	percent
affected by less production of milk	3	12%
affected poultry	3	12%
not affected by something	8	31%
does not raise Pets	12	45%
Sum	25	100%



15 - Are you or any other do examination of water
(A) I do it (b) others (c) None of the

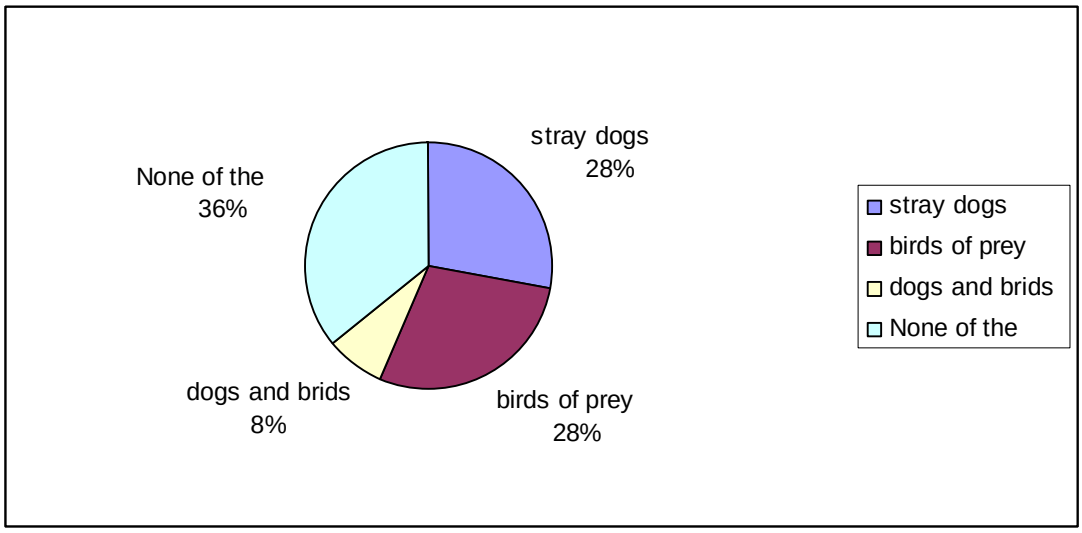
	number	percent
I do it	0	0%
Others	0	0%
None of the	25	100%
Sum	25	100%



16 - What are the animals and birds, which suffer from the presence in the region

(A) stray dogs (b) birds of prey (c) dogs and birds (d) None of the above

	number	percent
stray dogs	7	28%
birds of prey	7	28%
dogs and brides	2	8%
None of the above	9	36%
sum	25	100%



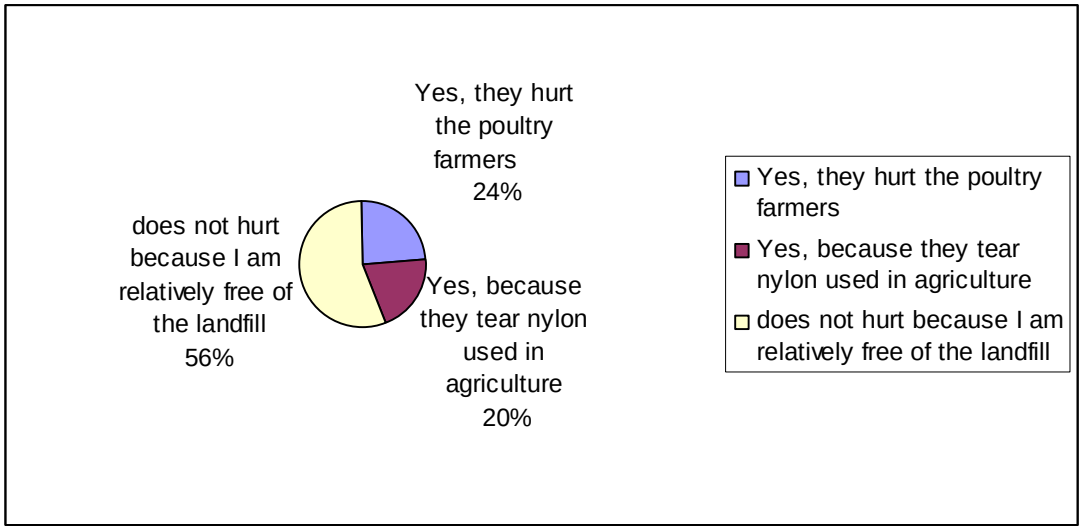
17 - Do you are bothering of presence birds of prey

(A) Yes, they hurt the poultry farmers

(B) Yes, because they tear nylon used in agriculture

(C) does not hurt because I am relatively free of the landfill

	number	percent
Yes, they hurt the poultry farmers	6	24%
Yes, because they tear nylon used in agriculture	5	20%
does not hurt because I am relatively free of the landfill	14	56%
sum	25	100%



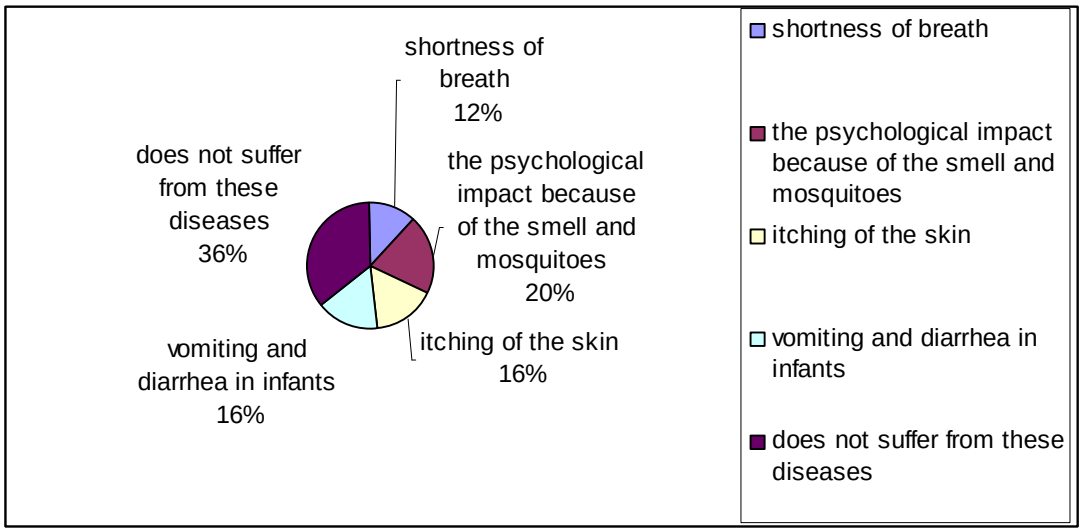
18 - Do you suffer from the following diseases:

(A) shortness of breath (b) the psychological impact because of the smell and mosquitoes

and (c) itching of the skin (d), vomiting and diarrhea in infants

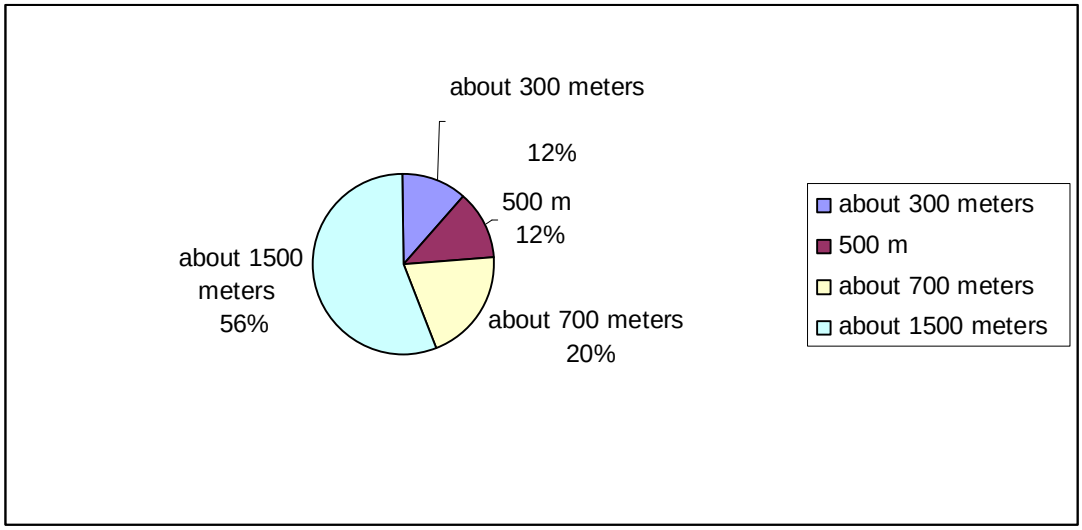
(H) does not suffer from these diseases

	number	percent
shortness of breath	3	12%
the psychological impact because of the smell and mosquitoes	5	20%
itching of the skin	4	16%
vomiting and diarrhea in infants	4	16%
does not suffer from these diseases	9	36%
sum	25	100%



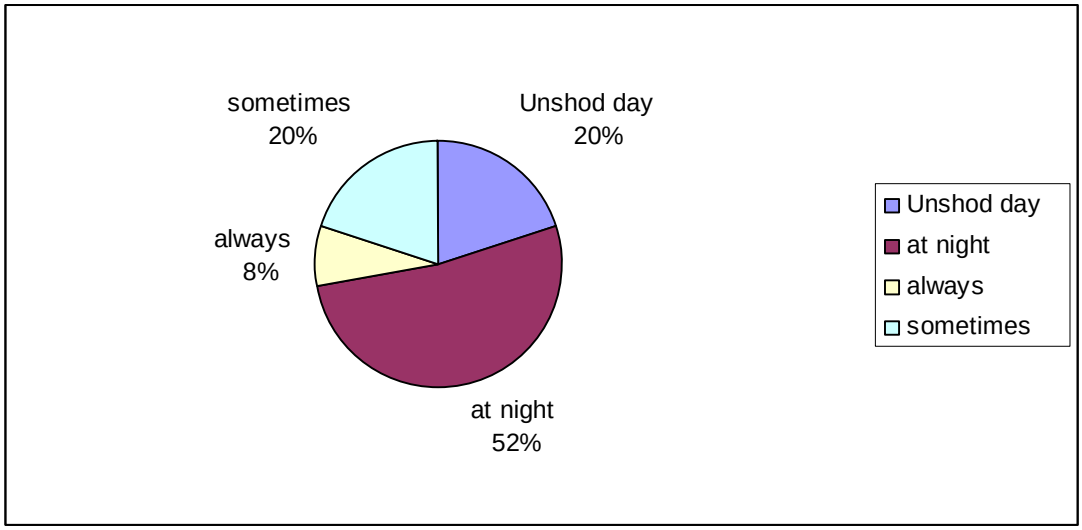
19 - How far is your place of residence for the landfill:
(A) about 300 meters (b) 500 m
(C) about 700 meters (d) about 1500 meters

	number	percent
about 300 meters	3	12%
500 m	3	12%
about 700 meters	5	20%
about 1500 meters	14	56%
sum	25	100%



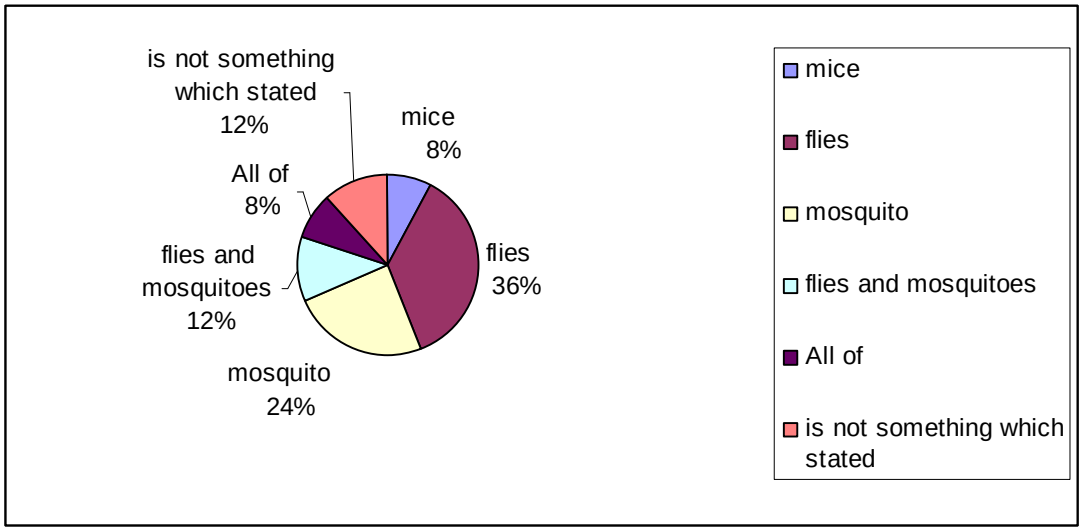
20 - What are the times that you feel the presence of an unpleasant smell
(A) on day (b) at night
(C) always (d) sometimes?

	number	percent
On day	5	20%
at night	13	52%
always	2	8%
sometimes	5	20%
sum	25	100%



21 - What are the insects and rodents that suffer from deployment
(A) rats (b) flies (c) mosquito
(D) flies and mosquitoes (e) All of (f) is not something which stated

	number	percent
Rats	2	8%
flies	9	36%
mosquito	6	24%
flies and mosquitoes	3	12%
All of	2	8%
is not something which stated	3	12%
sum	25	100%

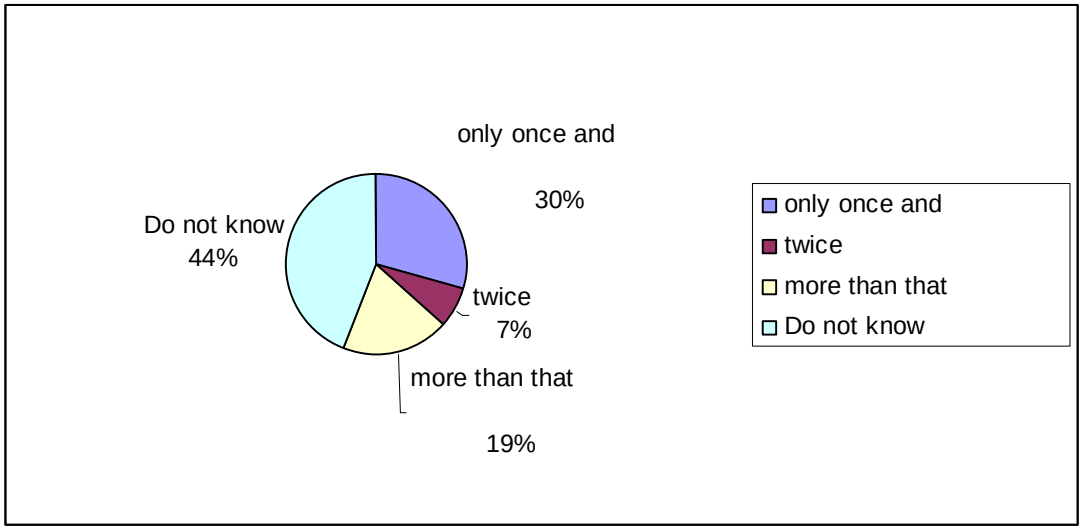


22 - How many times used the municipal body spray (insects)

(A) only once (b) twice

(C) more than that (D) Do not know

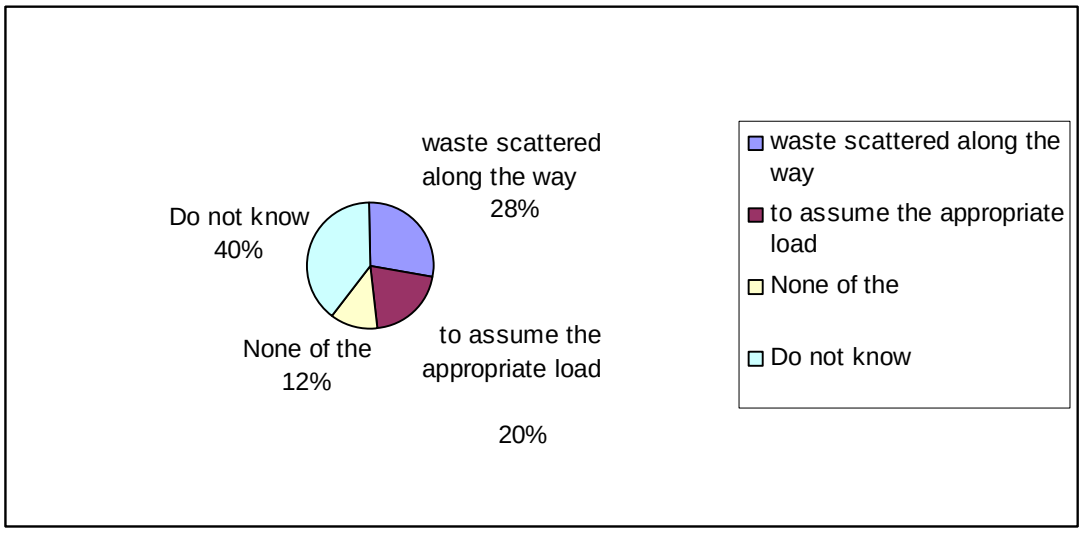
	Number	percent
only once	8	30%
twice	2	7%
more than that	0	19%
Do not know	12	44%
sum	25	100%



23 - What do you think of the performance of vehicles transporting waste to landfill

(A) waste scattered along the way (b) to assume the appropriate load
(C) None of the (d) Do not know

	number	percent
waste scattered along the way	7	28%
to assume the appropriate load	5	20%
None of the	3	12%
Do not know	10	40%
sum	25	100%

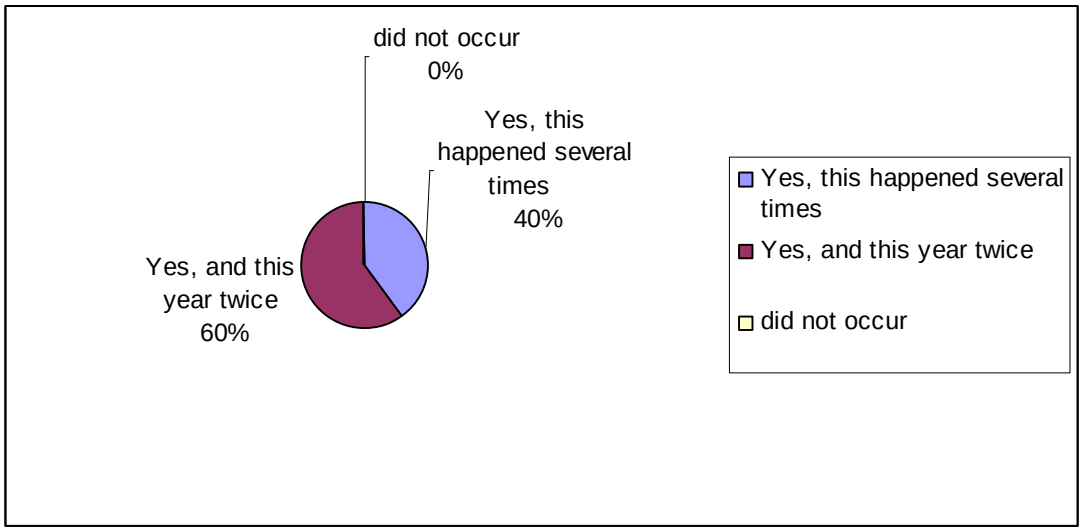


24 - Have you noticed a fire within the landfill

(A) Yes, this happened several times (b) Yes, and this year twice

(c) Did not occur

	number	percent
Yes, this happened several times	10	40%
Yes, and this year twice	15	60%
did not occur	0	0%
Sum	25	100%

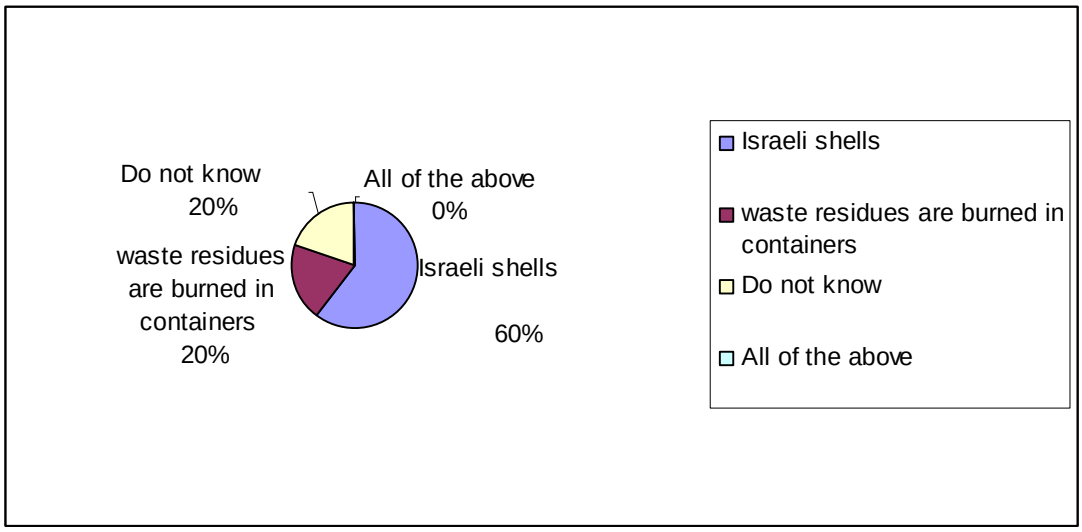


25 - What is the cause of afire in the landfill in your mind

(A) Israeli shells (b) waste residues are burned in containers

(C) Do not know (d) All of the above

	number	percent
Israeli shells	15	60%
waste residues are burned in containers	5	20%
Do not know	5	20%
All of the above	0	0%
sum	25	100%

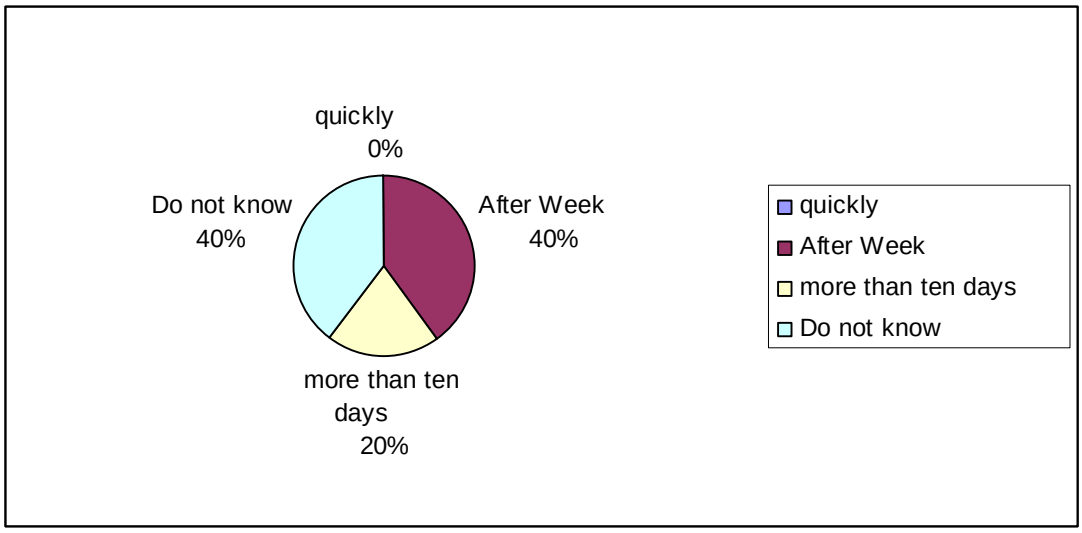


26 - When the fire under control within the landfill

(A) quickly (b) After a week

(C) more than ten days (d) Do not know

	number	percent
quickly	0	0%
After a Week	10	40%
more than ten days	5	20%
Do not know	10	40%
sum	25	100%

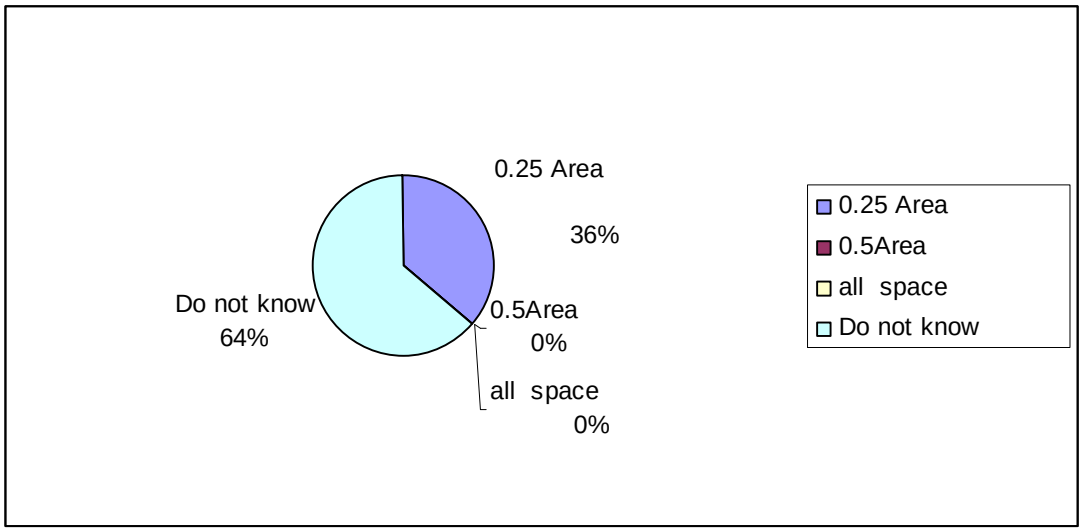


27 - What is the area of the landfill that is covered

(A) 0.25 Area (b) 0.5Area

(C) all space (d) Do not know

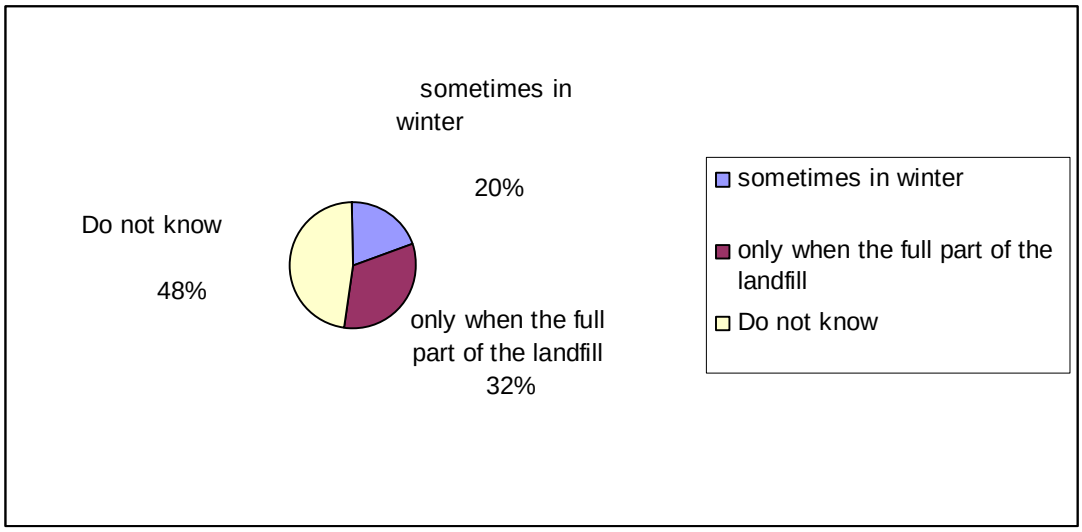
	number	percent
0.25 Area	9	36%
0.5Area	0	0%
all space	0	0%
Do not know	16	64%
sum	25	100%



28 - When do covering a waste in the landfill

(A) sometimes in winter (b) only when the full part of the landfill (c) Do not know

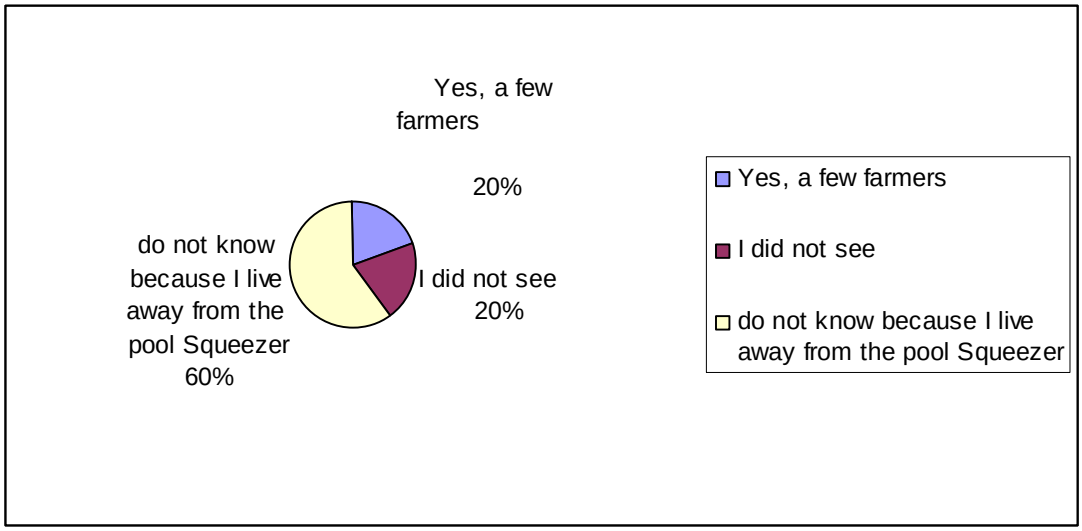
	number	percent
sometimes in winter	5	20%
only when the full part of the landfill	8	32%
Do not know	12	48%
sum	25	100%



29 - Have you seen people use leachate as a fertilizer

(A) Yes, a few farmers (b) I did not see (c) do not know because I live away from leachate ponds

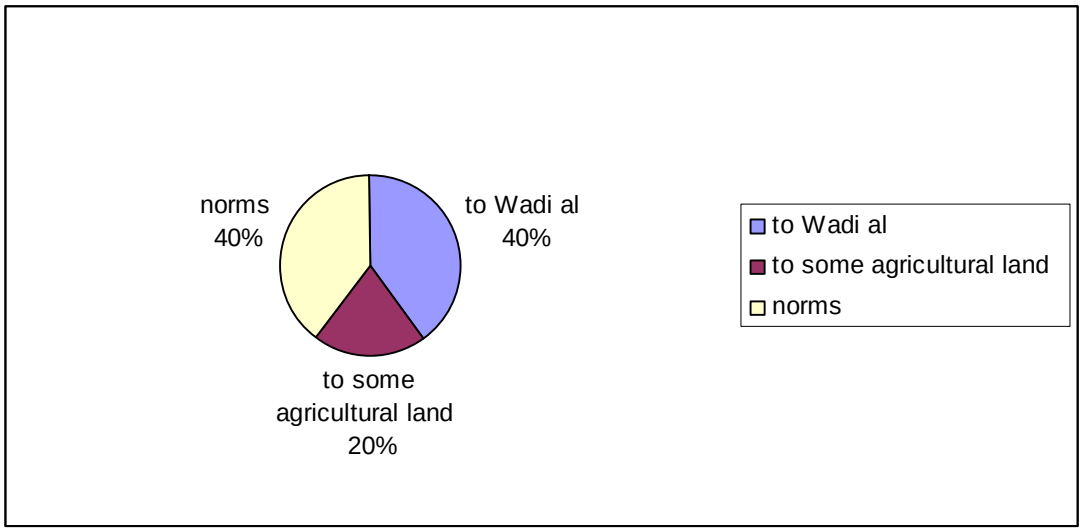
	number	percent
Yes, a few farmers	5	20%
I did not see	5	20%
do not know because I live away from leachate ponds	15	60%
sum	25	100%



30 - Where are leachate overflowing

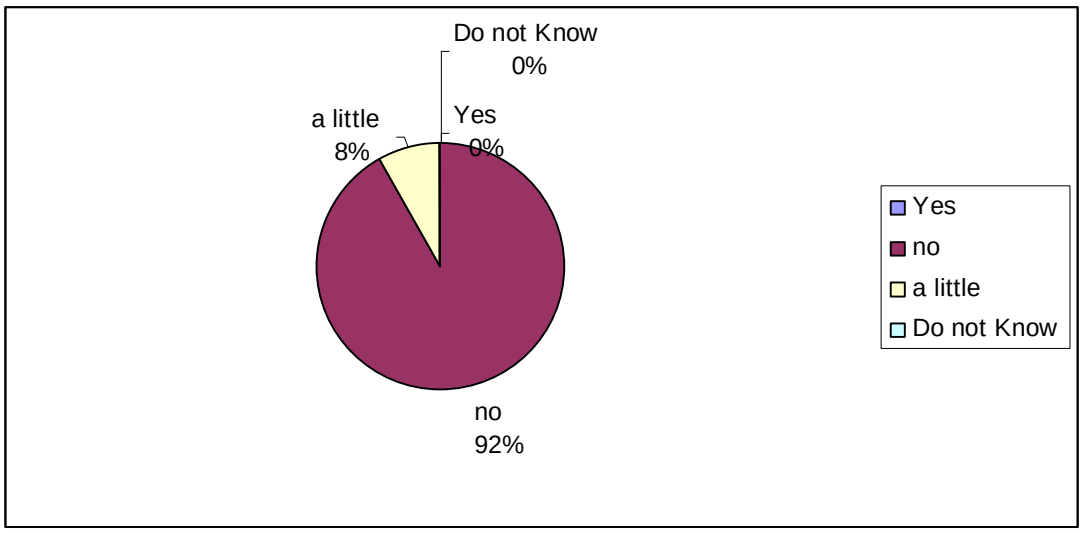
(A) to Wadi al Salqa (b) to some agricultural land (c) I don't know

	number	percent
to Wadi al Salqa	10	40%
to some agricultural land	5	20%
I don't know	10	40%
sum	25	100%



31 - Have you noticed a random dump
(A) Yes (b) no
(C) a little (d) Do not know

	number	percent
Yes	0	0%
no	23	92%
a little	2	8%
Do not Know	0	0%
sum	25	100%



Annex 3 some photos of the studied area.

Photo (1) Fire and Smoke in the Landfill area.

Photo (2) fire and Smoke in the Landfill area.

cover of the Dear EL Balah Landfill. Photo (3) Soil

Photo (4) Plastic cover of the Dear Balah Landfill.

Photo (5) Soil cover of the Dear Balah Landfill