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AL-Quds University

# Evaluation of domestic water resources in occupied West Bank by using nitrate, chloride, total organic compound concentration.

By

Oraib Ghazi Hammdan Al-Taweel

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Prepared By:

Oraib Ghazi Hammdan Al-Taweel

B.Sc. Biology, AL-Quds University

Supervisor: Dr. Amer Marie

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Thesis Approval

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Prepared By: Oraib Ghazi Hammdan Al-Taweel

Registration No:20211587

Supervisor: Dr. Amer Marie

Master thesis submitted and accepted:

The names and signatures of examining Committee members are as follows:

1.Head of Committee: Dr. Amer Marie Signature………..

2.Internal Examiner: Dr.Ziad Qanam Signature………..

3.External Examiner: Dr. Ziad Ghanem Signature………..

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**DEDICATED:**

**To my lovely parents, brother, sisters, my ante Khola, Rania my best friends , my grand mom spirit and finally To the soul that was always supportive and i did not have the chance to know them.**

**Declaration**

I will certify that this thesis for the Master degree as a result for my own research except where otherwise acknowledge. This thesis has not submitted for a higher degree to any other university or institution.

**Signature: :**

**Date**

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**Abstract:**

Ground water consider as the major source of water in west bank, and lack of water resources and increasing of population in west bank make it is important to make sure that the major source is safe to used and clean form harmful compounds and microbes.

The main hypothec of this research is the domestic ground water resources have low concentration of Nitrate, TOC, $Cl^-$ than the WHO standard in the west bank, which mean that ground water resources in the west bank safe to used for domestic.

More than 600 water samples collected during 2001-2009, over all district( Ramallah, Nablus, Bethlehem, Hebron, Jerich, Tulkarum, Jenin, Ququlia.) using the districts as options for collecting the samples because in west bank no fix method for management of waste water which is it the main source for nitrate in ground water.

The results show low concentration of nitrate and chloride in Jericho, Nablus ,Ramallah and Bethlehem, But in the other district Hebron, Tulkurm, Jenin , Qalqulia have general harmful indicter for polluted water in some samples , which could be cause by agricultural , waste water, and other man mad activities.

Other relation were studies in this research which is the relation between the nitrate and wells depth in some districts show generally that nitrate concentration decreased with well depth increase, according to different factors such as location and construction of the wells .

**الخلاصة :**

تعتبر المياه الجوفية مصدر رئيسي للمياه في الضفة الغربية ، وعدم وجود موارد المياه وزيادة السكان في الضفة الغربية تجعل من المهم للتأكد من أن المصدر الرئيسي امن لاستخدام ونظيف من المركبات الضارة والجراثيم.

الفرضية الرئيسة لهذا البحث هو ان المياه الجوفية المستخدمة للأغراض المنزلية في الضفة الغربية نحتوي على تركيز النترات، والكلوريد ،اقل من معيار منظمة الصحة العالمية ، مما يعني أن موارد المياه الجوفية في الضفة الغربية آمنة لاستخدامها للأغراض المنزلية.

تم جمع أكثر من 600 عينة من المياه خلال 2001-2009 ، قي كل من منطقة (رام الله ، نابلس ، بيت لحم ، الخليل ، اريحا، طولكرم ، جنين ، قلقيلية) وتم استخدام المناطق (المحافظات) كخيارات لجمع عينات لأنه في الضفة الغربية لا يوجد أسلوب واحد لتخلص من المياه العادمة التي هو المصدر الرئيسي للنترات في المياه الجوفية.وان كل منطقة لها نظام خاص خاضع لطبيعة المنطقة والوضع الاقتصادي لها.

وتظهر النتائج تركيز منخفض من النترات والكلوريد في أريحا رام الله ونابلس وبيت لحم ، ولكن في الخليل ، طولكرم ، جنين ، وقلقيلية اظهرت بعض العينات نسبة عالية من تركيز النترات و الكلوريد ويعود ذلك الى طبيعة المنطقة كونها زراعية ويتم استخدام كثير من الاسمدة و عدم وجو شبكات صرف صحي مؤهلة بشكل السليم.

وتم بحث العلاقة بين النترات وعمق الآبار في بعض المناطق تظهر أن تركيز النترات عموما انخفضت بشكل جيد مع زيادة عمق الابار ، وفقا لعوامل مختلفة مثل الموقع وبناء الآبار.

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**Abbreviations:**

TOC : Total Organic Carbon

WHO: World Health Organization

IC: Inorganic Carbon

TO: Total Carbon

NOM: Natural Organic Carbon

SMCL : Secondary Maximum Contaminant Level.

NPOC: Non-Purge able Organic Carbon

BOD: Biological Oxygen Demand

COD: Chemical Oxygen Demand

DBPs: Disinfection byproducts

TN: Total nitrogen

PCBS: Palestinian Central Bureau of Statistics

MPCA: Minnesota Pollution Control Agency

WBWD: West Bank Water Department

EAB: The Eastern Basin

TDS: Total Dissolved Solids

EC: Electrical Conductivity

EPA : Secondary Drinking Water Guideline

HWE: House of Water Environment

# Chapter one

# Introduction

## 1. Introduction:

West Bank located in the Middle East**.** The Geographic coordinates are 32 00 N°, 35 15 E°, with total area of 5,860 $km^2$, land*:* 5,640 $km^2$, water: 220 $km^2$**.** The Climate, temperature, and precipitation vary with altitude, warm to hot summers, cool to mild winters , according to data collected in 2008**,** January has the highest rainfall quantity in the period between 203-2008. The total numbers of ground water wells are 519 and the number of springs is 146 ( PCBS,2009). The quantities of rainfall ranges between 503.6 mm in Ramallah Station and 118 mm in Jericho Station. Elevation extremes lowest point*:* Dead Sea -422 m highest point Tall Asur 1,022 m. Usable land: 27% permanent crops: 0% permanent pastures: 32% forests and woodland: 1% , other 40% of the total area of West Bank there are 2,461,267 Palestinian inhabitants living within the 1967 borders **(**PCBS,2009).

The Water resources in West Bank, according to PCBS, are mainly ground water that is extracted from wells and springs and water purchased from the Israeli Water Company (Mekorot), with a total quantity of 308.7million $m^3$. The percentage of water wells was 73.1% which equals almost 225.7 million $m^3$ of water, which was pumped from water wells, the percentage of water springs was 8.2%, and water from the Mekorot percentage was 18.7% (PCBS,2009 ) **.**

General the world depends on one of the most important sources  of drinking water, which is ground water. It provides mostly 50% of drinking water. For that protections of ground water resources from contamination is very important because it concerns for all. According to it direct connection of health Nitrate is one of the contaminated material, that enter the ground water (Mahler.et.al ,2007).

This study is among the few studies focusing on evaluation of domestic ground water quality in the West Bank. The hypothec of this study is nitrate , chloride and TOC concentrations of domestic water is lower than the recommended limit of WHO- standard .

The WHO recommends the upper limit for nitrate is 50 mg\l, for chloride 250mg\l, and for TOC 2mg\l.

The main hypothesis:

Domestic water resources in the  West Bank contains low nitrate, low chloride and low TOC concentration, because thus water sources are located outside the urbanization centrum, and tape water originated  mainly from deep aquifer.

**Problem statement:**

Nitrate ,chloride and TOC concentrations were used as indicators for ground water pollution. Both $NO_3$ and TOC  are indictors for organic pollution, which could be from different sources, such as waste water, agricultural residual or leaching from soil horizons.

Chloride is a good environmental tracer and can be originated from man mad sources ( solid waste , waste water, agricultural return flow) or from geological sources (evaporates), and brines.

This study is acomprehensive one and serves the evaluation of the West Bank water resources (divide the study area to districts because no specific waste water treatment (one of main nitrate source), some districts has network,, some dumping site some non. Data was collected during the seven years and store in AL_Quds Environrnental Lab-data base.

**Objective:**

The overall objective of the study is to evaluate the quality of drinking water interns of nitrogen compound, chloride and total organic compounds (TOC) contents.

**Specific objectives:**

1. To evaluate the $NO_{3,}$ $Cl^-$, TOC, concentration in ground water , wells and springs.
2. To find out the relations between wells depth and grade of pollution.

**1.1. Different forms of Nitrogen:**

Nitrate ( $NO_3^-$ ) is inorganic chemical compound and composed of nitrogen and oxygen elements, its consider as very important source of nitrogen for plant and animal life. (Mahler. et.al ,2007 . Conrad. et.al, 1999).

Nitrogen has a symbol of N, with atomic number of 7, weight number 14.000674, melting point $^-210C^{\circ}$ and boiling point $^-192C^{\circ}$. It's bonding with other elements such as hydrogen and oxygen make nitrogen compounds which can be found in foods, organic materials, fertilizers, poisons, and explosives. When  Nitrogen reacts with hydrogen it forms ammonia ($NH_3$). However hydrazine ($N_2H_4$) (covalent bond ) ammonia which is used as a fertilizer, used in the plastic industry, and used in the livestock industry as a feed supplement. Ammonia is often the starting compound for many other nitrogen compounds. "(Wikipedia, 2009)

"One of a variety of nitrogen oxides that form a family often abbreviated as NOx. Nitric oxide (nitrogen monoxide, NO), is a natural free radical used in signal transduction in both plants and animals. For example, in vasodilatation by causing the smooth muscle of blood vessels to relax. The reddish and poisonous nitrogen dioxide $NO_2$ contains an unpaired electron and is an important component of smog. Nitrogen molecules containing unpaired electrons show an understandable tendency to dimerize (thus pairing the electrons), and are generally highly reactive. The corresponding acids are nitrous $HNO_2$ and nitric acid $HNO_3$, with the corresponding salts called nitrites and nitrates"( Wikipedia, 2009**),** which its concern in this research**).** In some area they found a relation between well depth (wells less than 100 feet) and nitrate concentration. It has a high concentration of nitrate and they are found a relation between $NO_3$ concentration and the potential for land used (Midison, 1998. Hudak, 2000). Agriculture activity and illegal dispose of row waste water surrounding the wells causing increasing the concentration of chloride, sulfate, and nitrate (Anayah and Almasri, 2009. Al-Absi, 2008. Boumes .et.al , 2008. Wakida and Lerner, 2005. Abdul-Jaber, .et. al 1999). The kind of crops used in land and N- fertilizer affected the nitrate concentration in ground water (Sently .et. al, 2003. Jaynes.et.al, 2001).

### 1.1.2 Healthy concerns of Nitrate:

High nitrate concentration in ground water could be related to animal waste, where isotopes ($N^{14}$, $N^{15}$ ( Gormly and Spalding, 1979. Charles and David,1975). The level of $NO_3$-N associated with source available and region environment factors which categories into two groups , in put (population density, the amount of nitrogen contributed by fertilizer manure and atmospheric source , second one is aquifer vulnerability ( soil drainage characteristic and the ratio of wood land to acres in agriculture area( Spalding and Exner ,1993. Bernard, et.al ,1997).

Generally Nitrate is ingested for older children and adult when it is absorbed it normally is excreted in urine. As human adult can consume large amounts of Nitrate for short time, it effects the chronic, for high level and long term consumption. It has needs many research to study its effect on health, in an infant younger than six month Nitrate is poisonous. The infant has a little acid in their digestive tract to help them to digest food, which is formed by bacteria. This bacteria can also change nitrate to toxic nitrite ($NO_2$). This bacteria should be killed by the age of six months by hydrochloric acid to stop convert nitrate to nitrite, if the nitrite enters the blood stream, it reacts with hemoglobin (molecular carry the oxygen in blood stream), giving new compound, which is Methenoglabin, causing Suffering for babies. This case is called “Methemoglobinemia”( Mahler. et.al, 2007).

#### 1.1.2.1 The symptoms of Methemoglobinemia

The Methemoglobinemia symptoms were regionalized as :

1. Bluish skin color around the eyes and the mouth.
2. Death can occur if 70% of hemoglobin convert to methehomoglabinm so its need quickly treatments (Mahler. et.al ,2007).

**1.1.2.2 N-nitrosamines:** It is considered to be another disease of the reaction to nitrate with organic compound (second amines) causing cancer (Mahler et.al,2007).

### 1.1.3 Livestock:

Nitrate effects the ruminate animals by converting nitrate to toxic nitrate through the bacteria in their rumen, causing Methemoglobinemia with symptoms including lack of coordination , labored breathing , blue membranes , vomiting, and abortions. For the baring cow no physical septum but producing less milk. In animals like swine and chicken their is no dangers of nitrate because it has no rumen (Mahler. et.al, 2007).

## 1.2. Chloride as ion:

Chloride is a chemical commonly found in soil and rocks, belonging to the chemical group (the halogens).Their behavior in the environment differs .Chloride is very mobile in ground water. The primary source of chloride is halite (salt) and brines. Anthropogenic (human) sources of chloride include fertilizer, road salt, human and animal waste, and industrial applications. These sources can result in significant concentrations of chloride in shallow ground water because chloride is readily transported through the soil. Chloride has a Secondary Maximum Contaminant Level (SMCL) of 250 mg/L (parts per million). Chloride may impart a bad taste to water. Aquifers can have high concentrations of chloride under a variety of settings. The high concentration of chloride and nitrate in ground water has a significant relation with irrigation agriculture from the input of nitrogen and pottasuim (pottasuim chloride fertilizer (saffigray and Keeney,1977). Chloride and sulfate in ground water could be increasing due to municipals and industrial waste dumping on the ground surface which  need high and good treatment to stop the pollutions (Venkateson and Swamnathan,2009). Chloride content of ground water is generally reliable indication of the contamination of ground water by sea as 90 % of the dissolved solid of sea water , chloride salt and high concentration of chloride depend on the depth of the wells (Brown ,1958).

Well-protected aquifers with large ground water residence times and a source of chloride will have the highest concentrations of chloride. These aquifers include the Cretaceous and buried Quaternary aquifers. Surficial aquifers, however, are also sensitive to contamination from anthropogenic sources. Road salt and animal wastes are the most likely sources of chloride. Even though salt and animal wastes may be distributed on the surface of the land, chloride is readily leached as water infiltrates the soil. Chloride in shallow ground water is a useful indicator of contamination from human sources. Compared to back ground concentrations, chloride concentrations are typically elevated in shallow ground water under urban land use, around septic systems, near waste impoundments and occasionally under agricultural fields. It moves with ground water, and is therefore an excellent tracer of contaminant sources. Chlorides are also used to assess quality control for ground water sampling and laboratory analysis.

Reverse osmosis, ion exchange and distillation are treatment methods for removing chloride from well water. Impacts from anthropogenic sources can be reduced by proper management of animal and human wastes and reduced use of road salts (MPCA, 1999) .

**1.3 Total organic carbon (TOC)**

Its definitions the amount of carbon bound in a form of organic compound and is often used as a non-specific indicator of water quality or cleanliness of pharmaceutical manufacturing equipment. A typical analysis for TOC measures both the total carbon present as well as the Inorganic Carbon (IC). Subtracting the inorganic carbon from the total carbon yields TOC. Another common variant of TOC analysis involves removing the IC portion first and then measuring the left over carbon. This method involves purging an acidified sample with carbon-free air or nitrogen prior to measurement, and so is more accurately called Non-Purgeable Organic Carbon (NPOC).

Since the early 1970s, TOC has been recognized as an analytic technique to measure water quality during the drinking water purification process. Studying TOC is essential for understanding the subsurface chemistry during environmental site characteristic. High TOC in ground water could be due to the high concentration of TC (Total Carbon) which hard to remove from water (Mahler. et.al, 2007). The TOC concentration is effected by several factors such as using pesticide, wells depth and ground water flow path, the geohydrochemical characteristic of ground water flowing toward the abstraction site( Amin. et.al ,2010).

TOC in water comes from decaying Natural Organic Matter (NOM) and from synthetic sources. Humic acid, fulvic acid, amines, and urea are types of NOM. Detergents, pesticides, fertilizers, herbicides, industrial chemicals, and chlorinated organic are examples of synthetic sources. Before source water is treated for disinfection, TOC provides an important role in quantifying the amount of NOM in the water source (Amin. et.al ,2010).

In water treatment facilities, source water is subject to react with chloride containing disinfectants. When the raw water is chlorinated, active chlorine compounds ($Cl_2$, HOCl, $ClO^-$) react with NOM to produce chlorinated disinfection byproducts (DBPs). Many researchers have determined that higher levels of NOM in source water during the disinfection process will increase the amount of carcinogens in the processed drinking water. With passage of the Safe Drinking Water Act, TOC analysis emerged as a rapid and accurate alternative to the classical but lengthy biological oxygen demand (BOD) and chemical oxygen demand (COD) tests traditionally reserved for assessing the pollution potential of wastewaters (Wikipedia, 2009).

# Chapter Two

## 2.1Study area:

This study will focus on evaluation of nitrate , chloride , TOC in domestic ground water resources. This includes Palestinian wells and springs.

Ground water is the only domestic water resource in the West Bank. Evaluation of the nitrate solvents ,TN in composition with TOC is essential for future management in term of health risk for taking action to protect this source by implementing protection zone .In the other hand measuring tritium in this source give a strong evidence about the ground water residence time through its pathway to reach the ground water body.

There are three primary groundwater basins underlying the West Bank (Eastern, Northeastern and Western Basins). Both the Northeastern and Western basins are shared between Israelis and Palestinians. The Palestinians have a limited access to the Northeastern Basin and strictly limited access to the Western Basin. In addition to the quantity of available water resources, the quality of water is emerging as a critical issue. Threats to ground water quality include disposal of untreated wastewater, increasing salinity due to agricultural activities and intrusion of native groundwater of poor quality. Widespread use of herbicides and pesticides also represent a threat to drinking water supplies” (Froukh,2007). Figure 1.1 show water samples locations over all district.

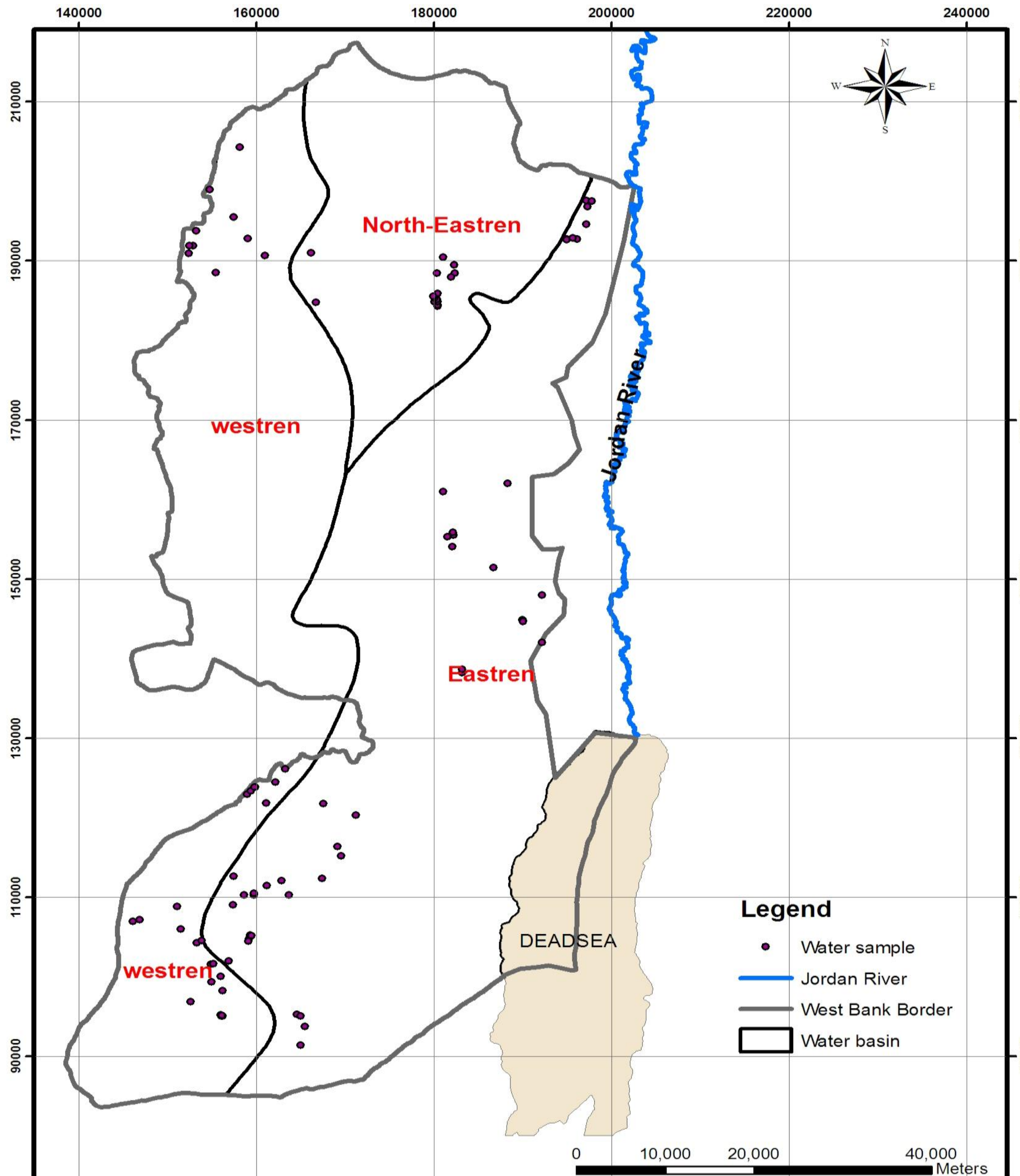


Figure 1.1 : Water samples locations over all District. (E.L, 2009).

## 2.1 The Mountain aquifers in West Bank are:

The structure of Northern West Bank is simple . it contains down warped Cretaceous strata, subsequently filled with a basin chalks and other limestone. The Eocene basin is a syncline. The upper cretaceous rocks frings a roughly triangular Eocene basin. The Ground Water direction is plunging to the North-West direction. In general, the total annual capacity of the ground aquifers is estimated at 600-650 MCM. The water in these aquifers flows in two main directions, east and west. The groundwater basins are recharged directly from rainfall on the outcropping geologic formations in the West Bank mountains (forming the phreatic portion), while the major storage areas are in confined portions (MEnA,2009).

Rainwater infiltrates to the water table forming the West Bank Aquifer System which is composed of dolomite and limestone rocks of the Lower Cenomanian and Turonian ages. The West Bank Aquifer System extends below the area of the West Bank. It is mostly recharged by rainfall from the mountains of the West Bank. The West Bank Aquifer System is divided into three main groundwater basins, each of which is subdivided into sub-basins. These basins are:

### 2.1.1 Western Groundwater Basin

It consists of two sub-basins, Nahr El-Auja El-Tamaseeh and Hebron Beer Shaba that drain the Lower and Upper Cenomanian aquifers with a total pump age and spring discharge ranging from 380-400 MCM/yr (Abdul-Jaber,1999 ). The storage capacity of this basin is about 360 MCM/yr. Eighty percent of the recharge area of this basin is located within the West Bank while 80% of the storage area is located within the Israeli borders. The groundwater movement in this basin is westwards towards the coastal plain in the west. As part of this aquifer extends under Israel, it is considered as a shared basin between Israel and Palestinians. There are more than 35 springs within this basin each having an average discharge of greater than 0.1 litre/sec in the West Bank (Abdul-Jaber. et.al, 1999 ).

### 2. 1.2.Northeastern Groundwater Basin

This consists of the Nablus-Jenin basin, which drains the Eocene aquifer and the overlying Samarian basin, which drains the Eocene and Neogene aquifers. Its storage capacity is approximately 140 MCM/yr. Palestinians consume about 18% of its annual safe yield for both irrigation and domestic purposes from wells and springs in the Jenin district and East Nablus (Wadi El Far'a, Wadi El-Badan). The groundwater in this basin flows north and northeast towards Bisan natural outlets ( Abdul-Jaber. et.al, 1999).

The Eocene aquifer formed about one third of total area of Northern West Bank ,specially numulitic limestone, limestone and chalky limestone group. This aquifer is very important because of the Karstic porosity and the widening of joints and fractures and bedding planes by solution erosion (Abdul-Jaber. et.al, 1999). A sea- floor ooze important by the subsidence the upper cretaceous strata led to inundation by warm shallow sea in which chemical and biogenic precipitation of calcium carbonate . The sea floor ooze evolved diagentically into the basin fill of chalk and nummulitic and **algic** limestone. The west and the central parts of the basin are the main aquifer Eocene. The Nablus -Biet Qd syncline show evidence of the relationship between the aquifers. The geological structure and the consequents Ground Water show that too. ) Figure1.2 shows the Water Basin in West Bank. Many springs drain water from this aquifer , and water used in domestic and in irrigation. Ein Faria and Al- Bathan spring group, in addition to many spring distributions all over Nablus and Jenin district ,are related to this aquifer. The regional ground water flow is from southeast to the northeast, where faults like Al – Faria fault drain the water to south east and many springs drain along this fault. The Eocene aquifer from north part have the greatest potential for Ground Water exploitation. The recharge in this part is about $200\times10^6 m^3$ /yr. This value does not include runoff, which may infiltrate some parts of the chalk to the limestone aquifer. The infiltrate depend on rainfall intensity and primary and secondary porosity. Few hundred ground water wells were taped water from about 100 meter depth. The majority of this wells were drilled during the last decades. The over exploitation cause decreasing of water table and increasing salinity (Abdul-Jaber. et.al, 1999).

## 2.2. Eastern Groundwater Basin

This constitutes the eastern flank of the West Bank Aquifer. Its groundwater generally flows towards the east (Jordan Valley). The available potential resource of this basin between 100 and 150 MCM/yr . The Eastern Groundwater Basin not exploited because of poor water quality. It needs extensive hydrogeological study to identify its potential resources, safe yield, hydrogeological characteristics, groundwater quality, and the flow pattern of each of the sub-basins. This basin supports over 79 large flowing springs of an average discharge greater than 0.1 liter/sec. These springs constitute around 90% of the total annual spring discharge in the West Bank.

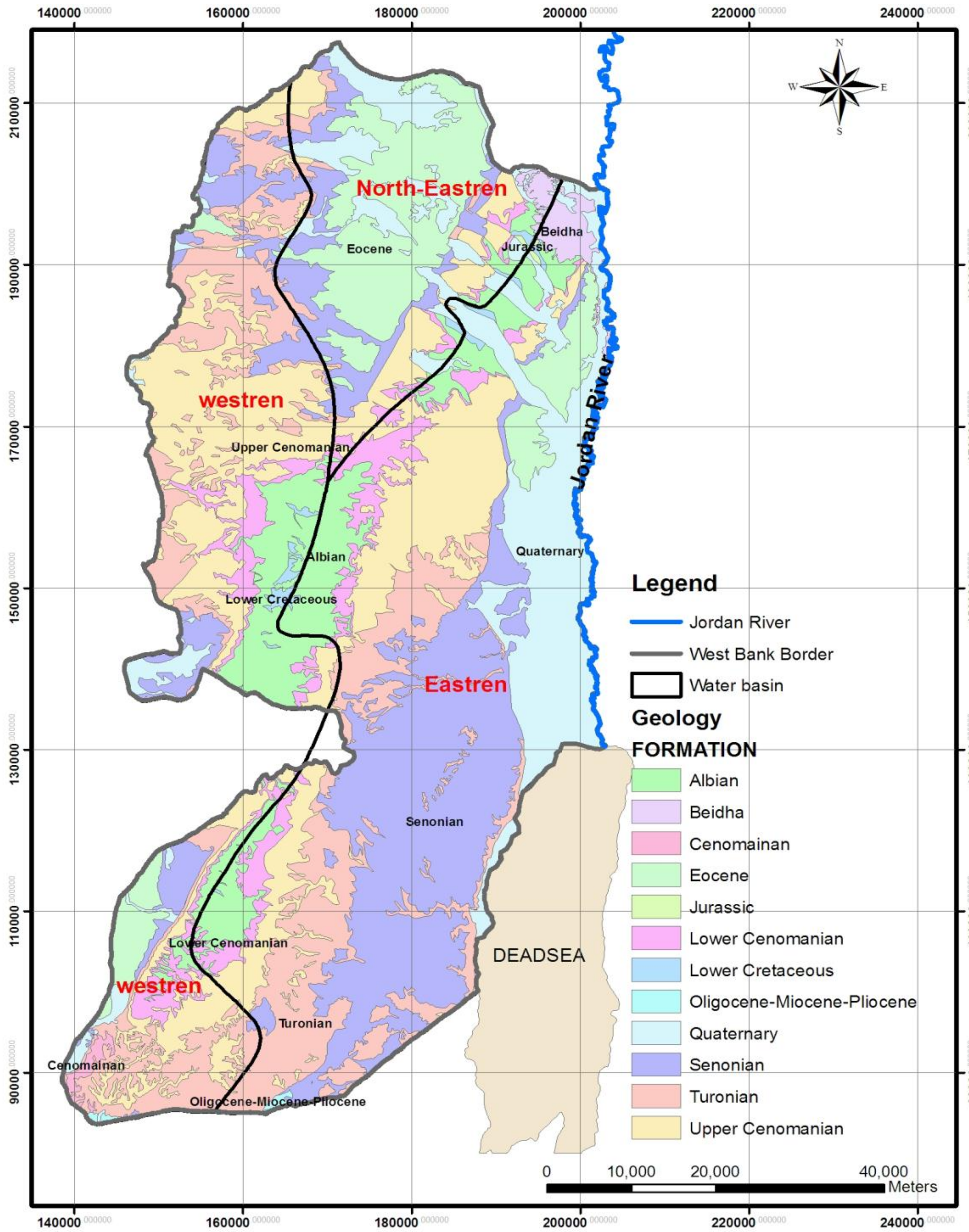


Figure 1.2: West Bank Ground Water Basin, and different rock outcrops.(E.L,2009).

## 2.3 Springs

There are 527 springs in the West Bank, of which 114 have a minimum discharge rate of 0.1 litre/sec. Most of these springs are located either east or west of the water divide and discharge water with the slopes towards east or west. There are 79 springs located east of the water divide, flowing towards the Jordan Valley and 35 springs which flow to the west of the water divide. Sixteen of the springs are used for domestic purposes while the rest are for agricultural use. The total annual discharge of the major springs ranges from 24 MCM/yr. in the 1978/79 hydrologic year, to 116 MCM/yr. in the 1991/92 hydrologic year. This data gives an average of 52 MCM/yr. These springs can be classified according to their surface catchment areas as first the Eastern Basin Spring Systems which consists of Jerusalem Desert Spring System (E'in Gedi, E'in Fashkha, Um Eddaraj, Aytan, Artas, Sa'ir, E'in Fara, E'in Fawwar, E'in El-Qilt, E'in Es-Sultan and Far'a Springs). Second is the Western Basin Spring Systems which more than 35 springs, of which 15 springs are used for domestic purposes such as Jerusalem spring system, Auja-Tamaseeh Spring and Nablus Spring System (MEnA,2009).

## 2.4 Wells:

Wells in the West Bank can be divided into three categories: Israeli (and settler) controlled wells under Palestinian control, and West Bank Water Department (WBWD) wells that are nominally Palestinian, but in reality Israel still has the last word in the operation of these wells. The Israeli wells are found mainly in the EAB( The eastern basin,) near the Jordan Valley, because groundwater in this autochthonous Palestinian basin does not flow into Israel. Thus, these wells mainly supply settlers and their intensively irrigated agriculture, in the Jordan Valley. Outside the West Bank, in the WAB(west basin), Israel disposes of hundreds of deep and productive wells (Messerschmid ,2009). Figure 1.3 show the Distrusting of spring and wells in West Bank.

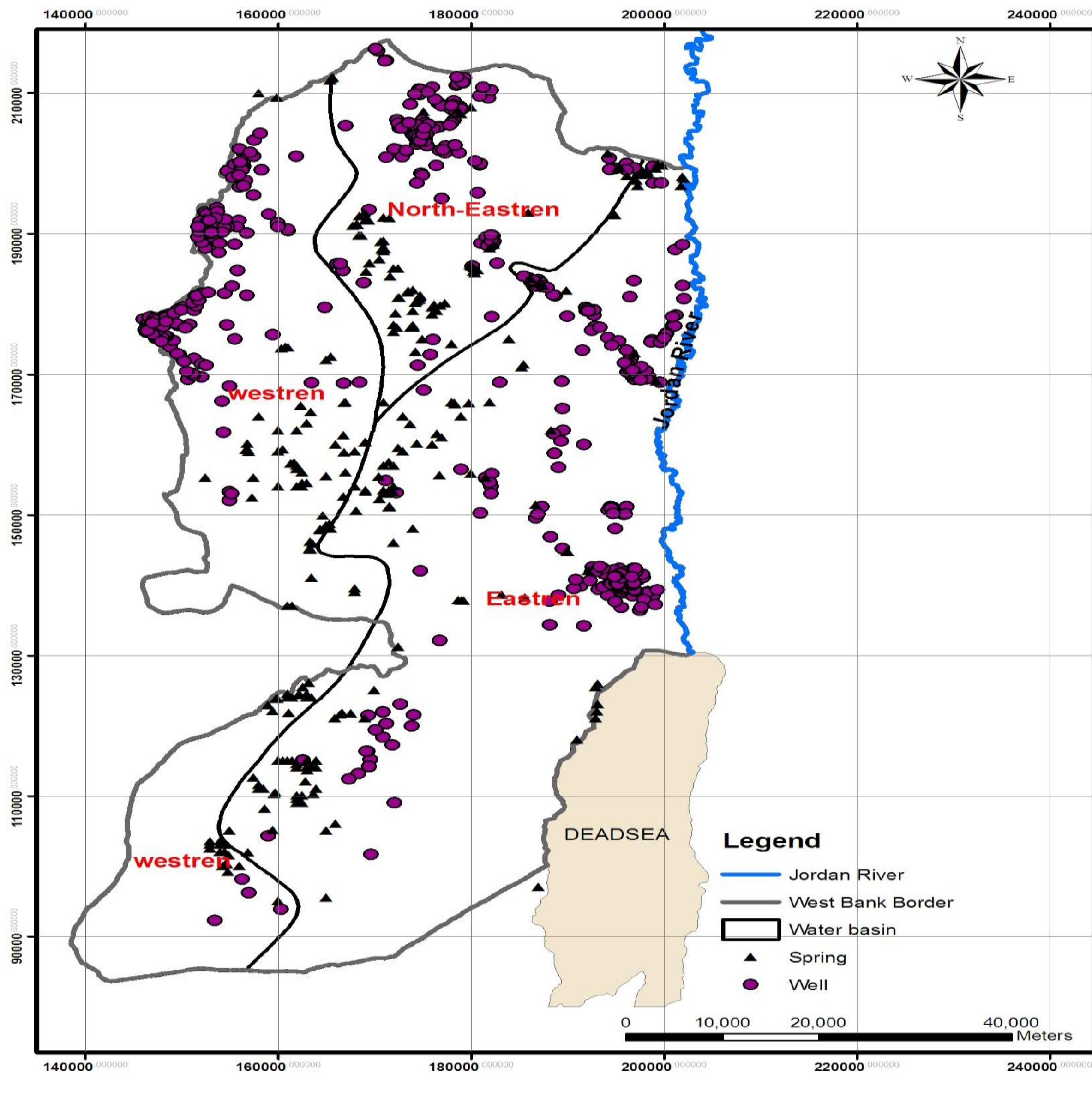


Figure 1.3: Distrusting of spring and wells in West Bank (E.L, 2009).

## 2.5. Sources of Ground Water pollution.

Ground water pollution is an unwanted change in the quality of ground water that cause from actions done by humans. The value of ground water puts the physical, chemical, and biological nature of water at risk. Seeing that ground water has no smell, color, or taste so it must pay attention to its chemical and biological qualities. Even though buying spring and ground water as "pure" their characteristics differ from that of pure water. Usually ground water has mineral ions. As the water travels through mineral surface in pores or fractures of the unsaturated zone, ions are slowly dissolved from the particles of soil, sediments, and rocks. It called "dissolves solids". From the precipitins water or river water that recharges the aquifer may it have perceived some of these dissolved solids (Wikipedia, 2009).

A list of the dissolved solids in any water is long, but it can be divided into three groups: major constituents, minor constituents, and trace elements (element that has an average concentration of less than 100 parts per million measured in atomic count, or less than 100 micrograms per gram) . The total mass of dissolved constituents is referred to as the total dissolved solids (TDS) concentration. In water, all of the dissolved solids are either positively charged ions (cations) or negatively charged ions (anions). The total negative charge of the anions always equals the total positive charge of the cations. A higher TDS means that there are more cations and anions in the water. With more ions in the water, the water's electrical conductivity (EC) increases. By measuring the water's electrical conductivity, we can indirectly determine its TDS concentration. At a high TDS concentration, water becomes saline. Water with a TDS above 500 mg/l is not recommended for use as drinking water (EPA secondary drinking water guidelines).

Water with a TDS above 1,500 to 2,600 mg/l (EC greater than 2.25 to 4 m /cm) is generally considered problematic for irrigation use on crops with low or medium salt tolerance. Except for natural organic matter originating from topsoils, all of these naturally occurring dissolved solids are inorganic constituents: minerals, nutrients, and trace elements, including trace metals. In most cases, trace elements occur in such low concentrations that they are not a threat to human health. In fact many of the trace elements are considered essential for the human metabolism.

In Europe, water from springs and wells with certain levels of trace elements has long been considered a remedy for ailments. Popular health spas usually are located near such areas. High concentrations of trace metals can also be found in ground water near contaminated sources, however, posing serious health threats. Some trace constituents that are associated with industrial pollution, such as arsenic and chromium, may also occur in completely pristine ground water at concentrations that are high enough to make that water unsuitable as drinking water.

Microbial matter is also a natural constituent of ground water. Just as microbes are ubiquitous in the environment around us, they are very common in the subsurface, including ground water. Hydrogeologists increasingly rely on these, for instance, for subsurface bioremediation of contaminated ground water. Human activities can alter the natural composition of ground water through the disposal or dissemination of chemicals and microbial matter at the land surface and into soils, or through injection of wastes directly into ground water ( Harter ,2003).

### 2.5.1 Sources of ground water pollution in West Bank:

Since the aquifers in the West Bank are of carbonate lithology , elevated levels of calcium, magnesium and bicarbonate are expected due to dissolution of $CaCO_3$ limestone. The degradation of the water quality in the West Bank aquifers is mainly due to wastewater, agricultural pollution and salinity problems (ARIJ, 2001). Figure 1.4 show hydrological vulnerability of ground water to pollution in the West Bank.

In general sources of groundwater contamination is also dumping of solid wastes in unprotected dumping sites, intensive use of agricultural fertilizers , disposal of untreated domestic water through sewage networks and/or cesspits and improper discharge of domestic wastewater (HWE,2007).

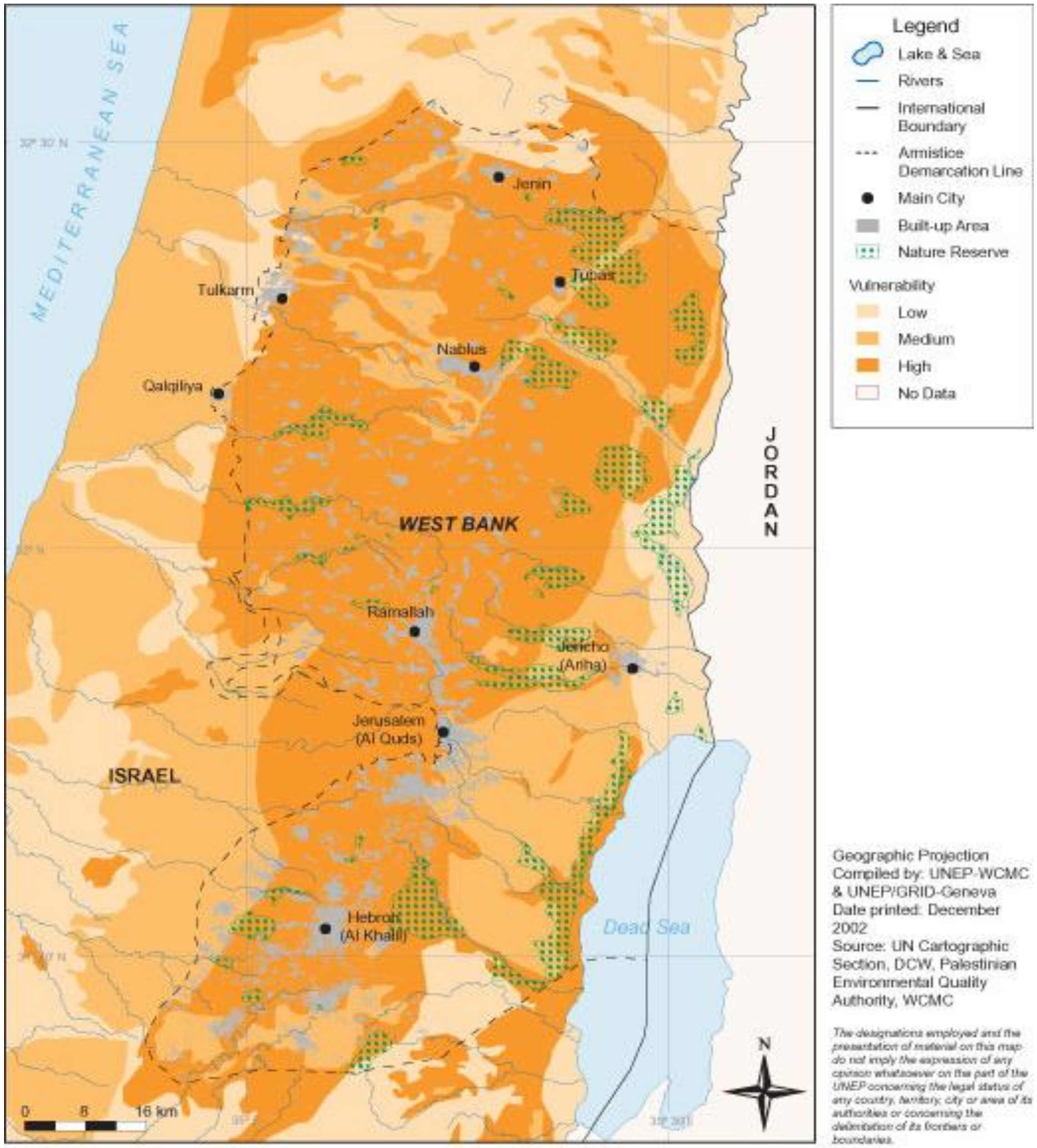


Figure 1.4: hydrological vulnerability of ground water to pollution in the West Bank.(Mid East- Maps, 2002)

#### 2.5.1.1 Wastewater:

Disposal from Palestinian built up areas by sewage collection networks in Palestine are limited to major cities and to some portions in their municipalities boundaries.

Most of them are poorly designed and old . Leakage and flooding are common ,in areas where sewage networks exist, wastewater is collected and discharged untreated into wadis . In the Palestinian refugee camps, open channels are common. Wastewater disposal from Israeli settlements , in the West Bank in which 45% of settlements in the West Bank are located on the highly sensitive areas, about 300,000 settlers produce 13 Mcm/yr of wastewater and water consumption in Israel is 200_300 l/capita/day, while the consumption in the Palestinian areas is 60 liter/capita/day which is high percentage (HWE,2007). Figure 1.5 show the wastewater wadies in West Bank and western aquifer basin.

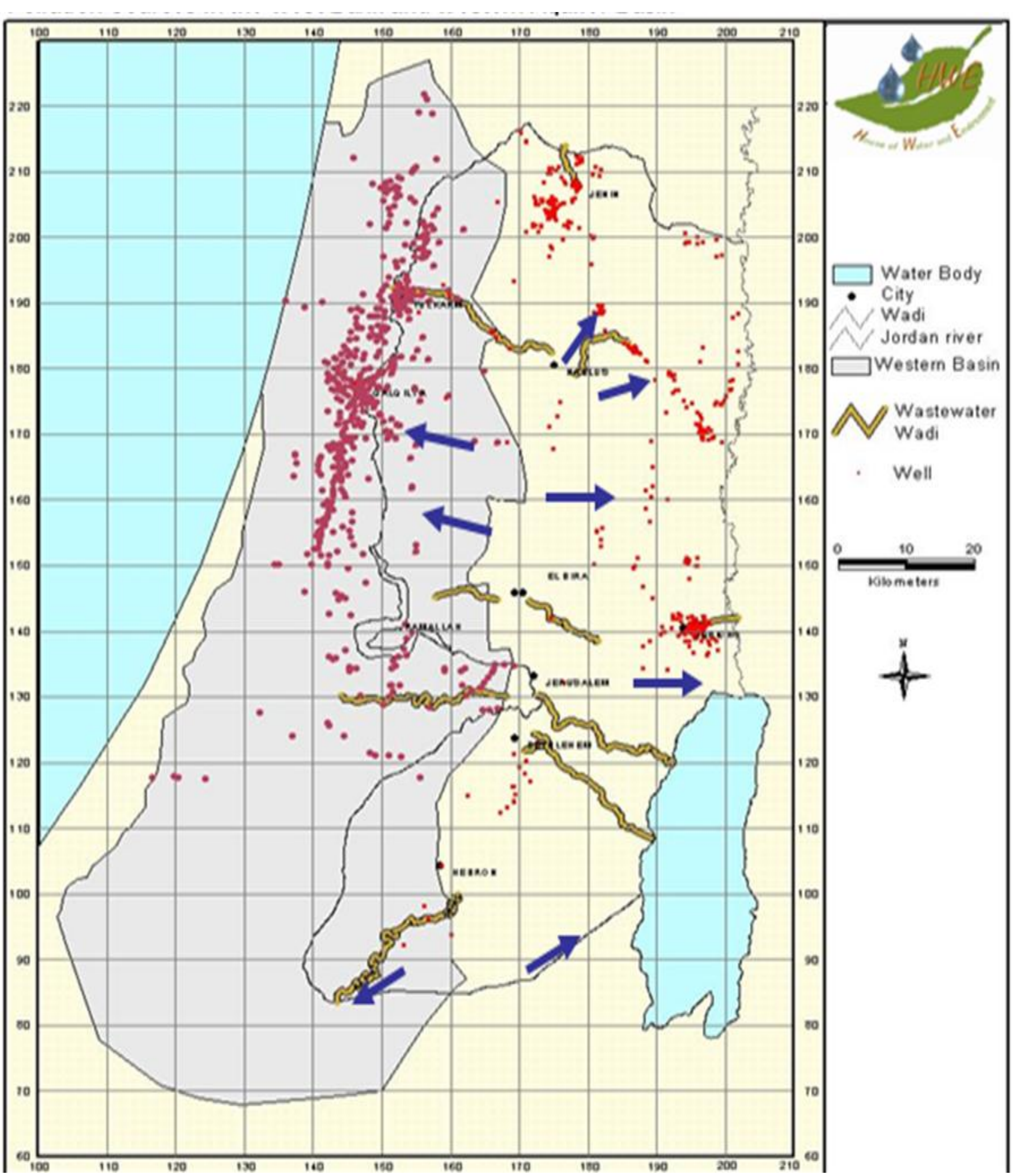


Figure 1.5: wastewater wadies in West Bank and western aquifer basin (HWE2007)

#### 2.5.1.2 Dumping Sites:

These sites consider as a current or potential source of pollution, there are 133 dumping sites in the West Bank and 4 in Gaza Strip, The solid waste management in Palestine is not adequate because of the following rezones:

1. None of dumping sites was designed as sanitary landfill.

2. None of them is protected to prevent leachate percolation.

3. The choice of location is arbitrarily with no consideration to the soil characteristics, topography, groundwater pollution potential or future planning.Figure1.6 shows location of dumping sites. where the majority of these sites located in the mountain area where the recharge of the aquifer takes place and where surface run off is common during winter months. It is to expected that different organic and non organic pollutants are leached through the krastic unsaturated zone and reach the Ground water body. The transport of the pollutants depends on the physical properties of the aquifers and the recharge mechanism of the aquifer (HWE,2007).

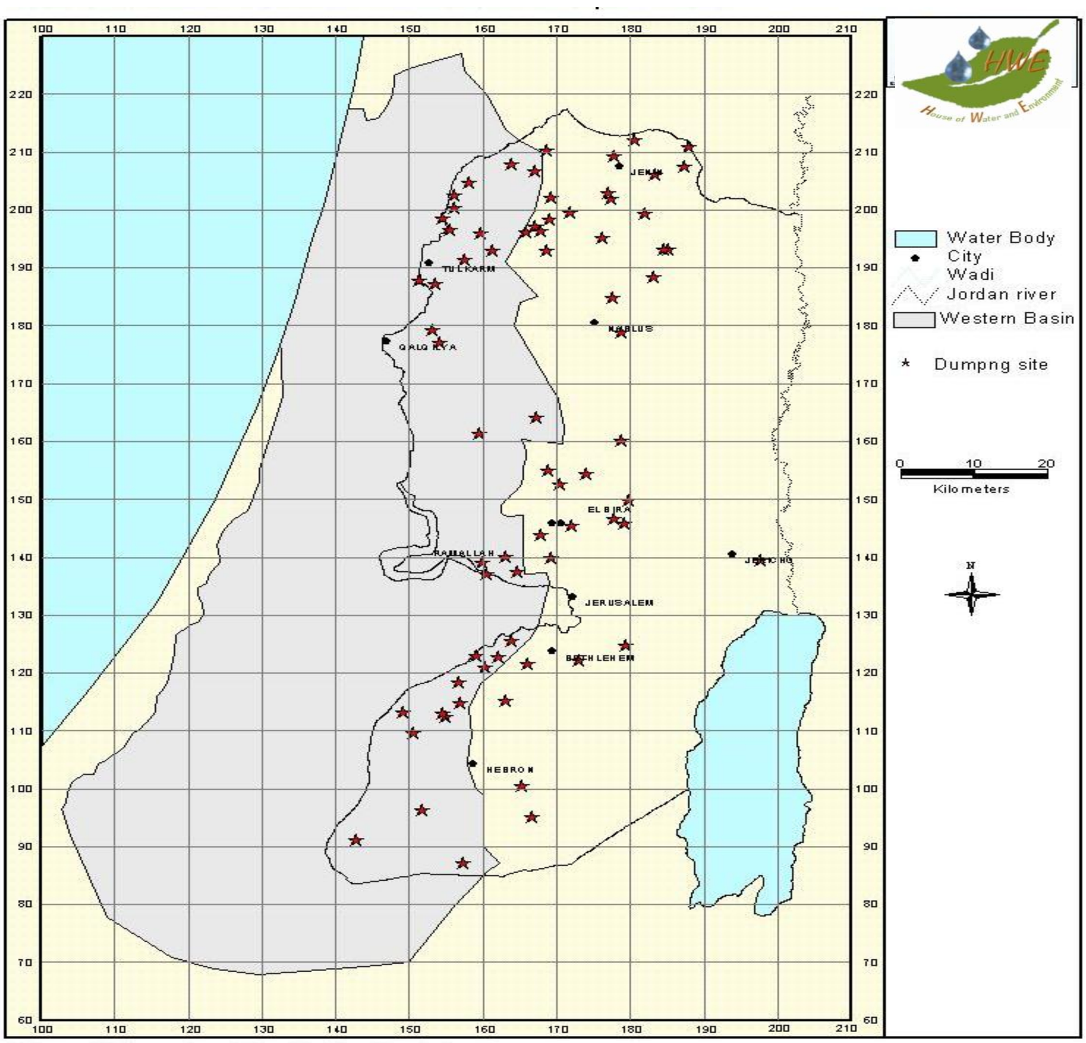


Figure 1.6: Location of dumping sites in West Bank (HWE,2007)

### 2.5.1.3 Industrial wastes:

Unwanted materials produced in or eliminated from an industrial operation and categorized under a variety of this headings, such as liquid wastes, sludge, solid wastes, and hazardous wastes. The Palestinians main industries are quarrying and stone cuttings, textile, chemical and agricultural industries. All types of industrial wastes may contain heavy metals or high organic loads are released untreated into the environment. In addition to this there are illegal 7 Israeli industrial zones mainly located on the tops of hills of the West Bank releasing wastes into the open environment without any treatments (Samhan,2007).

The chemical industry in Palestine includes three main product lines: paints, soaps and detergents. It also includes related chemical industries such as cosmetics. The industry which includes 119 factories, is widely spread provinces like Nablus, Jenin, Bethlehem, Ramallah, in Figure 1.8 shows industrial sites in the West Bank (Al-Habash,2008). The amount of chemicals and tannery materials vary depending on tanning recipes and fashion changes and colors. Table1.1 show some of the characteristics of industrial waste water (Al-Habash, 2008) .

Table 1.1: characteristics of industrial waste water West Bank (Al-Habash, 2008).

| **Parameter** | **Value** |
|---|---|
| PH | 9 |
| Total solids | 10000mg/l |
| Total suspended solids | 2500 mg/l |
| BOD | 900 mg/l |
| COD | 2500 mg/l |
| Sulfide | 160 mg/l |
| Total Nitrogen | 120 mg/l |
| Ammonium Nitrogen | 70 mg/l |
| $Cr^{+3}$ | 70 mg/l |
| Cl | 2580 mg/l |
| Sulfate $SO4^{-2}$ | 2000 mg/l |

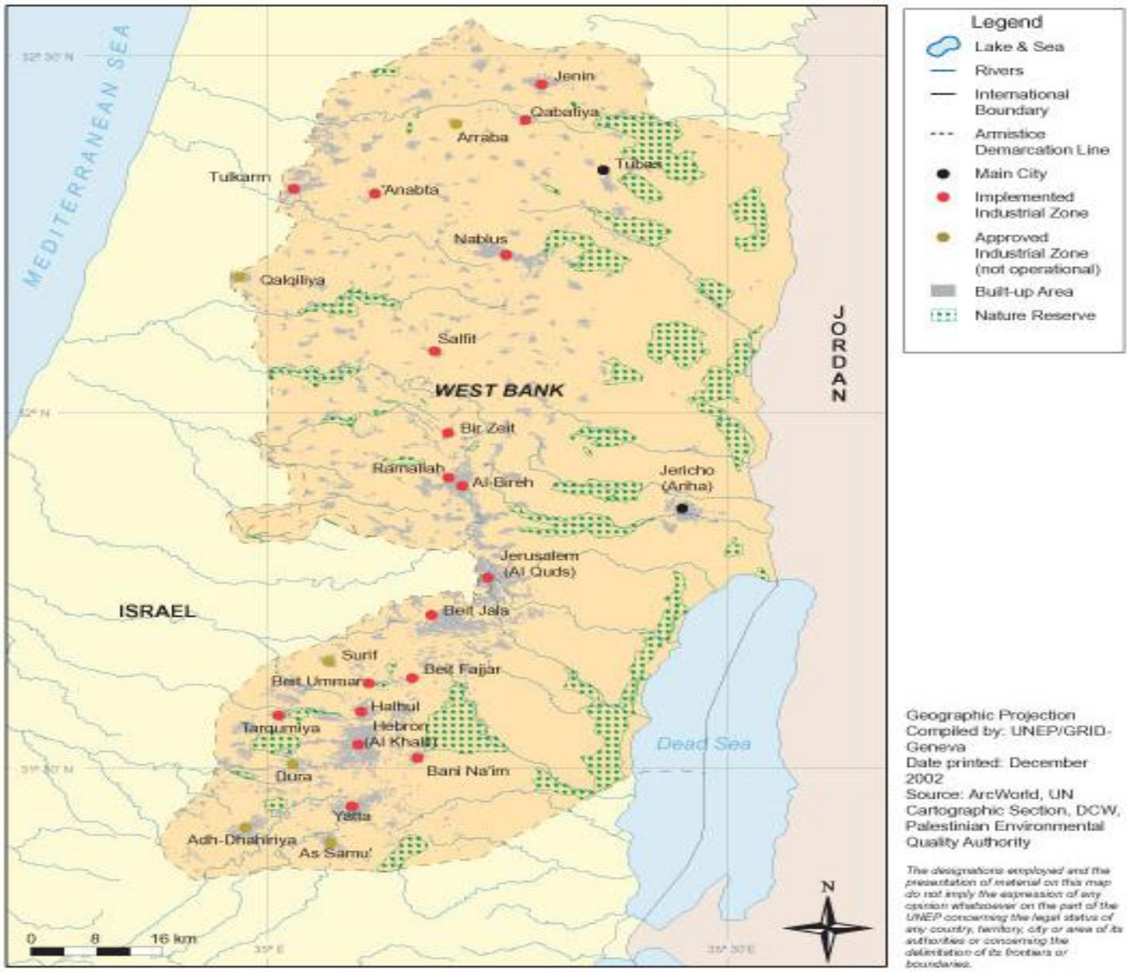


Figure 1.7: Industrial Sites in the West Bank. (HWE,2007).

### 2.5.1.4 Olive Mills:

90% of the olives produced in the West Bank are processed in 278 olive mills and effluent from olive mills (Zebar) drained untreated to the environment (HWE2007).

The general physical and chemical properties of Zebar (effluent from Olive mills) is notably extremely high in BOD, COD, TSS, fats and phenols as shown General Physical and Chemical Properties of Zebar (Samhan,2008). Table1.2 show the chemical compound of Zebar.

Table1.2: The chemical  compound of Zebar. (Samhan,2008).

| Parameter | Unit | Value |
|---|---|---|
| COD | (mg/l) | 40,000 –220,000 |
| BOD | (mg/l) | 23,000 –100,000 |
| pH | ----- | 3 -5.9 |
| Organic Nitrogen | (mg/l) | 154 -1106 |
| Phosphorous | (mg/l) | 100 -900 |
| Sodium | (mg/l) | 100 -500 |
| Potassium | (mg/l) | 2,800 -11,600 |
| Calcium | (mg/l) | 200 -900 |
| Magnesium | (mg/l) | 100 -700 |
| HydroxyTyrosol | (mg/l) | 71 -937 |
| Polyphenols | (mg/l) | 5,000 -80,000 |
| Carbohydrates | (mg/l) | 3,000 -24,000 |
| Oil Content | (mg/l) | 1,000 -23,000 |

### 2.5.1.5 Agriculture:

Farmers have used increasing doses of pesticides ,herbicides and fertilizers (207 tons of pesticides were used in 1996/97, without being aware of negative effects on the environment (HWE,2007).

"Pesticides are applied rather generously in the West Bank; for example, 15,000 metric tons are applied every year in Israel and the West Bank. Pesticides are also transported by runoff affecting aquatic ecosystems. The total quantity of pesticide used is estimated at 730 tons in the West Bank(ARIJ,2003).The pesticides are used intensively in the irrigated agricultural areas ,for example in the Jordan valley, north of the West Bank and Gaza Strip. The agricultural sector uses of pesticide have increased by using green house in which they use 372 tones per year from the disinfecting gas like Methyl Bromide. It is important to emphasize that this is halide organic compound and widely used .Fertilizers are applied in large quantities in the West Bank, often in the irrigation water. Fertilizers reach aquatic ecosystems, where they can cause eutrophication, and they also contaminate ground water. Thus, water drawn from Wades and aquifers for agriculture contaminates and alters ecosystem functioning. Again, such indirect effects of water use may be environmentally more significant than their direct effects"(Ghanem,2007).

Many farmers apply nitrogen as fertilizers or manures to their crops. Nitrogen applied through fertilizers or manure is converted to plant-available-nitrate by bacteria living in the soil. The growing plants consume part of these nitrates. Growing bacteria also consume nitrates. When sufficient decomposable organic matter is present, soil bacteria can remove a significant amount of nitrate-nitrogen through a process called immobilization. Nitrate- nitrogen becomes a part of soil organic matter through this process of immobilization. Another group of bacteria use nitrates as a substitute for oxygen when oxygen is limited. These bacteria convert nitrate-nitrogen to gases such as nitrogen, nitrous oxide, and nitrogen dioxide. This conversion of nitrate-nitrogen to gaseous form is known as denitrification. Nitrate-nitrogen not taken up by crops or immobilized by bacteria into soil organic matter or converted to atmospheric gases by denitrification can leach out of the root zone and possibly end up in groundwater (Bhumbla, 2008).

Nitrate leaching from fertilizer use depends upon the fertilizer types (ammoniacal, nitrate or organic), method of application, and climatic conditions. Nitrate leaching may be greater when a fertilizer contains the nitrate compared to the situations where ammonia nitrogen is the major component of a fertilizer. Nitrate losses are likely to be more when all the nitrogen is applied in one application compared to when nitrogen is applied in split applications. Fall-application of fertilizers or manures will cause high nitrate losses during early spring. Nitrate losses from fertilizer use can be reduced by matching fertilizer application with nitrogen needs of a crop.

Nitrogen fertilizers or manure used on a sandy soil are more vulnerable to leaching to groundwater than nitrogen used on a clay soil. Water moves rapidly through sandy or other coarse-textured soils. Nitrates move along with the water in a soil. Nitrogen loss to the groundwater from clay soils is smaller than those for the coarse-textured soils. The negative charge on the clay particles retains ammonium ions ($NH_4^+$). Retention of ammonium ions on clay particles protects them (ammonium ions) from leaching. Nitrate ions ($NO_3^-$) are negatively charged and are not retained by clay particles. Clay soils do not specifically retain nitrates. Water movement through clay soils is very slow and small. Water does not pass easily through clay soils so nitrates, which only move with water, do not leach to groundwater. Pore space in clay soils is often filled with water. Water-filled pores of clay soils lack oxygen. Lacking oxygen, a group of soil bacteria, called facultative anaerobes, substitute nitrates for oxygen for respiration. When bacteria use nitrates as a substitute for oxygen, they convert nitrates to nitrogen gas through a process called denitrification. More nitrates are lost by denitrification in clay soils than in sandy soils. Nitrate losses through denitrification in clay soils reduce the amount of nitrates that can potentially leach to groundwater( Bhumbla,2009).

# Chapter three

## Literature Review

Many studies talked about nitrate in drinking water around the world during the importance of drinking water and what poisons it. A literature review was carried out in similar area , where nitrate is a problem.

Brown(1958) .The reason for resampling and reanalyzing the water from these wells was to determine the change in the –chloride content of the ground water from 1947 to 1956. The chloride content of ground water is generally a reliable indication of the contamination of ground water by seawater, as 90 percent of the dissolved solids of sea water are chloride salts. During this period the chloride content increased in the water from 48 wells and decreased in that from 29 wells. The maximum increase and decrease in chloride content were found in the water from wells 49and 67, respectively. The chloride content of water from well 49, near Lake Tarpon, increased by 1,370 ppm and that from well 67, near Palm Harbor, decreased by 2, 030ppm.

Charles and David(1975). This study shows high containing of Nitrate in Runnels country , analysis of 230 water samples gave results of 250mg/l of $NO_3$ . The isotopes $N^{14}$ and $N^{15}$ identified natural soil as predominated sources . Nitrate from animal waste are miner importance and using N-fertilizing are one of the reasons too**.**

Saffigna and Keeney (1977).The result of this study indicate that nitrate and chloride concentration in the ground water of the central Wisconsin sand plain are significantly above background, and that the main source is the irrigated agriculture in the reign, Nitrate-N concentration range from nil to 56mg/l and chloride from nil to 68mg/l. Nitrate –N concentration exceeded 10ppm in 15 of 33 irrigations wells and in 2 of 3 domestic wells. Nitrate-N and chloride concentrations varied widely between adjacent wells but the CL/$NO_{3-}$N ratio was much less variable. This suggests similar relative input of nitrogen and chloride presumably from nitrogen and potassium ( potassium chloride) fertilizers.

Gormly and Spalding (1979). Study was done with the notes of high concentration of Nitrate-Nitrogen over (10mg/l). In 183 of 256 samples Ground Water collected from parts of Buffalo, Hall and Merrick countries in Nebraska, using comparison of isotopic values , suggested that the cause of this contaminating from animal wastes**.**

Spalding and Exner (1993)**.** This study reviews more than 20000 $NO_3$-N data points, the level of $NO_3$-N is associated with source available and region environment factors. The area of Missouri River show high contaminating of $NO_3$-N. The aquifer of South-Eastern USA are not contaminating, in the Middle Atlantic. The $NO_3$ exceed MCL (Maximum Concentration Level) because of using N-fertilizer.

Bernard. et.al (1997 ) .This study was occurred in USA to exam the quality of the national water resources using nationally consisted method. The samples collected from wells less than 100ft generally, and categories the factory affecting Nitrate concentration for two groups, one called input( population density, the amount of nitrogen contributed by fertilizer, manure and atmospheric sources. The second one is aquifer vulnerability ( soil drainage characteristic and the ratio of woodland acres to cropland acres in agriculture area ). The results show that the medium Nitrate concentration was 408mg/l and 25% of wells exceed the MCL( Maximum Concentration Level) of Nitrate.

Madison(1998) This study was occurred in Northeastern Montana .It presented the sources of nitrate in ground water, and determined that changes in land use may affect nitrate levels in ground water in less than 30 years. The results show that nitrate was high (more than 10 mg/L) in water from 84% of the 45 wells completed in the Flaxville aquifer and in water from more than half of all the 112 wells sampled. Most ground water in this area is less than 100 feet from the land surface, so the potential for land use to affect nitrate concentration in ground water is high.

Abdul-Jaber. et.al (1999 ). This study was occurred in West Bank using 210 water samples collecting during 1995-1997. The sample analysis for chemical and microbial to determine the major ions , some minor ions ,trace element and the total feacal coli form bacteria count. The result shows that most of water is suitable for irrigation. Varity of water chemistry during the microalogical composed of the aquifers , agriculture activity and illegal dispose of row waste water surrounding the wells causing increasing the concentration of chloride, sulfat and nitrate.

Hudak (2000). The aim of this study was to map and evaluate country-median nitrate concentration in Texas Ground Water , using 7793 wells in Texas Water Development Board database. The result shows that high concentration of Nitrate in nine counties were located in North and West central of Texas and the highest nitrate concentration were found in Seymour Aquifer with value of 59.9mg/l. This aquifer has lower depth more than others. They found a relation between the concentration of Nitrate wells depth.

Jaynes. et.al (2001). This study talked about the relationship between N-fertilization and NO3 leaching and try to find suitable soil and crap management with accepted economical and environmental. they used 33 ha privately owned field in central Iown, using 3 levels of N-fertilizer , L(low),M (medium) and H (high). The results show that in H and M, of N-fertilizer the $NO_3$ accessed the MCL which is 10 mg N /$L^{-1}$ when the crops were corn.

Stenly. et.al (2003). This studies aim was to determine if there is a relationship between agriculture activation in water shall and nutrient loading reservoir .The study was done in lake Manatee. Florida which is a water source for over 265000 people. The samples collecting monthly during 1983-1993 in mid morning, analysis by least squares liner regression and spearman correlation method. Results show high concentration of N-fertilize in land cause high concentration of $NO_3$ in lake Manatee.

Wakide and Lerner (2005**).** This Study done in Nottingham city to illustrate of non agriculture sources of Nitrogen of ground water. The results show that major sources of nitrogen urban aquifers are related to waste water disposal (on site system and leaky sewers), solid waste disposal( landfill and waste tips), and in this study in Nottingham area are mains leakage and contaminated land with approximately 38% each of total load of 21kg N $ha^{-1}$ $years^{-1}$.

Al-Absi (2008). This studies purpose was to evaluate the concentration of nitrate in ground water of Gaza Strip. Various samples were taken from drinking water wells and analyzed for nitrate concentration. The result show the high concentration of nitrate 129.7 mg/L and no well could be considered suitable for drinking according to WHO standards of 50mg/l of nitrate.

Boumans.et.al (2008). This Study was occurred in Netherland, two networks monitoring, one for agriculture and one for natural, the European community asked the states for comprehensive and coherent over the Ground Water status using two regression models. These models are used to draw nitrate leaching map. Both shallow and deep ground water including in monitoring networks.

Anayah and Almasri (2009). This paper focus on assessment of nitrate concentration in the aquifer of the West Bank. The samples were collected between 1982 to 2004 using GIS to facilities the analysis and to efficiently account for the spatiality of nitrate concentration. It observed that evaluated nitrate concentration in ground water greatly coincide with increasing rainfall practically in the last few years. The result shows that annual mean concentration in western ground water Basin has increased due to agriculture activates along with the high groundwater recharge.

Venkatesan and Swaminathan (2009) .Ground water drawn for various purposes, such as irrigation, drinking and industrial, is constantly on the rise in areas where surface water are sources now a days scarce due to erratic rainfall and climatic conditions. Chloride and sulphate in ground water increase due to municipal and industrial waste dumped on the ground surface. Elevated concentration of chloride ($Cl^-$) and sulphate ($SO_4^-$) in surface and ground water are common in all countries, and can serve as indicators of ground water pollution. We have to characterize the most prevalent natural and anthropogenic sources of chloride and sulphate in ground water and explore techniques that could be used to identify their source. There is an urgent need for additional solid-waste management capacity sites in many parts of developing countries. Current design, operation, closure, and post-closure activities for sanitary landfills do not guarantee sufficient public health and environmental protection of the groundwater resources near a landfill. While in the past, sanitary landfills have almost without exception contaminated ground waters in the vicinity of a landfill. Due to scarcity of hand, to many urban localities, people never mind having residents nearby a landfill site. Significant changes must be made in the approach used for landfill of metropolitan solid wastes. Chloride and sulphate may be taken as critical parameters in assessment of ground water quality.

# Chapter four

# Methodology

## 4.1 Sampling sites:

Nitrate analysis in water is one of the most frequently applied methods in environmental chemistry. Current methods for nitrate are generally based on toxic substances (Campbell 2006).

Between 2001 and 2009 AL-Qudes University Cooperative Extension Service performed a county-wide domestic well and spring samples. Each well and spring was sampled for nitrate levels (mg/L) , pH, TOC, $Cl^-$ ,DO, and temperature . During this period of time, more than one thousands samples were collected and integrated measurement into GIS sheets.

Standard analytical methods include ion specific electrode ,ion chromatography, reduction, hydrazine reduction used for nitrate analysis, (ASA2009). In this study it used spectrophotometer as it is available in AL-Quds University environmental laboratory .

## 4.2 Sampling and storage:

The samples were collected in clean plastic bottles, storage at 4 $^{\circ}$C or lower if the samples is to be analyzed within 24 to 48 hours, warm to room temperature before running the test.( Hand Book 2000). As we focus on domestic wells and spring, the actual samples used in this research are almost 600 samples distributed in the eight district (Ramallah, Bethlahem, Jenin, Jericho, Tulkarum ,Hebron, and Qalkqelia, and Nublas).

### 4.3 analysis method :

Standard Methods for Examination of Water and Wastewater and other sources recognize a screening method for detection of nitrate in water using two wavelength ultraviolet spectrometry. An absorbance measurement is made at 220 nm and is corrected by subtracting a second measurement at 275 nm. Theoretically, this will compensate for the presence of organics. However, the method recommends prior 0.45 micron (is one-millionth) sample filtration to remove the effects of turbidity. The method is not recommended if significant correction for dissolved organic matter are required or if a variable organic content is expected, since the relative response of each organic substance is different at 220 nm and at 275 nm (ASA, 2010).

The spectrophotometer used to analysis nitrate depending on " Cadmium Reducation Method" Using powder pillows( NitraVer 5 Nitrate Reagent Pwd.Pillows).

Two cells each one is (25 ml of samples) and one is blank and the other for measuring (after we add the reagent on it).This cell should be shake vigorously until the timer beeps on one minute, waiting for five minutes, the reaction will begin then measure the samples in 500 nm (Hand Book,2000).

Determined of $Cl^-$ by titration is a method used commonly in chemistry laboratories and classrooms, which uses a solution of a known concentration to analyze and determine the unknown concentration of a second solution. Many times, the solution whose properties are known is a base, meaning it has a pH value of more than seven, while the unknown solution is an acid, meaning its pH is below seven. A typical titration involves the gradual addition of the base to the acidic solution, until a neutral pH of 7 is reached, or until a pH indicator turns a certain color, indicating that a certain other known pH has been reached.

### 4.3.1 The procedure used in my research for chloride analysis was:

**Reagent:**

1) indictor potassium chromate $K_2CrO_4$

2) 0.1 N Ag NO3 or 0.01 N depending on the hardness of the water.

**Procedure**:

- 50 ml water samples
- 2-3 drops of Potassuim Chromate as indicter
- Titrate with 0.1 $AgNO_3$ or .01 N depending on the hardness of the samples.
- Shake continuously and keep titration slowly until it reach the end point.

In the ending point the color of the samples will change from Yellow to Red Brown. Then it has done the calculation:

$$Cl^- \ mg/l = \frac{A*N*1000*C}{B}$$

Where:

A: volume of $AgNO_3$ required for water titration- volume of AgNO3 required for distilled water titration.

B: volume of sample 50 ml.

C: equivalent weight of the CL 35.45

N: Normality of $AgNO_3$

When it using 0.01 $AgNO_3$ mg/l the" A" multiplied by 7.09, but when it using 0.1 $AgNO_3$ the "A" multiplied by 70.9 according to hardness of the water samples.

The GIS program is used to determine the location of wells and springs used for samples that had been collected from it, then we disturbe the samples in GIS map for each district.

Total organic carbon (TOC) analyzers measure the amount of total organic carbon present in a liquid sample. Generally, all TOC analyzers employ the same basic technique. A liquid sample is initially introduced to an inorganic carbon (IC) removal stage, where acid is added to the sample. At this point, the IC is converted into carbon dioxide ($CO_2$) gas that is stripped out of the liquid by a sparge carrier gas. The remaining inorganic carbon-free sample is then oxidized and the carbon dioxide generated from the oxidation process is directly related to the TOC in the sample.

The analysis methods total organic carbon (TOC) analyzers use to oxidize and detect the organic carbon may be combustion, UV persulfate oxidation, ozone promoted, or UV fluorescence. With the combustion method, analysis is determined when carbon compounds are combusted in an oxygen-rich environment, resulting in the complete conversion of carbon-to-carbon dioxide. In UV persulfate oxidation, the carbon dioxide is purged from the sample and then detected by a detector calibrated to directly display the mass of carbon dioxide measured. This mass is proportional to the mass of analyte in the sample. Persulfate reacts with organic carbon in the sample at 100 degrees Celsius to form carbon dioxide that is purged from the sample and detected. The ozone-promoted method for total organic carbon (TOC) analyzers oxidizes the carbon by exposing it to ozone. UV fluorescence is a direct measurement of aromatic hydrocarbons in water. Fluorescence occurs when a molecule absorbs an "excitation" energy of one wavelength to be measured as concentration of the hydrocarbon. This may also be referred to as spectrophotometry or colorimetry( Global spec 2010). In this study used multi-c as its available in E.L.

# Chapter five

# Result and Discussion

Water samples were collected from groundwater wells and springs which are used for domestic purpose for this reason West Bank was divided into districts ,taking consternation different sources for demotic water such as the Israel company Makarot which cover 37 mcm/a from the total water demand.

## 5. 1 Jericho District:

Demotic ground water samples were collected from all over the district. This includes samples from Uja, Fasael, Jeftlic, Zabadat in addition to Jericho. Table 5.1 present the sample distributions among different site and average and standard division for $NO_3$ and $Cl^-$.

Table 5.1 :distribution of water sample and concentrations in Jericho district

| **Number of Water samples** | **Jericho** | **Uja** | **Fasael** | |
|---|---|---|---|---|
| **Wells** | **-** | **-** | **-** | |
| **Springs** | **18** | **5** | **2** | |
| **Concentration** | **max** | **min** | **mean** | **stdv** |
| **$NO_3$** | **31.4** | **6.7** | **20.5** | **6.3** |
| **$Cl^-$** | **249.4** | **30.91** | **56.1** | **4.6** |

Domestic water resources in this district limited to Ein Sultan,  Duwk, Nuwemeh springs. Samples where collected during the time span from 2001 to 2008 .Figure 5.1 present the nitrate concentration distributions in domestic ground water samples.

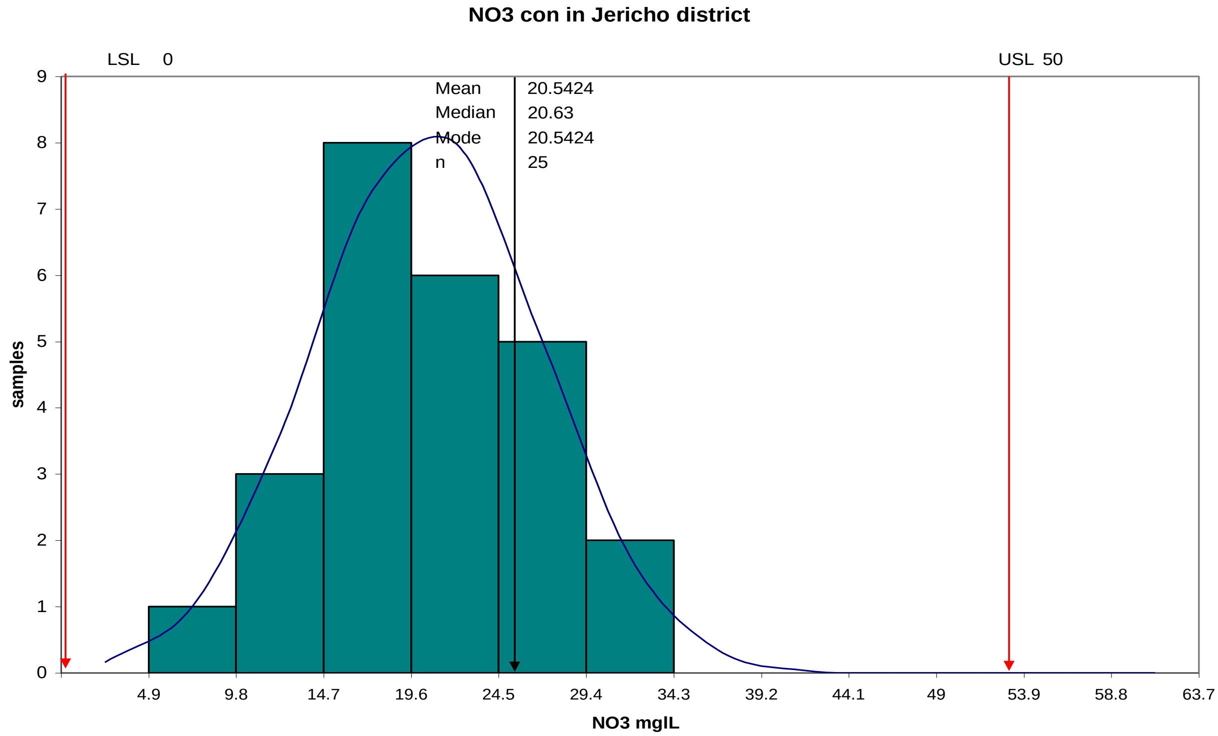


Figure 5.1 : $NO_3$ concentrations in domestic ground water in Jericho district

### 5.1.1 Nitrate concentration

The majority of water samples has concentration less than 50 mg/l with main focusing between 9.8 and 29.4 mg/l. This result indicated that water resources are not polluted, and no impact of agriculture activity or others pollution sources taken into consideration all spring drain water from carbonate mounting aquifer.

### 5.1.2 Chloride concentration

The majority of water samples has concentration lower than 250 mg/l with main focusing between 43.7 and 131.1 mg/l. This result indicated that water resources are not polluted, and has impact of agriculture activity and waste water pollution. The result for nitrate and chloride show match with result in (Abudul-Jaber.et.al,1999). Figure 5.2 present the chloride concentration distribution in domestic ground water samples.

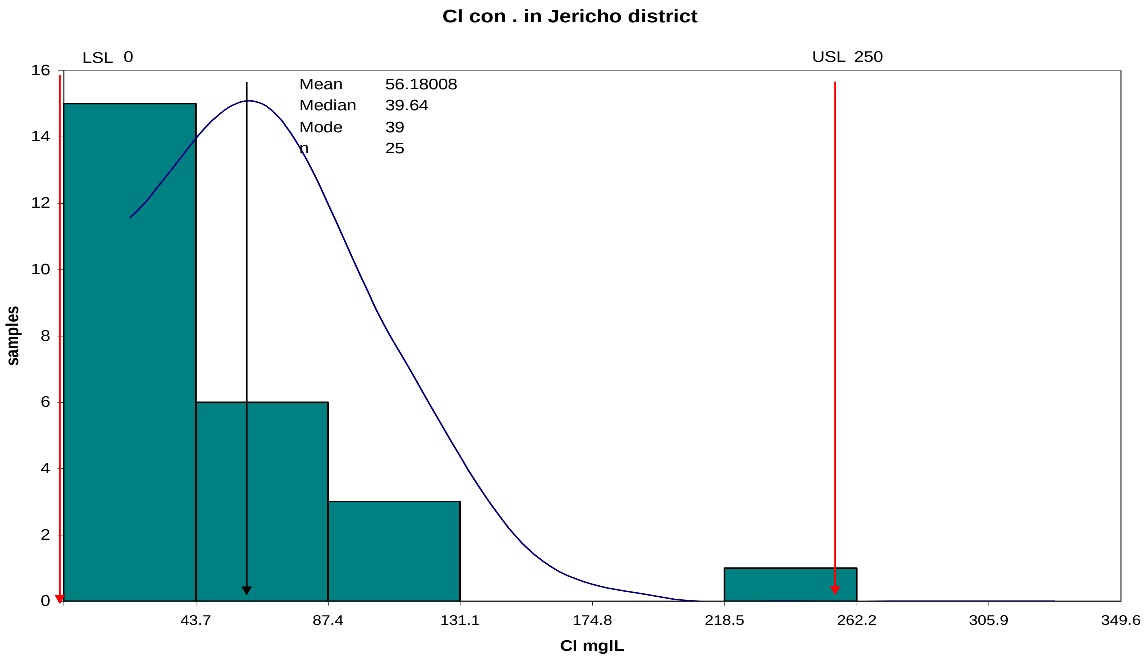


Figure 5.2: $Cl^-$ concentration in domestic ground water in Jericho district

### 4.1.3 Nitrate concentration with time variation:

The samples taken between 2002 and 2005 . The result show different variation of $NO_3$ concentration during this period, as indicator on the activity of the district in which highest concentration of $NO_3$ were present in 2004and during the winter season . The concentration was high according to the rainfall .This result show match with (Anayah.et.al,2009) .Figure 5.3 present the concentration distribution of $NO_3$ variation by time.

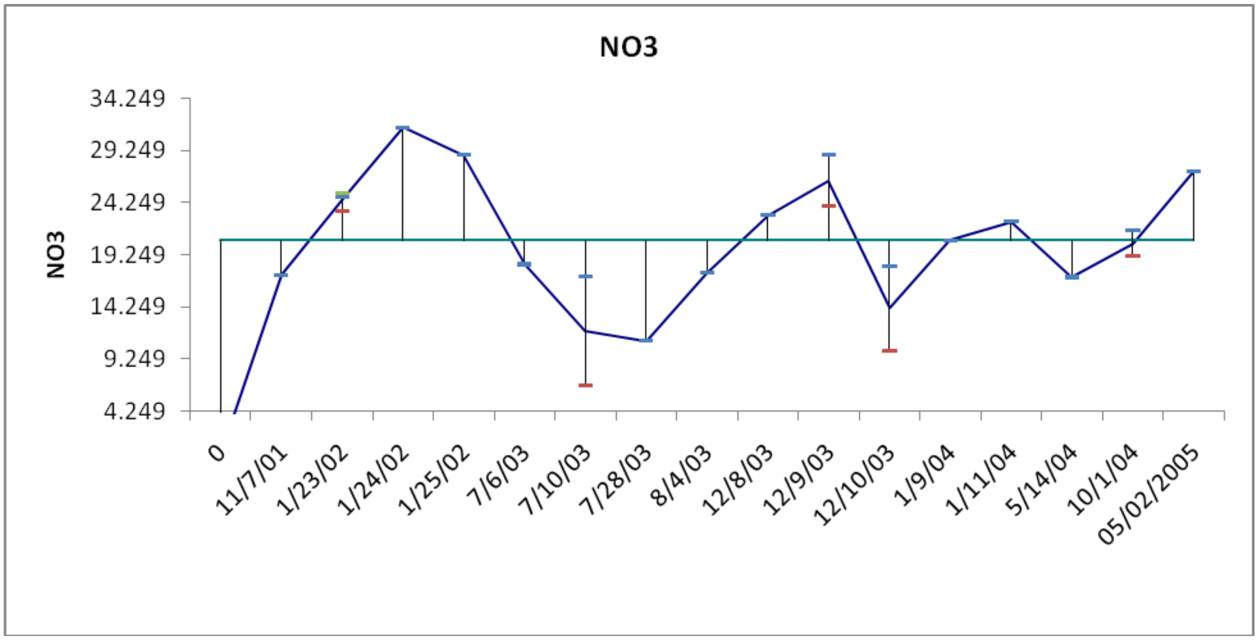


Figure 5.3: $NO_3$ concentrations in domestic ground water variation by time in Jericho district.

### 5.2 Nablus district

Demotic ground water samples were collected from all over the district. This includes samples from Ein Sidra Ein, Al Far'aa, Ein Dlaib, Ein Subian, Ein Taban , Ein Al Jeser, Ein Qudeeri, Ein, Ein Baida,, Deir Sharaf No. 2 , Udala in addition to Nablus. Table 5.2present the sample distributions among different sites in Nablus district.

Table 5. 2 : Distributions of water samples over Nablus district.

| Number of Water samples | Nablus | Ein Sidra | Al Far'aa | Ein Taban | Ein Dlaib | Ein Al Jeser | Ein Subian | Ein Qudeeri | Ein Baida, | Deir Sharaf No. 2 and Udala |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wells** | **10** | **-** | **-** | | **-** | | **-** | **-** | **-** | **-** |
| **Springs** | **-** | **26** | **41** | **34** | **36** | **35** | **36** | **35** | **36** | **36** |

Domestic water resources in this district limited to Ein Ras Al- Aen, Ein Al-Asal, Ein Defna, Ein Qareot, and Ein Beit alma. Samples were collected during the time span from 2002 to 2007, In table 5.3 present the $NO_3$ and $Cl^-$ mean , stdev (standard devotion) with maximum value and minimum value in this district.

Table 5.3: $NO_3$ and $Cl^-$ mean , stdev with max value and min value in this district

| **Concentration** | **max** | **min** | **mean** | **Stdev** |
|---|---|---|---|---|
| **NO3** | **183** | **4.5** | **19.0** | **9.8** |
| **Cl-** | **137** | **14.9** | **43.6** | **11.5** |

And in figure 5.4 present the nitrate concentration distribution in domestic ground water samples

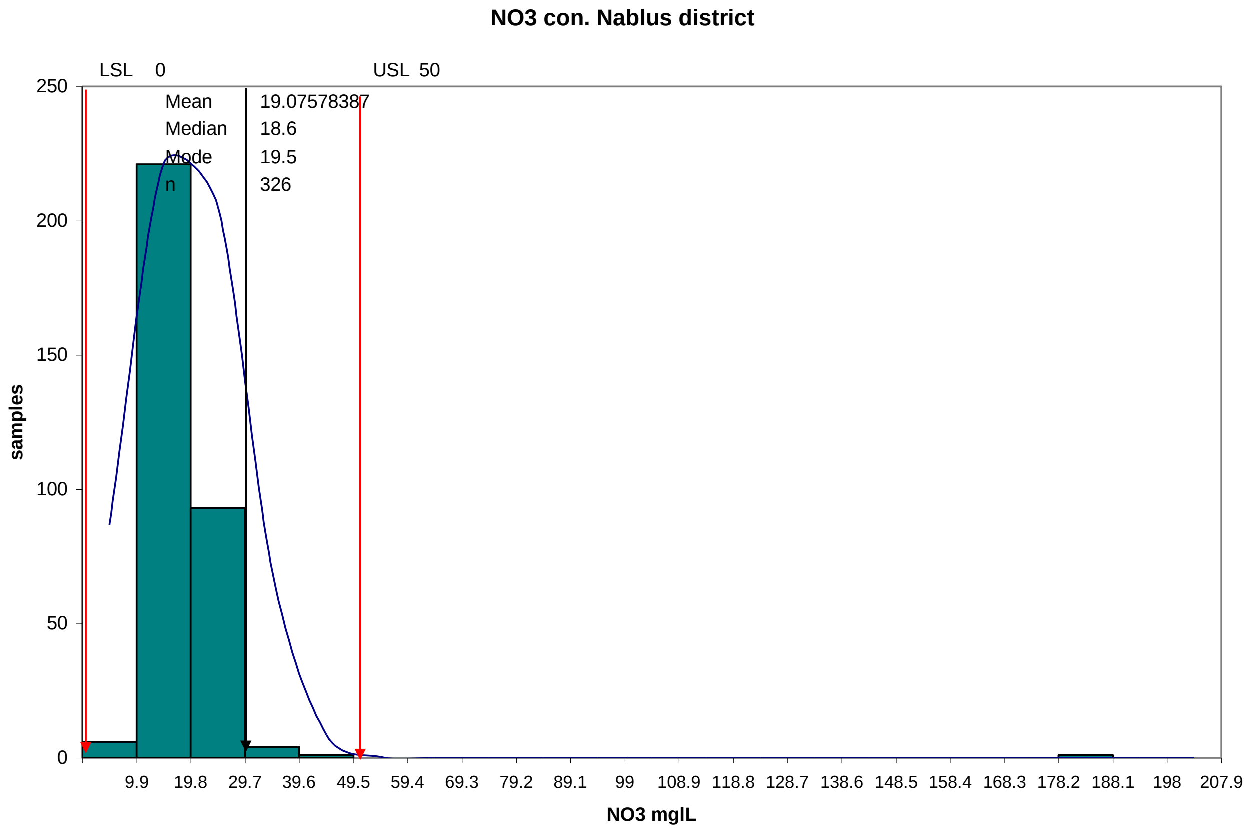


Figure 5.4 : $NO_3$ concentration in domestic ground water in Nablus district

### 5.2.1 Nitrate concentration:

The majority of water samples has concentration less than 50 mg/l with main focusing between 9.9 and 29 .7mg/l. This result indicated that water resources are not pullulated, and no impact of agriculture activity or others pollution sources taking into consideration all spring drain water from carbonate mounting. The high $NO_3^-$_ concentration of 183 mg\l was measured in 18-18/017 well that related to Tubas Water Project. This value could be related to the  error in measuring or to location of well.

### 5.2.2 Chloride concentration:

The majority of water samples has concentration higher than 250 mg/l with main focusing between 33.9 and 74.5mg/l. This result indicated that water resources are  not polluted, and has no impact of agriculture activity and waste water pollution. Figure 5.5 present the chloride concentration distribution in domestic ground water samples. The high concentration was measured in 18-18/017 well that related to Tubas Water Project. This value could be related to the  error in measuring or to the well location.

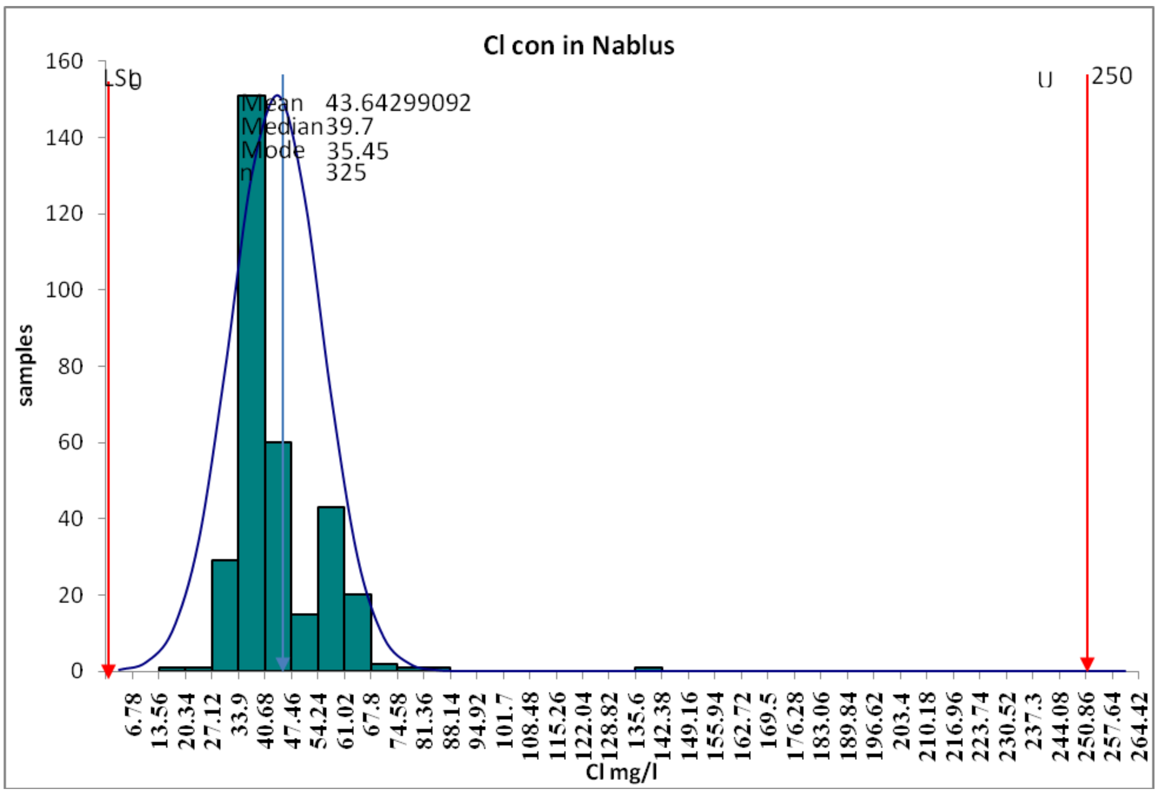


Figure 5.5: $Cl^-$ concentration in domestic ground water in Nablus district.

### 5.2.3 Nitrate concentration with time variation:

Time series samples were taken between 2002 and 2007 . The result show different variation of $NO_3$ concentration during this period, as indicator on the activity of the district in which highest concentration of $NO_3$ were present in 2005.Figure 5.6 present the concentration distribution of $NO_3$ variation by time.

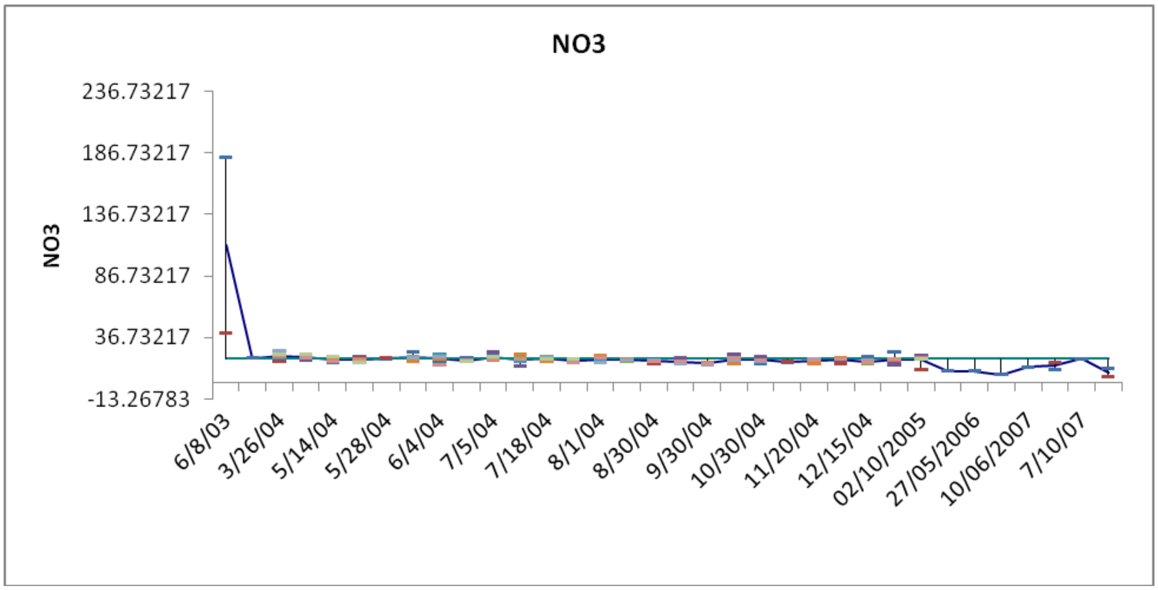


Figure 5.6: $NO_3$ concentration in domestic ground water variation by time in Nablus district.

## 5.3. Ramallah District:

Domestic ground water samples were collected from all over the district, this include samples from Ein samia wells 1.2.3.6. Table 5.4 present the sample distributions among different site and average and standard division for $NO_3$ and Cl.

Table 5.4 distribution of water sample and concentrations in Ramallah district

| **Number of Water samples** | **Samia1** | **Samia2** | **Samia3** | **Samia6** | **Shabtian** |
|---|---|---|---|---|---|
| **Wells** | **15** | **2** | **8** | **14** | **1** |
| **Springs** | **-** | **-** | **-** | **-** | **-** |
| **Concentration** | **max** | **min** | **mean** | | **stdev** |
| **$NO_3$** | **28** | **2** | **15** | | **7** |
| **$Cl^-$** | **63** | **14** | **33** | | **9** |

Domestic water resources in this district limited to Ein Samia, samples were collected during the time span from 2001 to 2008 . The well field locates outside the urban area, and the catchments covers with olive trees and rainfall agriculture. The low chloride and nitrate concentration reflect the low agricultural activates in the catchments area .Figure 5.7 presents the nitrate concentration distributions in domestic ground water samples.

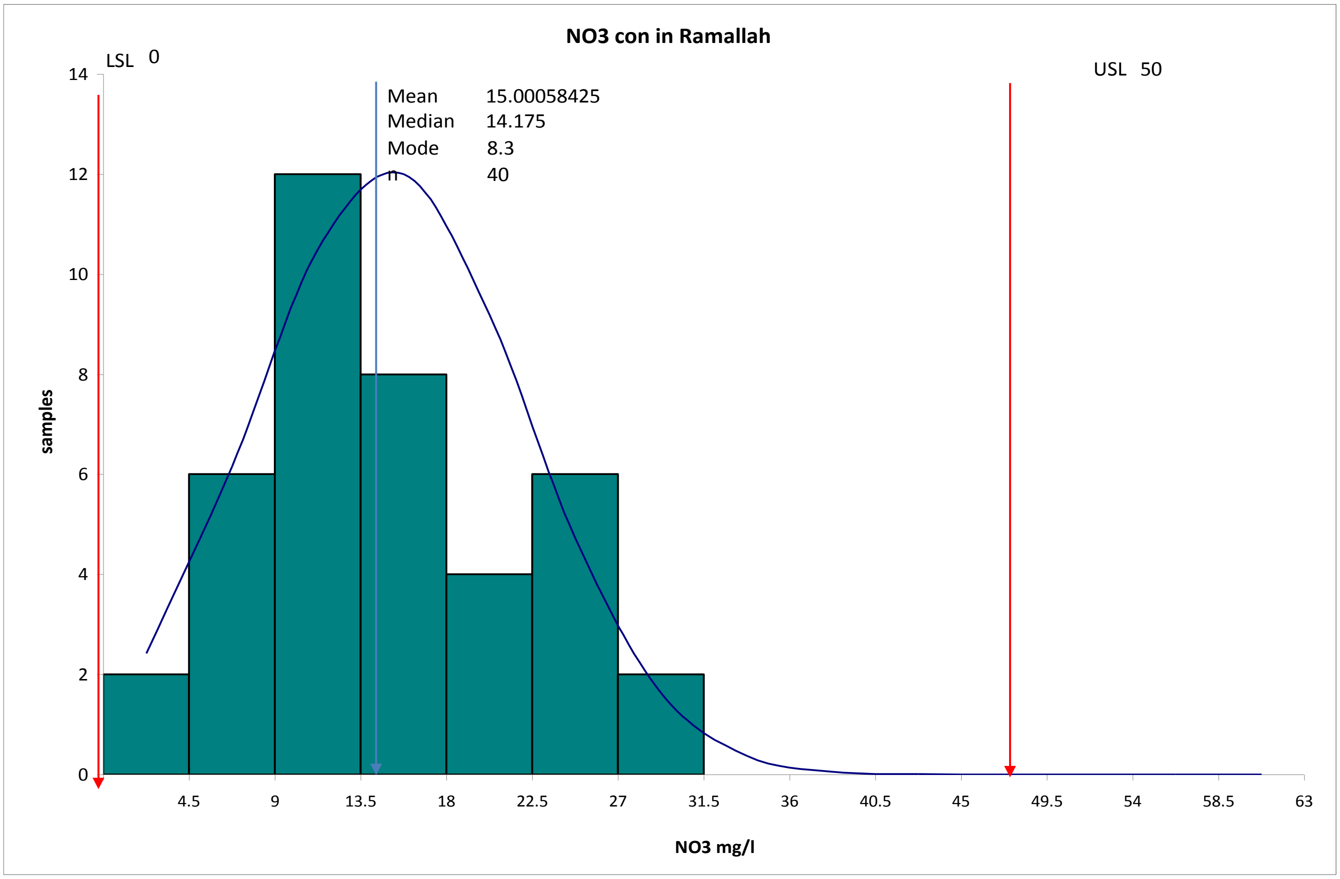


Figure 5.7 :$NO_3$ concentrations in domestic ground water in Ramallah district

### 5.3.1 Nitrate concentration

The majority of water samples has concentration less than 50 mg/l with main focusing between 9 and 18 mg/l. This result indicates that water resources are not polluted , and no impact of agriculture activity or other pollution sources taken into consideration, all wells drain water from carbonate mounting aquifer system, and the depth of these wells rang between 20m and 600m.

### 5.3.2 Chloride concentration:

The majority of water samples has concentration lower than 250 mg/l with main focusing between 16 and 42mg/l. This result indicated that chlorides originate from rainfall and from soil horizons .Agriculture activity and waste water have minimum impact on ground water quality. Figure 5.8 present the chloride concentration distribution in domestic ground water samples.

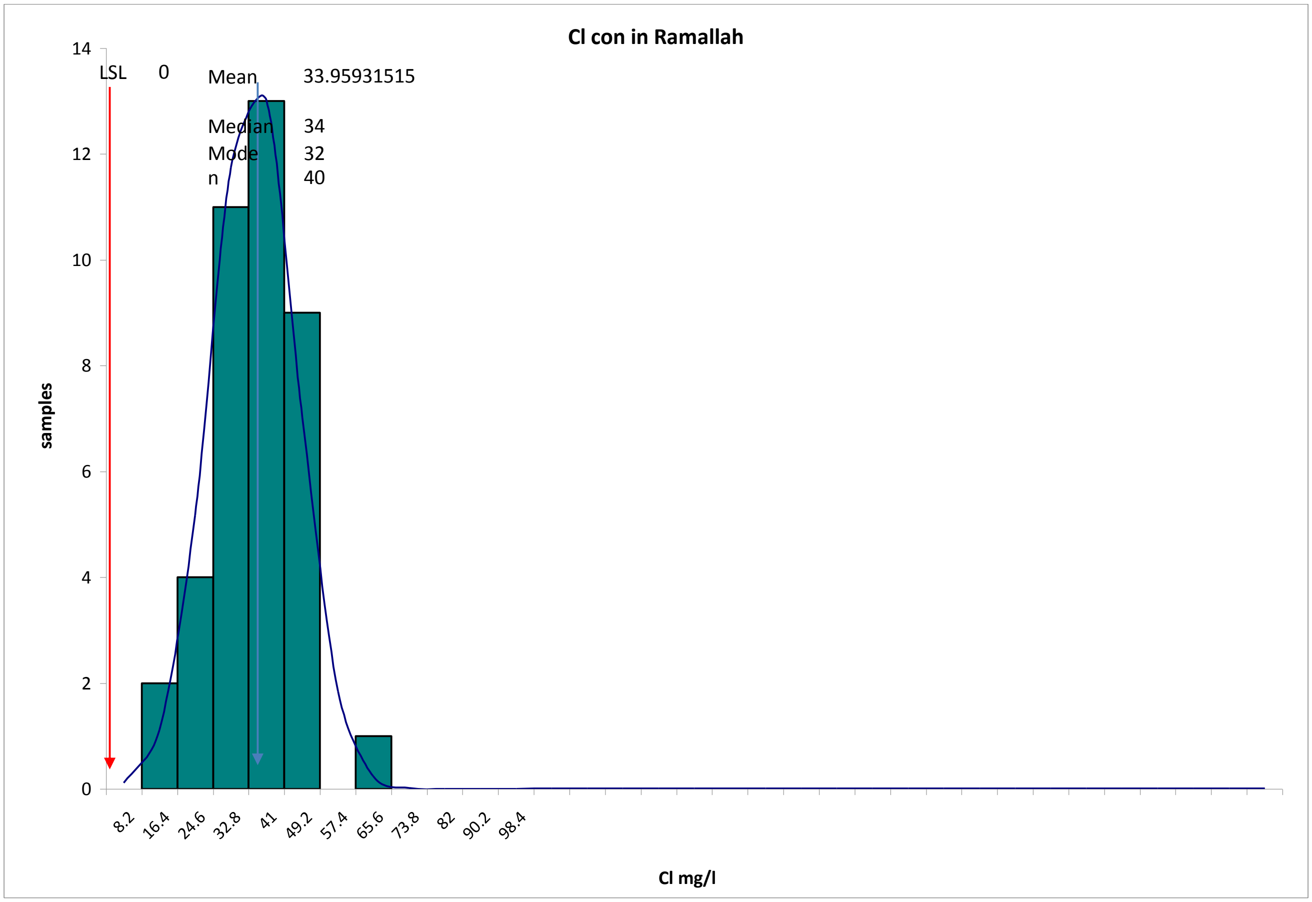


Figure 5.8: $Cl^-$ concentration in domestic ground water in Ramallah district

### 5.3.3 Nitrate concentration with time variation:

The samples taken between 2001 and 2007 . The result show different variation of $NO_3$ concentration during this period, as indicator on the activity of the district in which highest concentration of $NO_3$ were present in 2005 where sample collected during April month .Figure 5.9 present the concentration distribution of $NO_3$ variation by time.

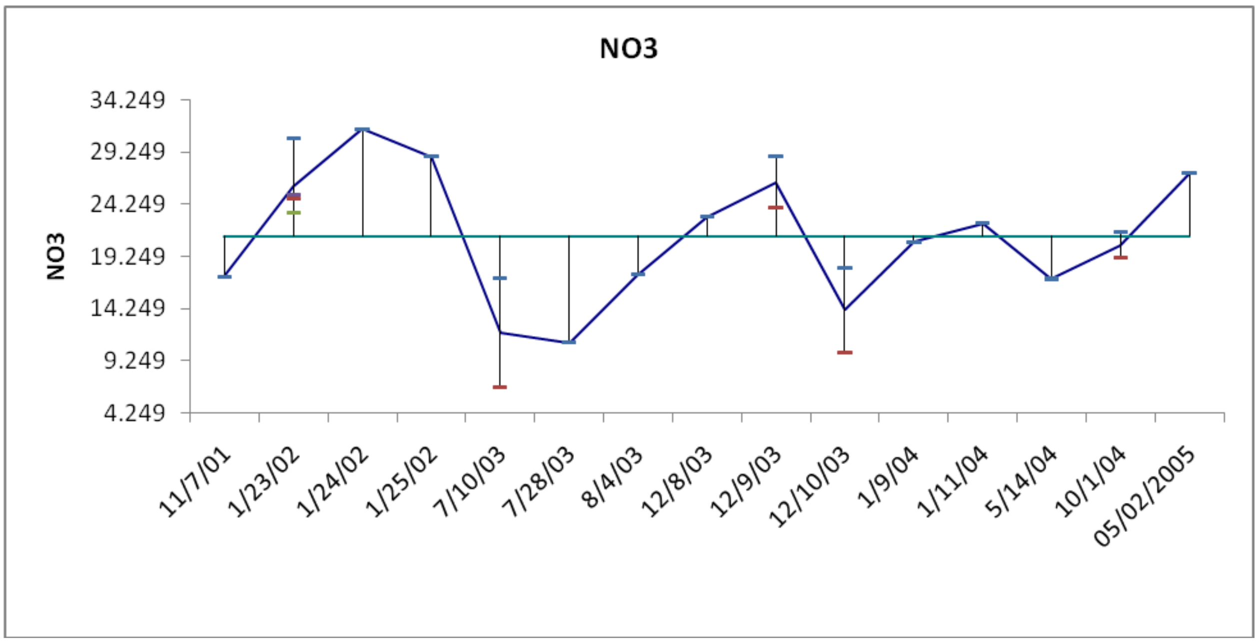


Figure 5.9 : $NO_3$ concentrations in domestic ground water variation by time in Ramallah district.

## 5.4 Hebron district:

Domestic ground water samples were collected from all over the district .Table 5.5 present the sample distributions among different sites from Hebron district.

Table 5.5 distribution of water sample over Hebron District.

| Samples location | Spring | well |
|---|---|---|
| **Ein Ma'modiya/ Taffuh** | **1** | |
| **Ein Sa'beia** | **1** | **-** |
| **Ein Hijra** | **2** | **-** |
| **Ein Delba** | **3** | **-** |
| **Ein Lingor** | **2** | **-** |
| **Ein Naqiah** | **2** | **-** |
| **Ein El-Buss/Idna** | **2** | **-** |
| **Ein Mussallam/Tarqomia** | **2** | **-** |
| **Ein Sarah** | **1** | **-** |
| **Ein Quf West Alghqrbia** | **3** | **-** |
| **Ein Hasaka** | **3** | **-** |
| **Ein Eth-Tharwa** | **3** | **-** |
| **Ein Misleh /Halhul** | **1** | **-** |
| **Ein Kheir Ed-Dein #1** | **1** | **-** |
| **Ein Arab/Hebron** | **1** | **-** |

| | | |
|---|---|---|
| **Ein Deir Bahha** | **1** | **-** |
| **Ein Saeer** | **1** | **-** |
| **Ein Deir Bahha** | **2** | **-** |
| **Ein Alkarmel (C)** | **2** | **-** |
| **Ein Alkarmel (B)** | **2** | **-** |
| **Ein Alkarmel (A)** | **3** | **-** |
| **Ein Tuwani/Tharwanin** | **3** | **-** |
| **Ein Al-Rifa'eya/Yatta** | **2** | **-** |
| **Abu Shabban** | **2** | **-** |
| **Ein Baqqar/ Halhul** | **1** | **-** |
| **Ein Sa'beia** | **1** | **-** |
| **Ein Alaqa Foqa** | **2** | **-** |
| **Ein Ma'moud/Taffuh** | **1** | **-** |
| **Ein Kurza** | **2** | **-** |
| **Ein Qais** | **2** | **-** |
| **Ein Kanar Alsharqya** | **2** | **-** |

| | | |
|---|---|---|
| **Ein Kanar Alwusta** | **2** | **-** |
| **Ein Fira'a** | **2** | **-** |
| **Ein Alaqa Tahta** | **2** | **-** |
| **Ein AlBus/Alaroob** | **1** | **-** |
| **Al Fawwar Camp** | **-** | **4** |
| **Beit Fajjar (Substitute)** | **-** | **1** |
| **Sa'ir** | **-** | **3** |
| **Herodion (Butn El Ghul) No. 4** | **-** | **1** |
| **Al Rehea (الريحية)** | **-** | **2** |
| **Asamoua** | **-** | **2** |

The result show that the mean value was 76.8mg\l for $NO_3$ and 113.5mg \l for chloride, the table 5.6 present most important values for nitrate and chloride.

Table 5.6 statistic values for $NO_3$ and $CL^-$

| **Concentrations** | **max** | **min** | **mean** | **stdev** |
|---|---|---|---|---|
| **$NO_3$** | **736** | **3** | **76.8** | **106** |
| **$Cl^-$** | **1167** | **14** | **113.5** | **140** |

Domestic water resources in this district is limited to the municipality, samples were collected during the time span from 2002 to 2008. The majority of these samples were collected from springs locate within urban areas, where sewage system does not exist, and the majority of houses use septic tanks. The highest chloride concentration was measured in Beit Fajjar well no. 001A , with total depth of 80 meters. The max value for $NO_3$ were occur in Ein Alkarmel (C**)** spring which show high concentration in nitrate which could be according the sewage this result match results in Al-Absi (2008), Boumans.et.al.( 2008), Wakida .et.al (2005). (Substitute) well. In Figure 5.10 present the nitrate concentration distributions in domestic ground water samples.

### 5.4.1 Nitrate concentration

The majority of water samples has concentration more than 50 mg/l with main focusing between 81.5 and 326 mg/l. This result indicated that water resources are pullulated , and has an impact of both agriculture activity and waste water(sewage).This result match with the result for Al-Absi. (2008), Boumans.et.al.( 2008), Wakida .et.al (2005).

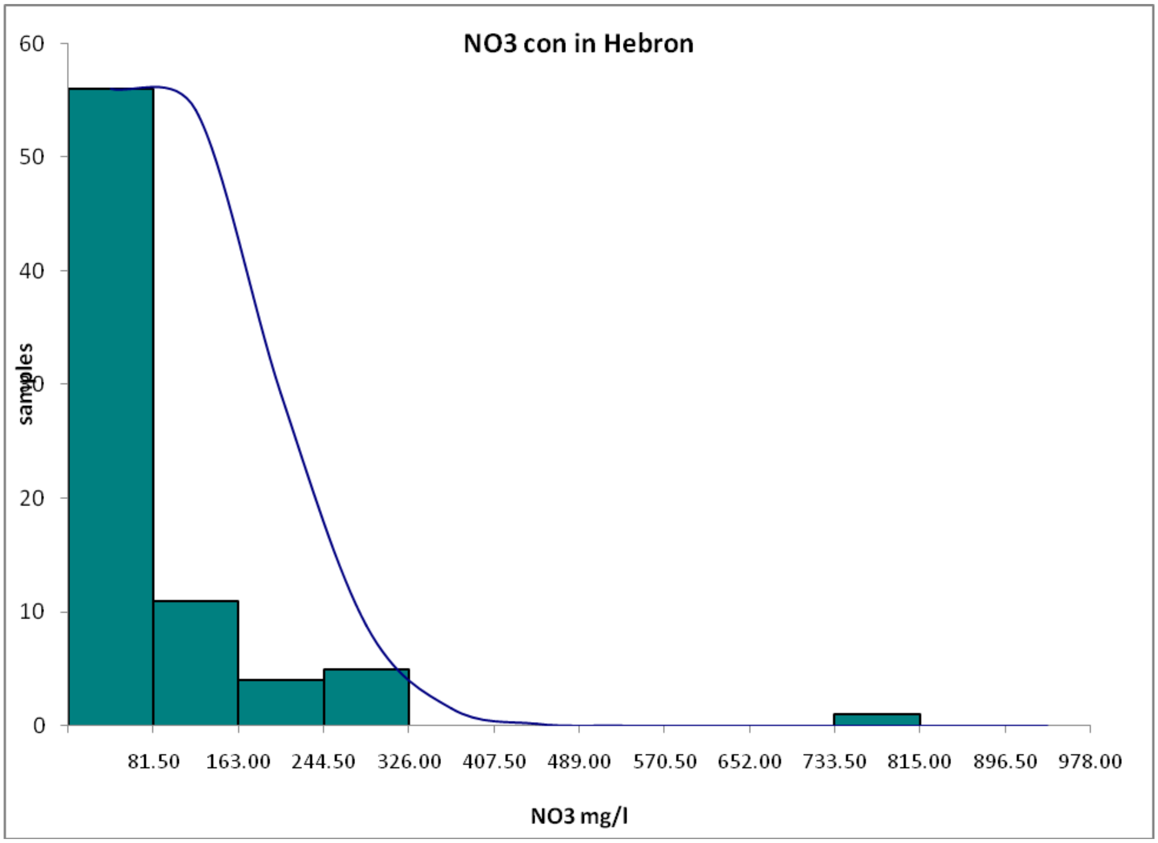


Figure 5.10: $NO_3$ concentration in domestic ground water in Hebron district

### 5.4.2 Chloride concentration:

The majority of water samples has concentration higher than 250 mg/l with main focusing between 128 and 384mg/l. This result indicated that water resources are polluted, and has an impact of agriculture activity and waste water pollution. This result match with the result for Al-Absi. (2008), Boumans.et.al.( 2008), Wakide and Lerner (2005). Figure 5.11 present the chloride concentration distribution in domestic ground water samples

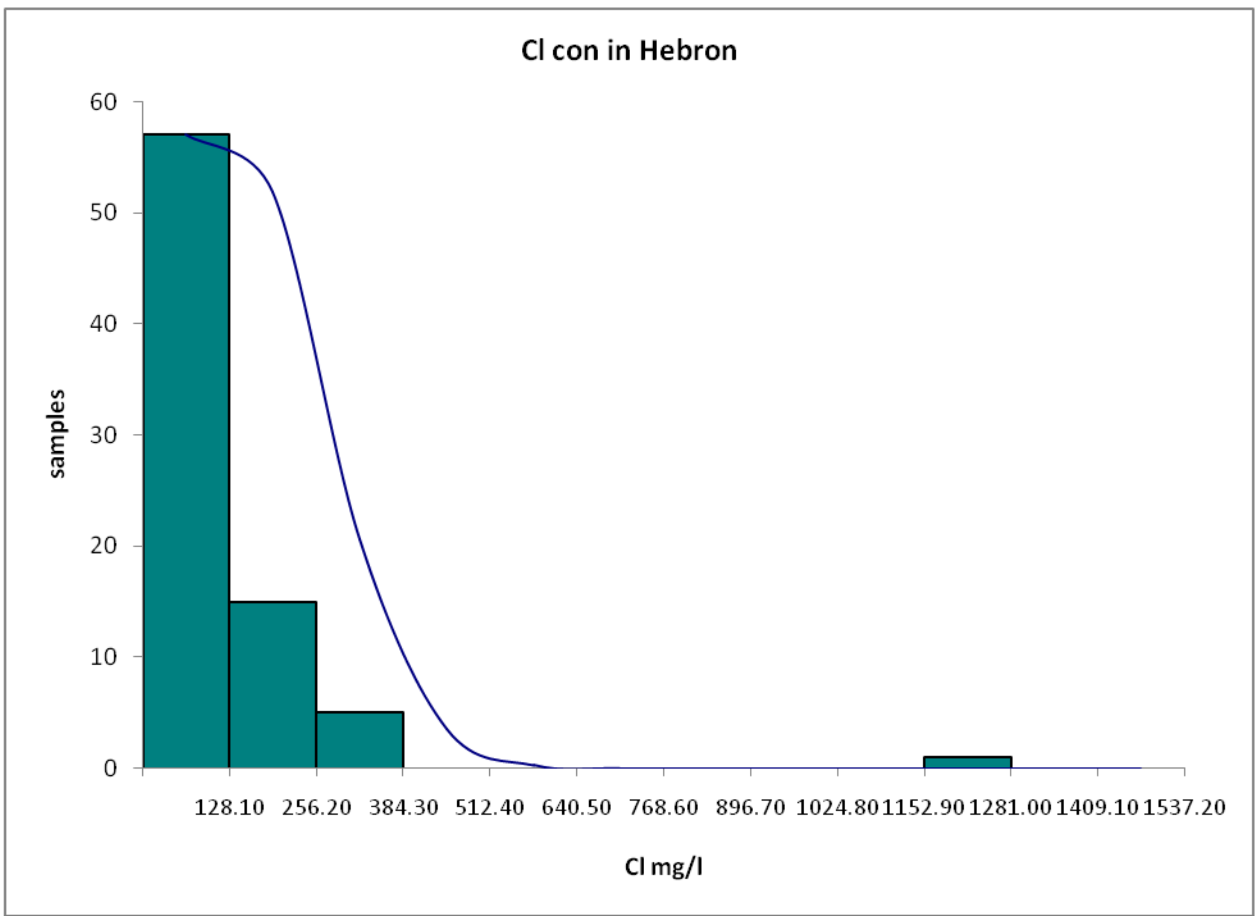


Figure 5.11:$Cl^-$ concentration in demotic ground water in Hebron district

### 5.3.3 Nitrate concentration with time variation:

The samples were collected between 2002 and 2008. The result show different variation of $NO_3$ concentration during this period, as indicator on the activity of the district in which highest concentration of $NO_3$ were present in 2004 , were samples collected during January to July months . Figure 5.12 present the concentration distribution of NO3 variation by time.

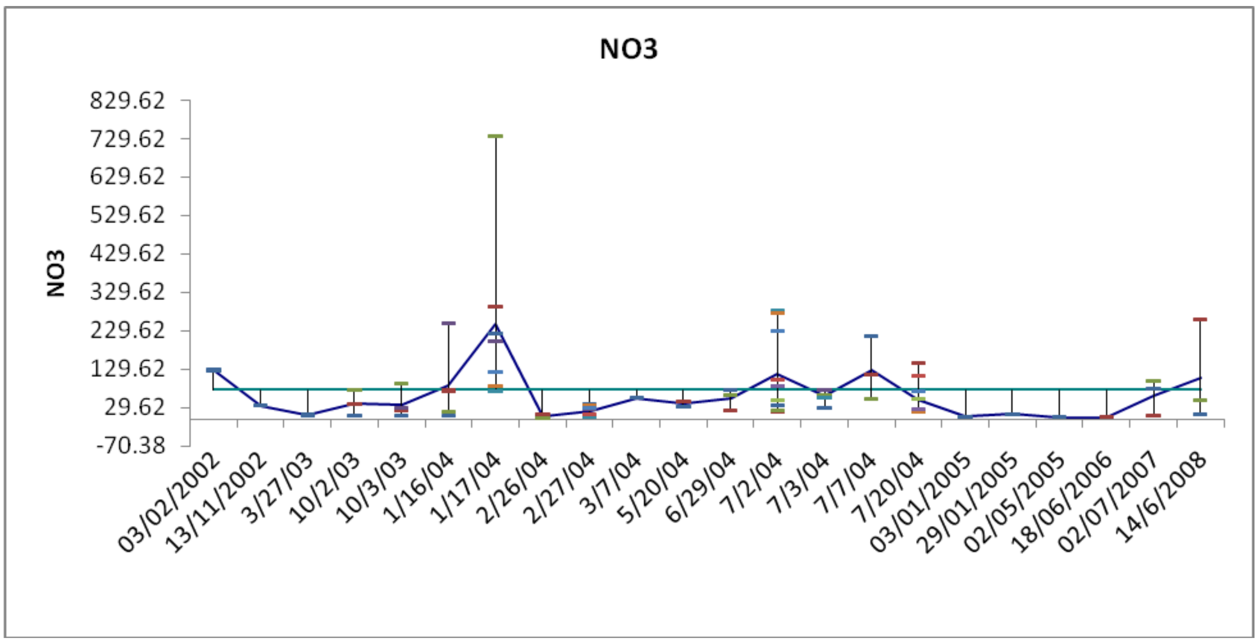


Figure 5.12: $NO_3$ concentrations in domestic ground water variation by time in Hebron district

**5.5 Bethlehem District:**

41 Domestic ground water samples were collected from the district .Table 5.6 present the sample distributions among different sites in the district.

Table 5.7 distribution of water sample over Bethlehem District.

| **Sample location** | **Number of samples from spring** | **Number of samples from well** |
|---|---|---|
| **PWA III** | **-** | **2** |
| **PWA1** | **-** | **2** |
| **PWA11/ Manshia** | **-** | **3** |
| **Beit Fajar Well 1** | **-** | **5** |
| **Ein Elbalad/Nhaleen** | **3** | **-** |
| **Ein Um Aldeek** | **2** | **-** |
| **Ein Fuqeen Elbalad** | **2** | **-** |
| **Ein Sadeeq** | **2** | **-** |
| **Ein Irtas** | **1** | **-** |
| **Ein A l 'Amud/ Hussan** | **1** | **-** |

| | | |
|---|---|---|
| **Ein AlFawwar/ Wadi Fukeen** | **1** | **-** |
| **Ein Batteer** | **1** | **-** |
| **Harmala** | **-** | **3** |
| **Bethlehem (Beit Lahm)** | **-** | **3** |
| **Herodion (Butn El Ghul No. 3** | **-** | **1** |
| **Herodion (3)** | **-** | **1** |
| **Herodion (2)** | **-** | **1** |
| **Izzariya (2)** | **-** | **1** |
| **Izzariya (1)** | **-** | **1** |
| **Hindaza** | **-** | **1** |
| **JWC 4** | **-** | **1** |
| **Herodion (4)** | **-** | **1** |

The results show that the mean value of $NO_3$ was 26 and mean value for chloride was 40. The Table 5.8 present most important values for nitrate and chloride.

Table 5.8 : statistic values for $NO_3$ and $CL^-$

| **Concentrations In mg/l** | **max** | **min** | **mean** | **Stdev** |
|---|---|---|---|---|
| **NO3** | **150** | **5** | **26** | **18** |
| **Cl-** | **113** | **20** | **40** | **11.5** |

Domestic water resources in this district limited to the municipality, samples were collected during the time span from 2002 to 2008 .Figure 5.13 present the nitrate concentration distributions in demotic ground water samples.

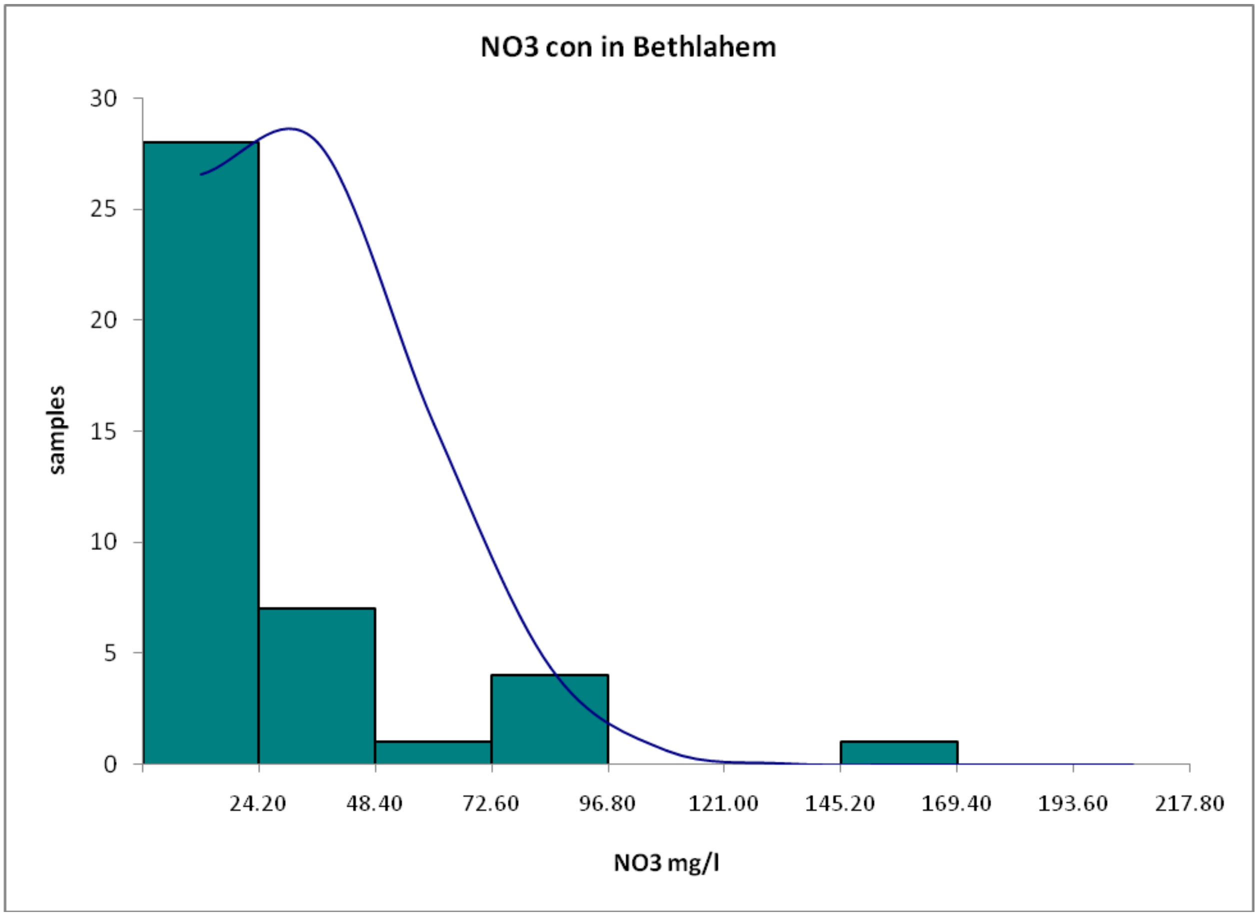


Figure 5.13:$NO_3$ concentrations in domestic ground water in Bethlehem district

### 5.5.1 Nitrate concentration

The majority of water samples has concentration less than 50 mg/l with main focusing between 24 and 48 mg/l, where less than 10 samples have concentration above 50 mg\l. The high concentration are related to Ein A l 'Amud springs, where these sources located in the urban areas, ground water wells normally outside the building zones, where communication with nitrate is it not common. This result indicated that water resources are pullulated , and has impact of agriculture activity and the others pollution sources such as waste water (sewage) and fertilizer. This result match the result in Sently.et.al, 2003, Jaynes.et.al. 2001 .

### 5.5.2 Chloride concentration:

The majority of water samples has concentration less than 250 mg/l with main focusing between 15and 46mg/l. This result indicated that water resources are not polluted, and has no impact of man made activities such as waste water pollution. Figure 5.14 present the chloride concentration distribution in domestic ground water samples

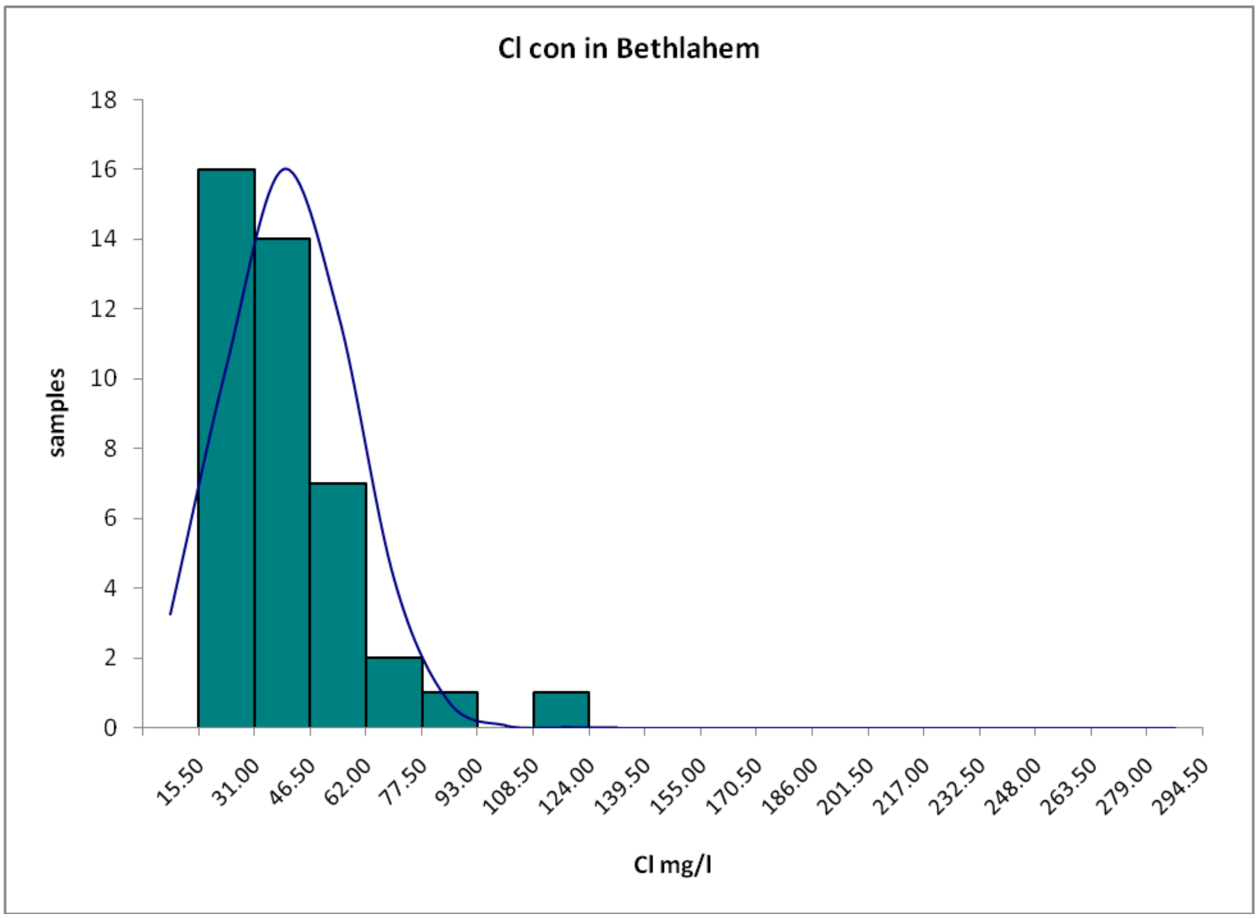


Figure 5.14 : $Cl^-$ concentration in domestic ground water in Bethlehem district

### 5.5.3 Nitrate concentration with time variation:

Time series samples were taken between 2001 and 2008. The result show different variation of $NO_3^-$ concentration during this period, as indicator on the activity of the district in which highest concentration of $NO_3$ were present in 2005 .Figure 5.15 present the concentration distribution of $NO_3$ variation by time.

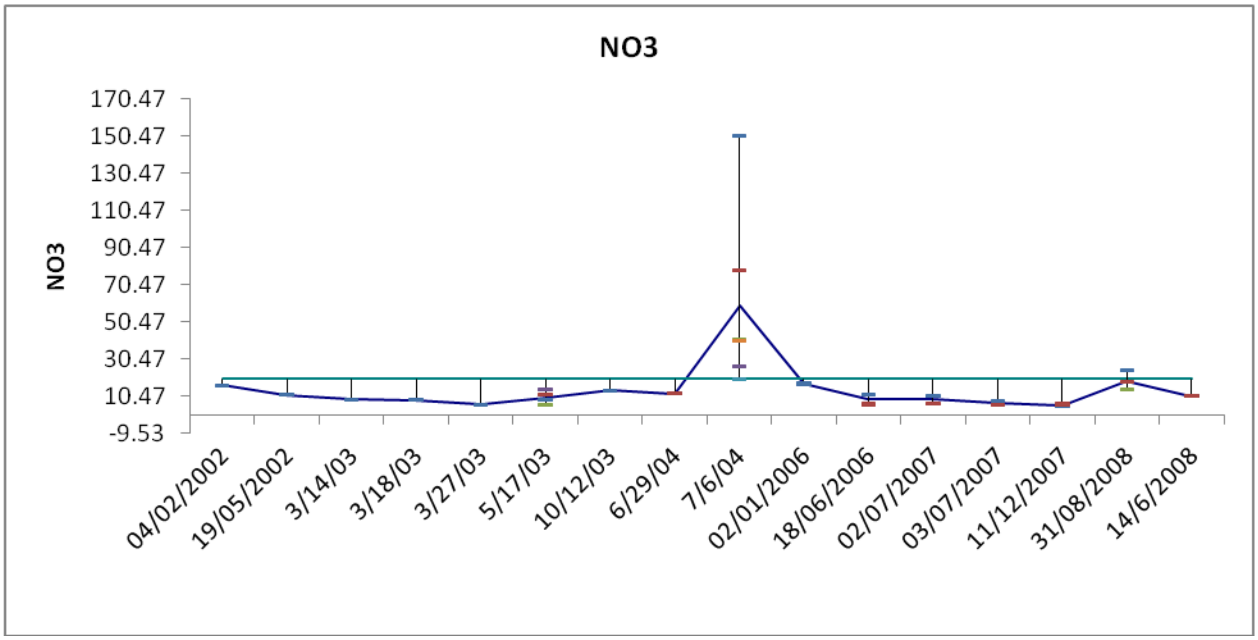


Figure 5.15 : $NO_3$ concentration in domestic ground water variation by time in Bethlehem district

### 5.6 Tulkurm District

Domestic ground water samples were collected from the district, this include samples from Zita, Anabta, Shufa, Kafer zabad, Bala, Deir Sharef in addition to Tulkurm,. All samples are related to ground water wells where water taped from carbonate aquifer system. The depth of these wells varied between 100 to250 meters. Table 5.9 present the sample distributions among different site and average and standard division for $NO_3$ and Cl.

Table 5.9: distribution of water sample and concentrations in Tulkurm district

| **Sample location** | | **Number of samples well** | | |
|---|---|---|---|---|
| **Tulkarm city** | | **23** | | |
| **Zeita village** | | **7** | | |
| **Anabta city** | | **18** | | |
| **Shufa village** | | **9** | | |
| **'Kafr Zibad village** | | **1** | | |
| **Bal'a Village Council** | | **1** | | |
| **Deir Sharaf 2A** | | **1** | | |
| **Concentration** | **max** | **min** | **mean** | **Stdev** |
| **NO3** | **141** | **16.5** | **54** | **30** |

| | | | | |
|---|---|---|---|---|
| **Cl-** | **151** | **28** | **88** | **36** |

Domestic water resources in this district limited to the municipality and agricultural wells, that used for domestic purposes. The samples were collected during the time span from 2001 to 2008 without 2007.Figure 5.16 present the nitrate concentration distributions in demotic ground water samples.

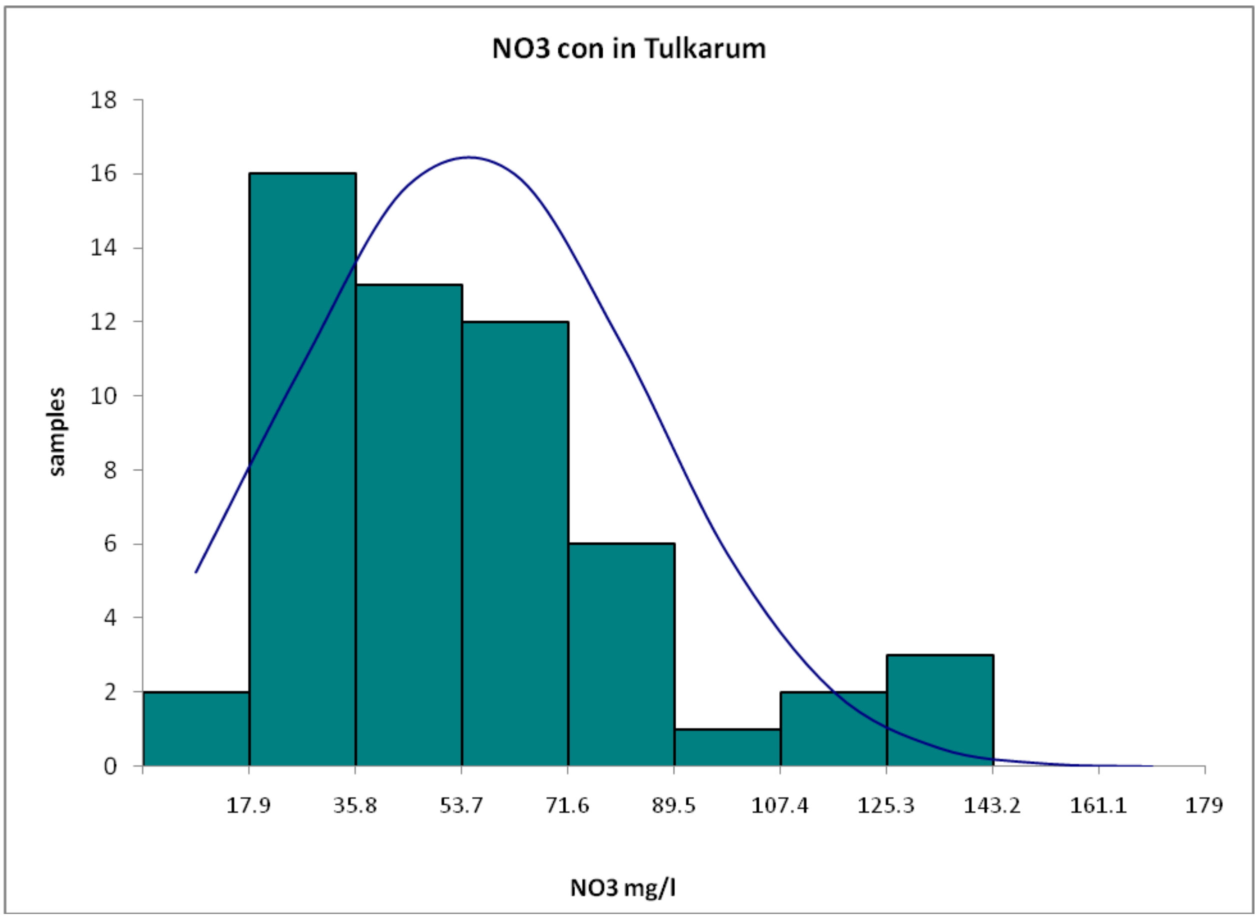


Figure 5.16 : $NO_3$ concentrations in domestic ground water in Tulkurm district

### 5.6.1 Nitrate concentration

The majority of water samples has concentration more than 50 mg/l with main focusing between 17.9 and 89.5mg/l. this result indicated that water resources are polluted , and has impact of agriculture activity and the others pollution sources such as waste water(sewage).where agricultural activities is distribute over the district. This result match with results in (Sently .et.al 2003, Jaynes. et.al .2001).

### 5.6.2 Chloride concentration:

High chloride value was 140m\l, this value was measured in well no.( 16-19/011 ) in Tulkurum city .Most of the value rang between 30and 154mg/l .This result is less than the upper limit of 250mg\l but indicate the impact of man mad activities. The high variation in chloride concentration is related to the location of wells as well as to the depth and there is no impact of agriculture activities and waste water pollution. Figure 5.17 present the chloride concentration distribution in domestic ground water samples.

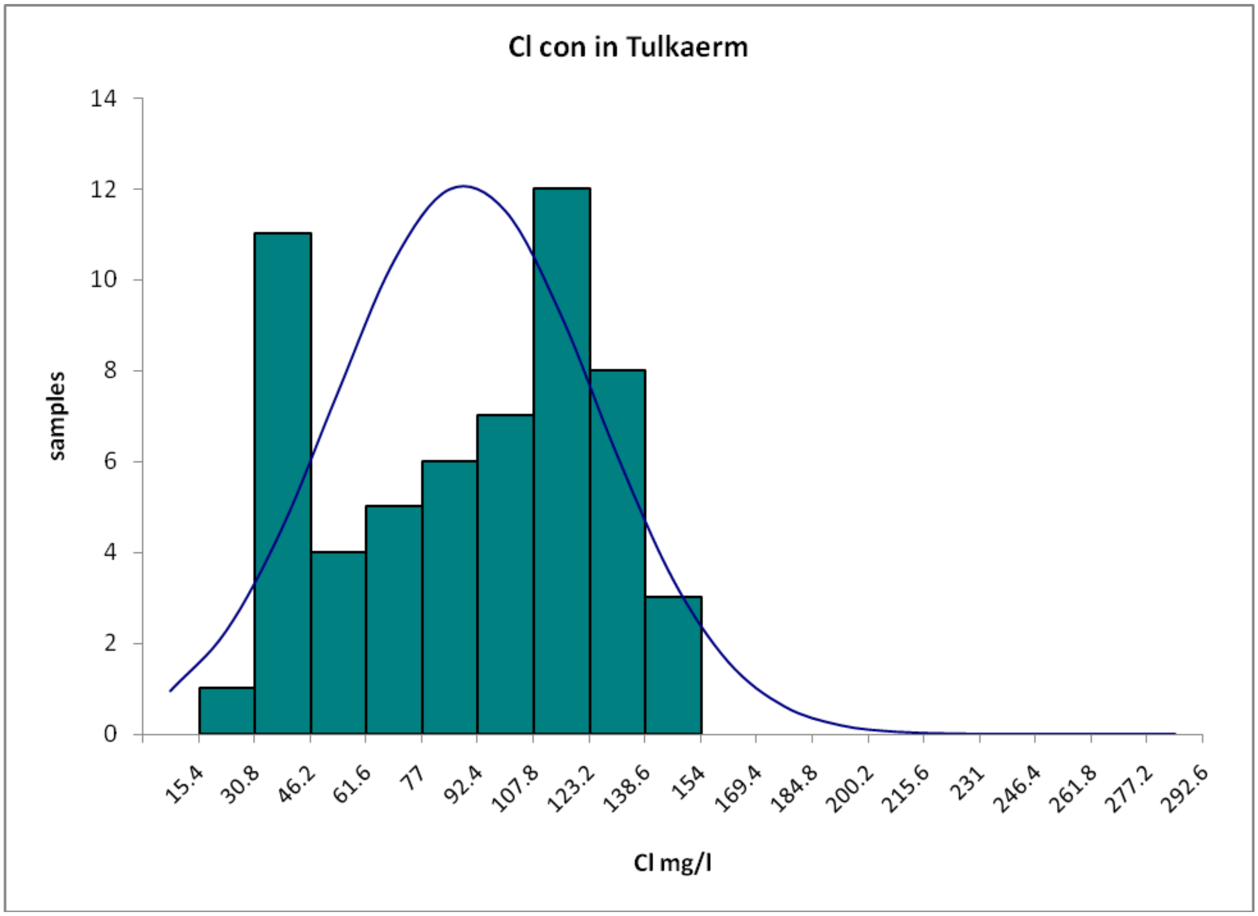


Figure 5.17  $Cl^-$ concentration in domestic ground water in Tulkurm district

### 5.6.3  Nitrate concentration with time variation:

The samples  taken between 2001 and 2008. The result show different variation of $NO_3$ concentration during this period, as indicator on the activity of the district in which highest concentration of $NO_3$ were present in 2005.Figure 5.18 present the concentration distribution of NO3 variation by time.

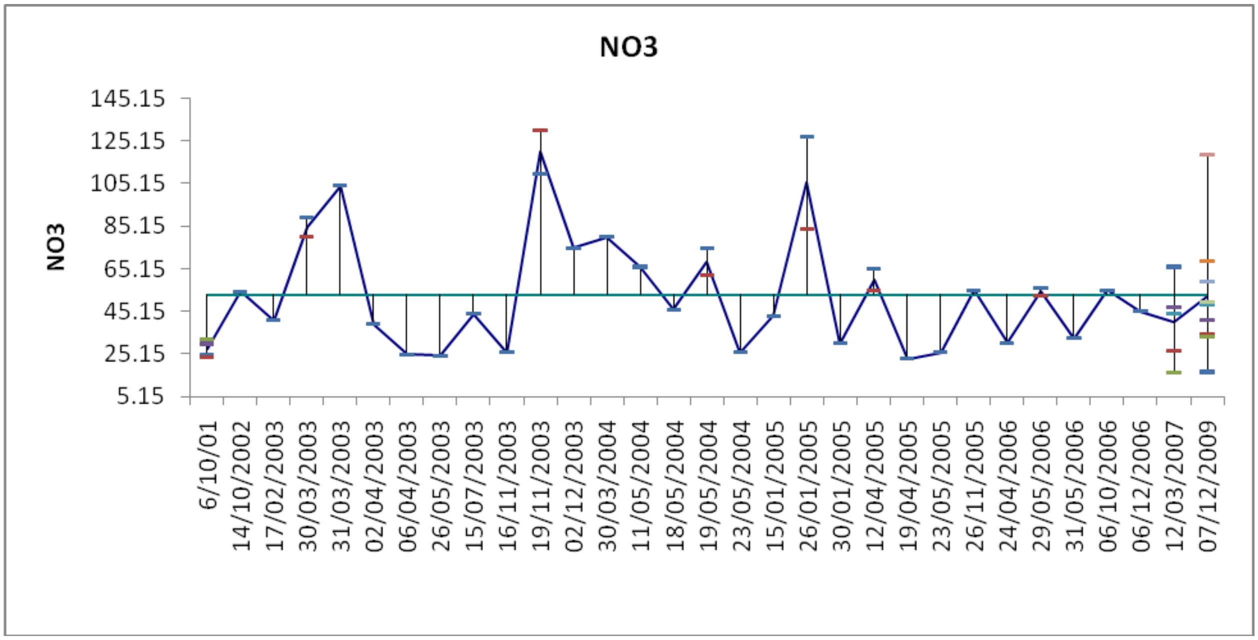


Figure 5.18: $NO_3$ concentration in domestic ground water variation by time in Tulkurm district

## 5.7 Jenin District

Demotic ground water samples were collected from springs and wells all over the district, this include samples from Deir Ghzal, Arrana, Sanur,Qabatiya, Yabad, Arraba, Maythalon, Tinnik, Kafer Dan in addition to Jenin. The aquifer system is Eocene one which consists of limestone, chalky limestone .The depth of the wells range between 100 and 250 m. this district is known for its agricultural activities , and most of wells are used for both purposes (agricultural and domestic). Table 5.10 present the sample distributions among different site and average and standard division for $NO_3$ and Cl.

Table 5.10: distribution of water sample and concentrations in Jenin district

| **Sample location** | | **Number of samples from well** | | |
|---|---|---|---|---|
| **Deir Ghazala** | | **9** | | |
| **Arrana** | | **7** | | |
| **Sanur** | | **23** | | |
| **'Jenin** | | **33** | | |
| **Qabatiya** | | **7** | | |
| **Ya'bad** | | **3** | | |
| **Arraba** | | **13** | | |
| **Maythalun** | | **1** | | |
| **Tinnik** | | **7** | | |
| **Kafr Dan** | | **4** | | |
| **Concentration** | **max** | **min** | **mean** | **Stdev** |
| **$NO_3$** | **122** | **3** | **34** | **29** |
| **$Cl^-$** | **340** | **29** | **115** | **71** |

Domestic water resources in this district comes from the municipality wells and home wells, samples were collected during the time span from 2001 to 2007 .Figure 5.19 present the nitrate concentration distributions in demotic ground water samples.

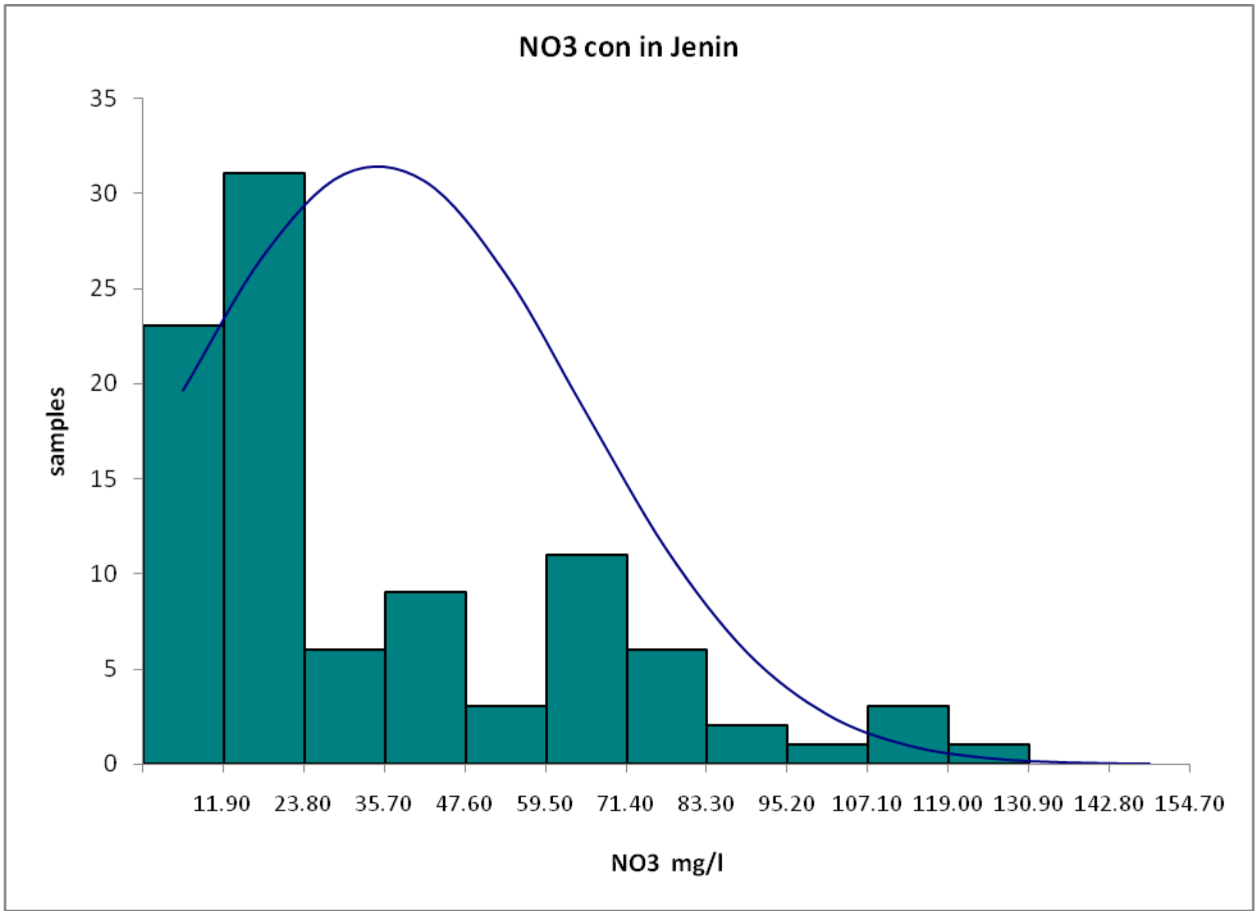


Figure 5.19 $NO_3$ concentrations in domestic ground water in Jenin district

### 5.7.1 Nitrate concentration

The majority of water samples has concentration less than 50 mg/l with main focusing between 11and 50mg/l, where some samples have concentration above 100mg\l This result indicated that water resources are polluted, but others are not yet Sources of nitrate are agriculture and waste water taking into consideration that the agriculture is the main resource for $NO_3$ in this district. This result match with results in (Anayah and Almasri, 2009, Al-Absi. (2008), Boumans.et.al.( 2008), Wakide and Lerner (2005) , Abdul-Jaber.et.al 1999).

### 5.7.2 Chloride concentration:

$Cl^-$ concentration range between 30 and 370mg\l where the most of samples is less than 120mg\l. This result indicated variation on chloride contents due the location of the well and the activates within the catchments area. This result match with results in (saffigray and Keeney,1977).Figure 5.20 present the chloride concentration distribution in domestic ground water samples.

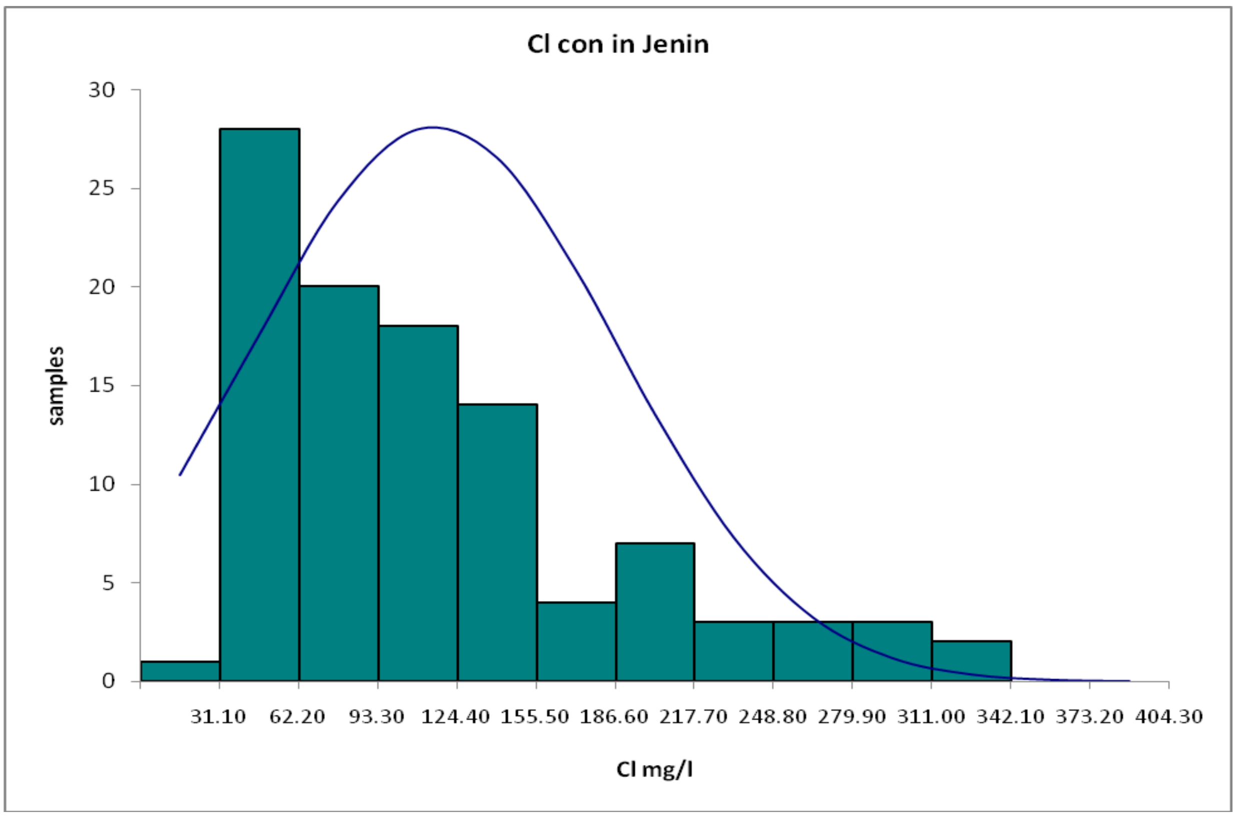


Figure 5.20: $Cl^-$ concentration in domestic ground water in Jenin district.

### 5.7.3 Nitrate concentration with time variation:

Samples were collected between 2001 and 2007. The result show different variation of $NO_3$ concentration during this period, as indicator on the activity of the district concentration of $NO_3$ were high all the time. This variation could be related to the leaching of N- compounds during winter months .Figure 5.21 present the concentration distribution of NO3 variation by time.

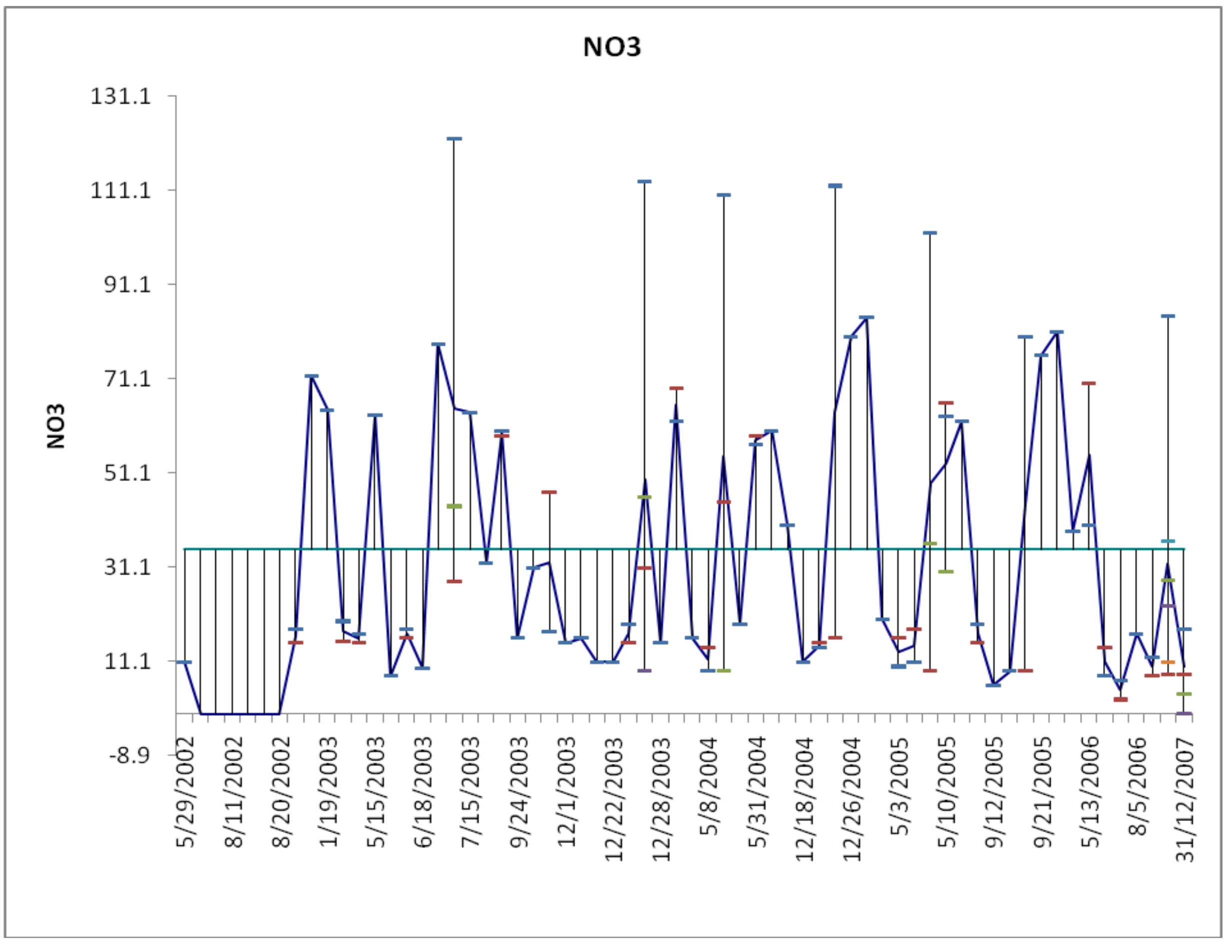


Figure 5.21: $NO_3$ concentration in domestic ground water variation by time in Jenin district.

### 5.8 Qalqilia District

This district located in the western part of the west bank water resources limited to wells that taped water from carbonate rocks. The depth of these wells ranged from 100 to 200 m. Demotic ground water samples were collected from all over the district, this include samples from Azzun, Habla in addition to Qalqilia. Table 5.11 present the sample distributions among different site and average and standard division for $NO_3$ and Cl.

Table 5.11: distribution of water sample and concentrations in Qalqilia district

| **Sample location** | | **Number of samples from wells** | | |
|---|---|---|---|---|
| **Qalqilia** | | **13** | | |
| **Habla** | | **8** | | |
| **Azzun** | | **7** | | |
| **Concentration** | **max** | **min** | **mean** | **Stdev** |
| **NO3** | **138** | **40** | **66** | **26** |
| **Cl-** | **145** | **35** | **86** | **26** |

Samples were collected during the time span from 2003 to 2006 .Figure 5.22 present the nitrate concentration distributions in demotic ground water samples.

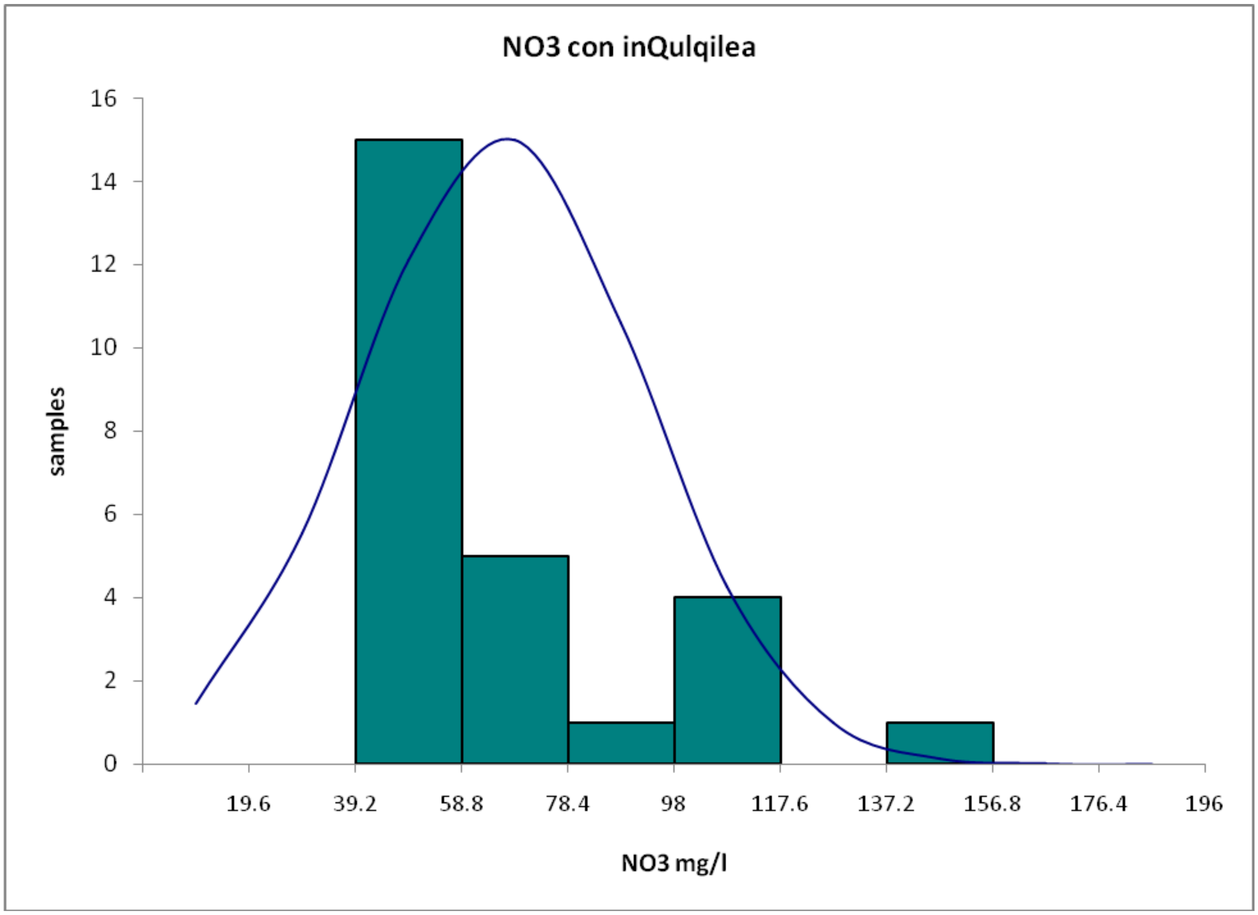


Figure 5.22 : $NO_3$ concentrations in domestics ground water in Qalqilia district

### 5.8.1 Nitrate concentration

The majority of water samples has concentration less than 80 mg/l with main focusing between 39 and 58 mg/l. This result indicated that nitrate concentration is above the drinking water limited of 50mg\l.The source of $NO_3$ related to the agricultural activities so water resources are polluted , and has impact of agriculture activity and the others pollution sources such as waste water(sewage). This result match with results in Anayah and Almasri, 2009, Al-Absi. (2008), Boumans.et.al.( 2008), Wakide and Lerner (2005) , Abdul-Jaber.et.al 1999.

### 5.8.2 Chloride concentration:

Figures 4.23 show normal distribution of $Cl^-$ in ground water resources in the district. The majority of water samples has concentration less than 250 mg/l with main focusing between 22and 154 mg/l. this result indicated that water resources are not polluted, and has no impact of agriculture activity and waste water pollution. But the values are high in general according to some of this wells locate in villages with no sewage system. Figure 5.23 present the chloride concentration distribution in domestic ground water samples.

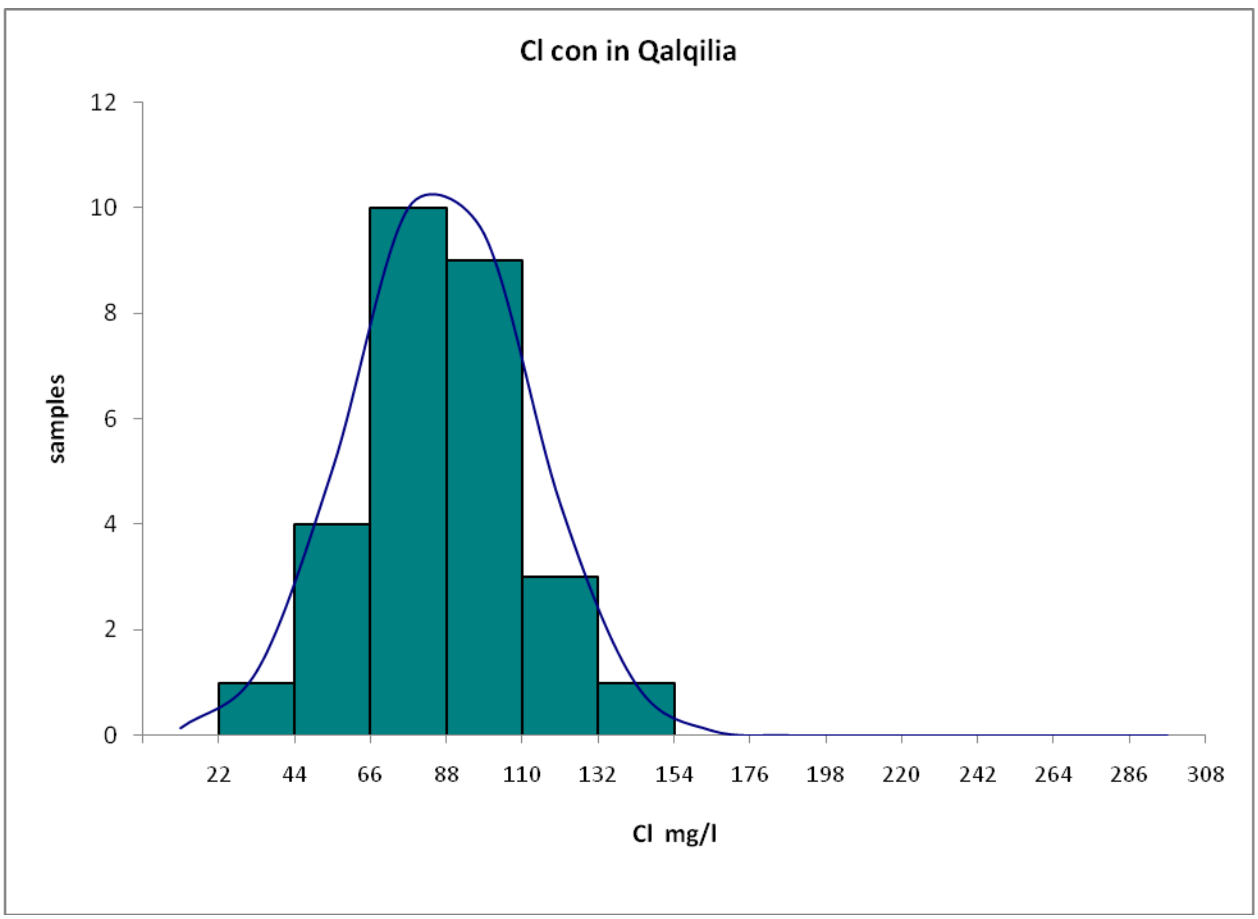


Figure 5.23: $Cl^-$ concentration in domestic ground water in Qalqilia district

### 5.8.3 Nitrate concentration with time variation:

The samples were collected between 2002 and 2006. The result show different variation of $NO_3$ concentration during this period, is related to the sampling time. The highest concentration of $NO_3$ were found in 2005.Figure 5.24 present the concentration distribution of NO3 variation by time.

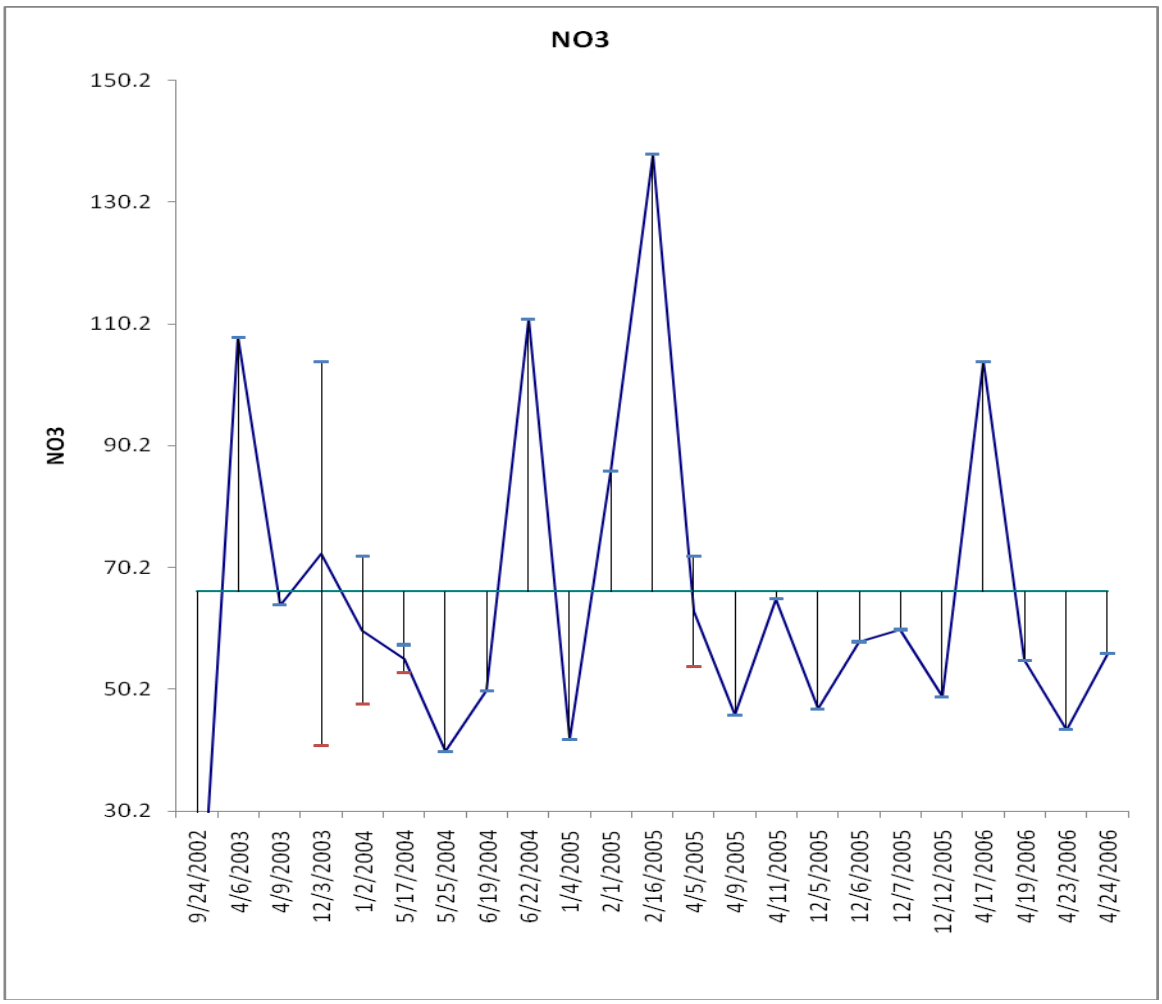


Figure 5.24: $NO_3$ concentrations in domestic ground water variation by time in Qalqilia district.

### 5.9. TOC concentration:

Allmost 200 groundwater samples were collected from all district in west bank.

Figure5.25 present the distribution of TOC- concentration. 80% of the samples have concentration lower than 2mg\l. In Hebron district where 40 samples were collect, the majority of the samples are less than 6mg\l where few samples contain relatively high values up to 50mg\l which could be caused by human activity (sewage). This result match with the result in ( Amin.et.al 2010).

In Bethlehem district 7 samples were collect, the majority of samples are higher than 21mg\l so in that district indicters for water with high concentration of TOC. (Pollutant water which could be realities to sewage) . This result match with the result in ( Amin. et.al 2010).

In Ramallah district the samples collect less than 10 samples and has concentration less than 2mg\l., and that give indicter that we have clean water in Ramallah.

In Nablus district which has the largest number of samples( 160), all the samples value higher than the WHO standards, with majority of samples between 5.6-1.2. This result show that Nablus district has series problem with TOC ( high polluted) which could be according to the waste water( no scientific treatment for the sewage).

In Jericho district almost we have 5 samples and has concentration higher than 2mg\l, but we can say that water is polluted with TOC because the samples is not significant to give result.

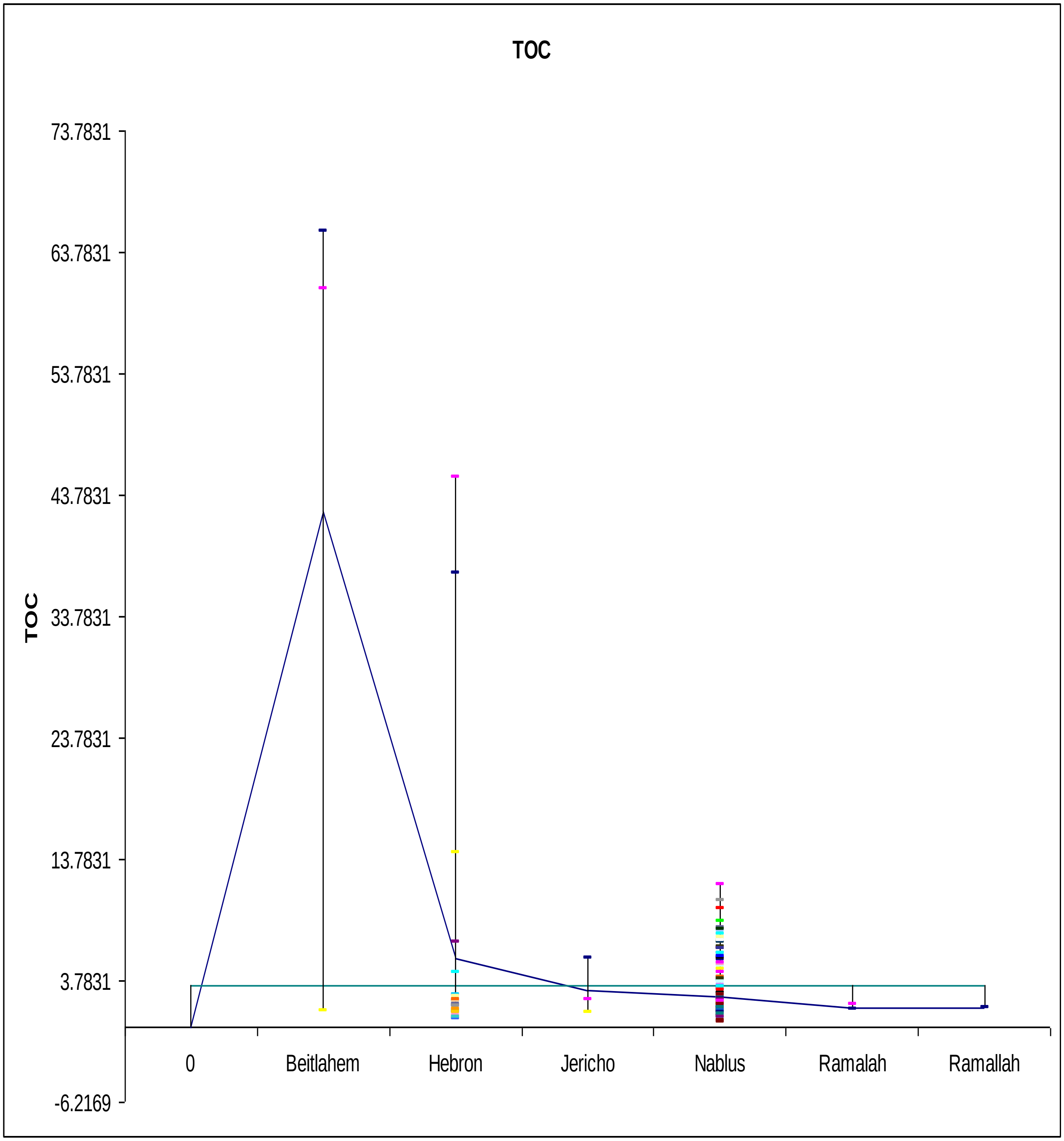


Figure 5.25 : the distribution of TOC- concentration over 5 district in west bank

### 5.10 The relation between NO3 concentration and depth

The result of the three districts wells (Ramallah, Bethlehem, Tulkurm, ) proved that when well increase the $NO_3$ concentration decreased, due to hardest of receiving pollutant from a rounding out side, taking in place the location and the construction of the wells. This result match with the result in (Brown 1958). The figure 5.31 present the nitrate concentration with depth in Ramallah district,figure 5.32 present the nitrate concentration with depth In Bethlehem district and figure 5.33 present the nitrate concentration with depth in Tulukrum district.

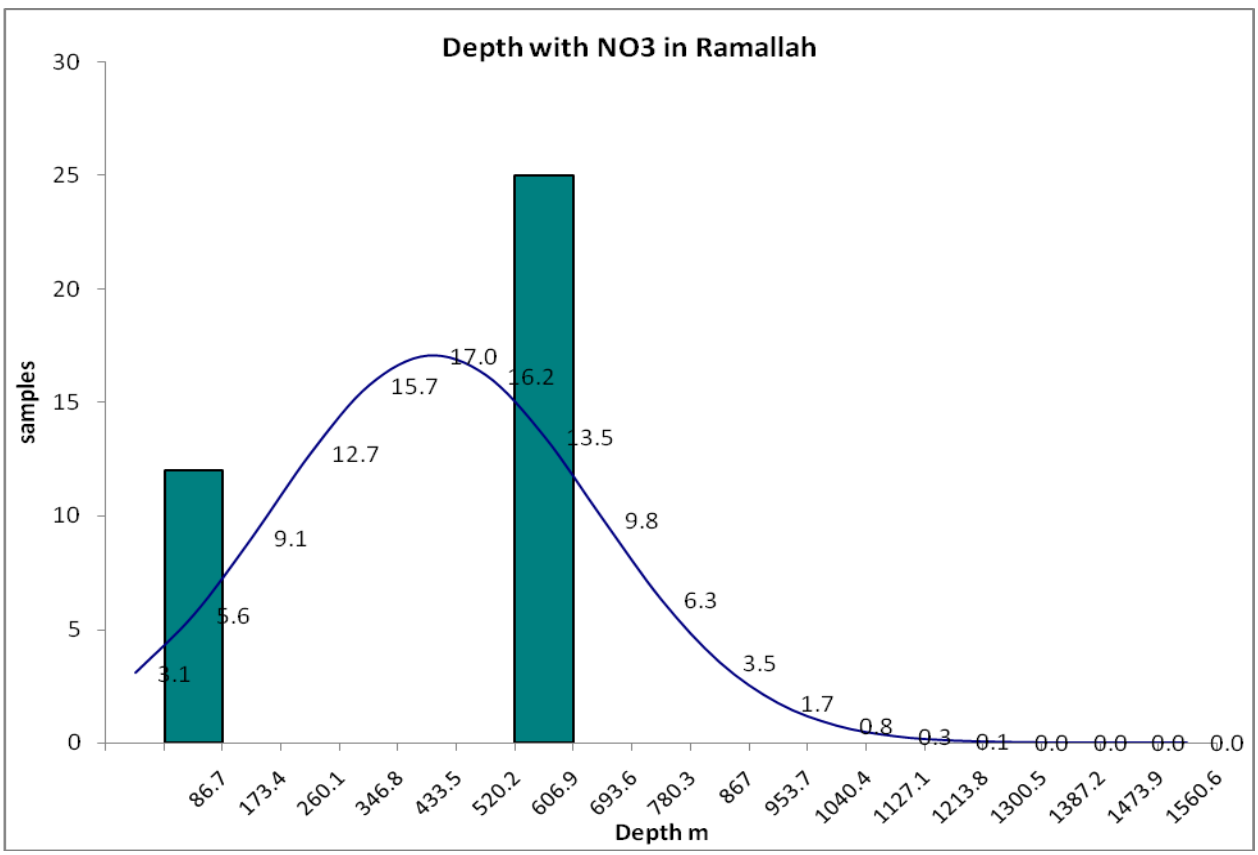


Figure 5.26 : $NO_3$ concentration with depth in Ramallah district.

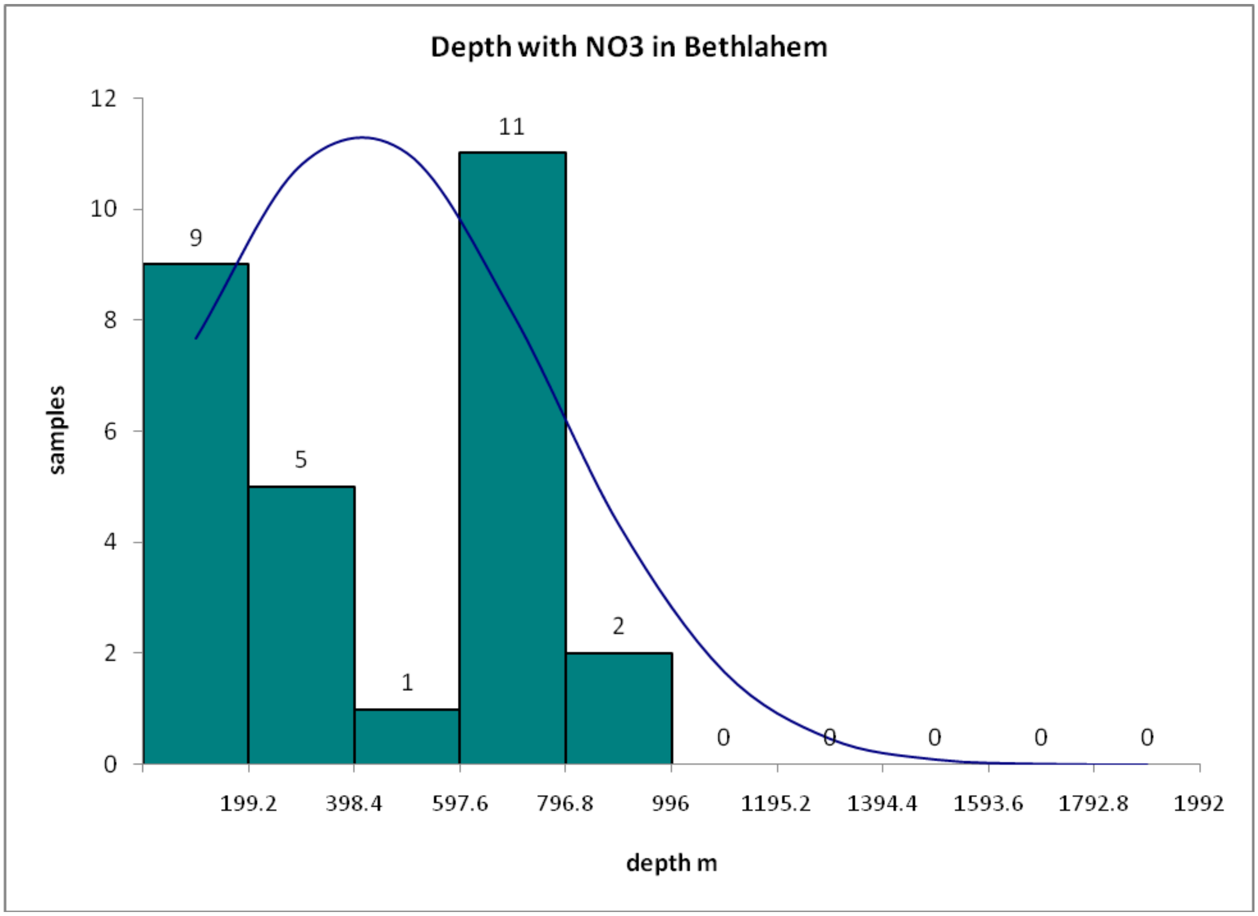


Figure 5.27 : $NO_3$ concentration with depth in Bethlehem district.

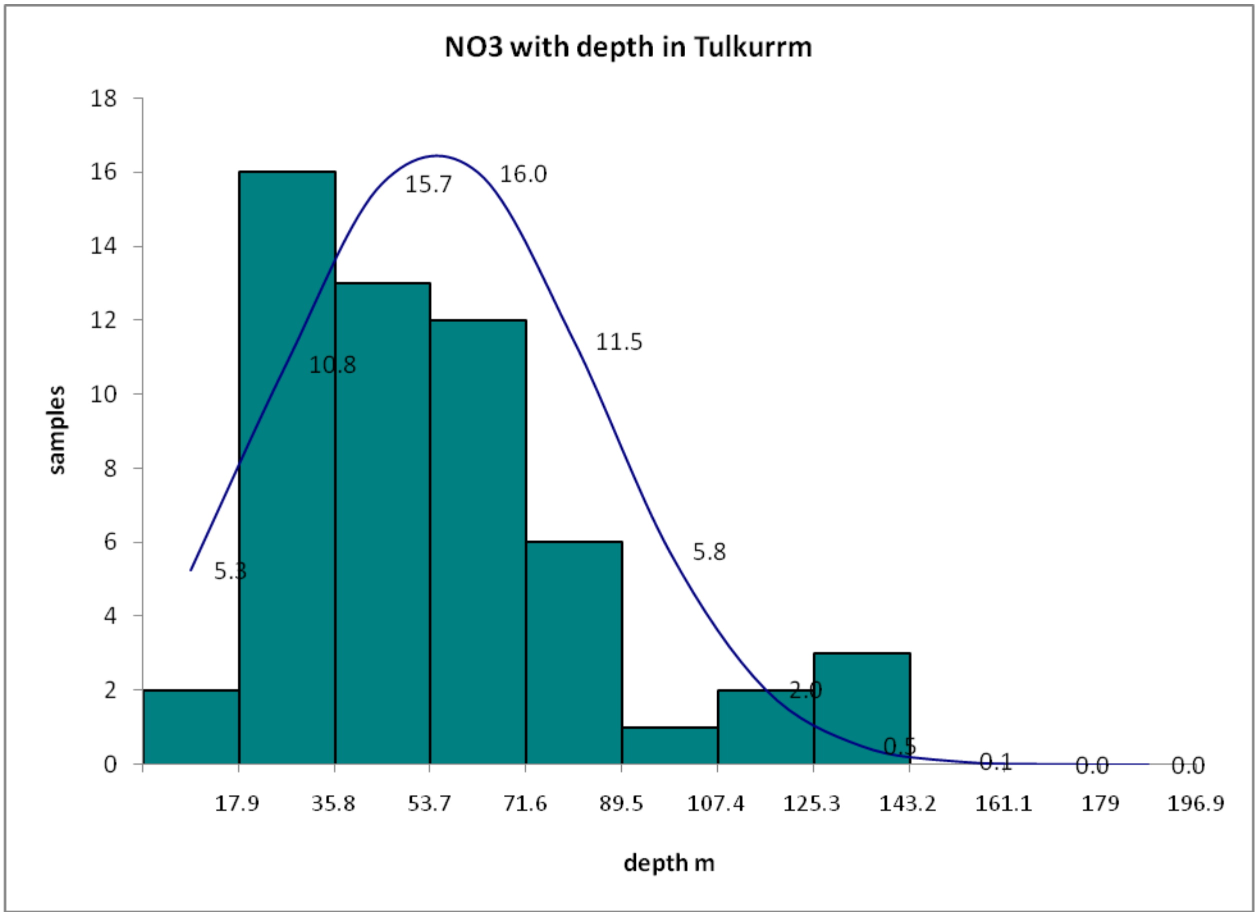


Figure 5.28 $NO_3$ concentration with depth in Tulkurum district

## 5.11 Summary of the results

According to the data the results summarized to several points:

- In four district (Jericho, Nablus ,Ramallah ,Bethlehem) the concentration of nitrate in general less than 50mg/l except some samples located near waste water, so this district is not considered as polluted of nitrate.
- The same four districts are not polluted with chloride and Total Organic Carbon and have concentration less than WHO standard so ground water their safe for used and have no significant impact in health.
- The concentration of nitrate, chloride, TOC in the other districts (Hebron, Tulkurm, Jenin , Qalqulia ) show high concentration in several samples in this districts, due to man made activities ( agriculture, waste water), and the rainfall too effect by leaching the nitrate from soil horizon. But much samples have low concentration of $NO_3$ , $Cl^-$ and TOC so water can be consider not polluted.

- The results show that the relation between nitrate and the depth of the well is inverse relation. (Low concentration of nitrate in the deeper wells), with ignoring the wells location and construction.

### 5.12 Conclusions :

Domestic water depends in ground water in the world, the special situation in west bank and limited sources of water made it important to examine the safety of it, including physical and chemical properties. In this research samples were collected from the districts according to not having special management for water waste treatment, each village as its own way.

Generally the ground water in this districts are not polluted and has concentration of nitrate, chloride and total organic compound less than the WHO standard, and safety to used.

Some samples show high concentration of nitrate, chloride and total organic compound exist in districts (Hebron, Tulkurm, Jenin , Qalqulia) .Generally they are agriculture areas, using much fertilizers containing nitrate, poor network swage, and the leaching from soil horizon.

The location and the construction of wells has affected the nitrate, chloride and TOC concentration. The study show inverse relation between the wells depth and the nitrate concentration (low concentration of $NO_3$ in the deeper wells).

**5.13 Recommendations:**

Several recommendations could be considering in addition to the result and the conclusion:

Do comprehensive testing and continuous for all toxic substances and pollutants and carcinogens ( cause cancer) that can be present in groundwater and disseminate the results and compare them with the Environmental protection agency guideline levels.

Carry out a new study in same subject but  sampling not by the provinces( districts ), but according to the geological division of the West Bank and making a comparison between the results.

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