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Institute of Community & Public Health

Industrial Liquid Waste

Impact on the Environment and Public Health

Proceedings of the Workshop entitled "Industrial Waste Water in Palestine - Impact on Environment and Public Health"
December 1997

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Preface

A scientific seminar entitled, "Industrial Wastewater in Palestine - Impact on Environment and Public Health", was held at the Institute of Community and Public Health, Birzeit University on the sixth of December 1997. The seminar participants, local Palestinian researchers, presented their research in order to disseminate information to Palestinian researchers and professionals in the area.

Due to the importance of the subject to the future of Palestine, the participants recommended publishing the seminar papers and a summary of the proceedings.

For reasons beyond our control, we couldn't finalize the publication earlier. We hope that this delay will not lessen the importance and value of this publication.

Maisoun Filfil
Institute of Community and Public Health

Introduction

Industrial development is considered an important aspect of economic growth. However, industries may generate different types of hazardous waste, causing negative impacts on the environment and public health. This issue has been of great importance in industrialized countries when it became clear that industrial discharge into lakes and rivers caused loss of bio-diversity and endangered public health. In developing countries, dealing with the issue of industrial pollution and the environment is still in its early stages.

During the 30 years of occupation, little concern was paid to infrastructure development and environmental protection in the Palestinian areas. Israeli policy viewed the Palestinian occupied areas of the West Bank and Gaza Strip as a market for Israeli products. Industrial liquid waste was disposed of into municipal treatment plants or into the open environment without receiving proper treatment.

Although industrial waste and its impact on health and environment is recognized as an important concern to Palestinians, limited data and information are available on the current situation. In principal, it is known that industrial waste has to be treated prior to discharge into the environment yet, little information is available on waste constituent and waste management in industrial plants.

After the signing of the Oslo Accords, different studies were undertaken to develop a master plan for wastewater treatment and disposal. The impact of industries on the environment and public health as well as its importance to economic development has been under discussion among Palestinian environmentalists, public health professionals, development planners, and others. The issue is seen as one of the 'hot' environmental issues. Nonetheless, the limited information and data available was recognized as a constraint for damage control measures and strategic planning. Additionally, individual work on the issue has not been shared among concerned communities.

In order to address these concerns, the Institute of Community and Public Health held a scientific seminar on "Industrial Wastewater and its Impact on the Environment and Public Health" where professionals from different disciplines came together to discuss the issue.

Local Palestinian researchers and professionals presented nine papers, covering the main topic of industrial wastewater. The papers presented dealt with a variety of issues including water consumption by industry, possibilities of treatment specific to the industries, and the effects of industries in Israeli settlements on Palestinian communities.

In his presentation on Water and Wastewater for the Industrial Sector in the West Bank, Iyad Ya'quob from Palestinian Water Authority (PWA) presented the estimations of water consumed by industries and the amounts of wastewater generated based on the data from the Central Bureau of Statistics (PCBS). Industries consume 152,656 cubic meters per month, with the food and beverages industry as the largest consumer. The amount of wastewater generated is estimated at 90,000 cubic meters per month. In his conclusion, Ya'qoub mentions that the figures may not be accurate because it covered only the major industries.

In their presentation, Awni al-Khateeb and Yousif Sobuh from Hebron University described a method for treating wastewater generated from olive-oil mills through an Up-flow Anaerobic Sludge Blanket (UASB) reactor. The importance of developing treatment for wastewater generated from olive oil mills lies in the fact that such effluents have high grease content and organic load. When connected with domestic treatment plants, the efficiency of the plant may be hindered. Using UASB to treat olive-mills' wastewater proved encouraging, resulting in a decrease of the organic load and the elimination of different pollutants. Yet the process is going through further development in both the laboratory and the field, supervised by a team of researchers at Hebron University.

Taghreed Najjar, Palestinian Hydrology Group (PHG), presented a paper describing different types of pollution caused by industrial activities in the West Bank and Gaza Strip. Najjar took a sample of fifteen industrial firms and estimated the different types of waste generated from each site. She concluded that dyeing industries generate the highest quantities of wastewater, followed by the stone cutting industry. The electroplating, dyeing, and pharmaceutical industries all produce a high concentration of heavy metals in their wastewater. The food and dyeing industries generate wastewater with high organic load. Yet this study is not finalized and more data needs to be gathered and analyzed.

The method of environmental audit to prevent pollution and minimize waste is discussed in the paper of Muna Hindiyyeh from the Department of Community and Public Health. The audit was conducted in an electroplating - galvanization company in al-Bireh. This company galvanizes iron with zinc to improve appearance and provide it with characteristics to withstand weather changes. Like the tanning industry, different chemicals are used in electroplating industry, some of which are dangerous to human health. As this industry is not connected to the municipal sewerage system, wastewater is collected into a septic tank and then discharged into an unknown location in the surrounding valleys. It was found that the wastewater contains high concentrations of Cyanide which is known as heavy poison. The audit followed the stages of the galvanization industry in an attempt to detect the sources of pollution, environmental compliance with standards of wastewater discharged into the environment, and most importantly, the possible means of pollution control and waste minimization. The second part of the paper discusses the environmental and public health hazards of the plant wastewater.

Qasem Abdul-Jaber from PHG discussed chemical pollution of groundwater wells alongside Wadi Zeimar from Anabta to Tulkarm, caused by infiltration of untreated wastewater flowing in the wadi. Industries alongside the wadi from Nablus to Tulkarm dispose their waste in the catchment area of water wells. The wells that extract good water quality are located far away from wastewater streams and collection pools. The polluted wells that extract poor water quality are located beside wastewater collection pools.

Reem Musleh and Amy Shmit from the Department of Community and Public Health, Birzeit University presented an industrial profile of the Ramallah District focusing on environmental aspects with special emphasis on industrial wastewater. The authors analyzed data from the records of the Ministry of Health.

Samir Afifi from the Islamic University - Gaza discussed the considerations for connecting industrial liquid wastes with municipal treatment plants. Taking the Northern Governorate treatment plant in Gaza as a study case, Afifi classified the industries according to the quantity and quality of wastewater generated in the different factories. Detailed investigation of potential effects on the treatment plant from industrial waste was conducted to find possible measures to be taken prior to their connection to the wastewater treatment plant.

Violette Qumsieh and Yousef Tushyeh from the Applied Research Institute - Jerusalem (ARIJ) highlighted the environmental damage from Israeli settlements in the West Bank. The authors highlighted the types of settlement industries located in the proximity of Burqan and Wadi al-Teen near Tulkarm and estimated the quantities and types of hazards generated.

Sayel Khader al-Wishahi from PHG discussed the environmental impact of the leather tanning industry in Nablus area. Different chemicals are used in the industry and discharged into the environment. These chemicals include acids, alkaline liquids and heavy metals, organic solvents, and other material with unknown composition. Measurements of the wastewater generated from two tanning factories was found to contain a concentration of different hazardous chemicals and some physical properties that exceeded the Jordanian standards for disposing wastewater into the environment. The hazardous material mixes with the surface water of springs in the area causing high risk of water pollution. Such water is used for irrigation which causes soil and crop contamination. Recommendations included the monitoring and treatment of liquid waste before discharge into the environment to minimize soil and water pollution.

From the presented papers, we can see that the issue of industrial liquid waste and its impact on the environment and public health has already been dealt with by Palestinian researchers, although on a limited scale. We hope that this publication will be of benefit to all those concerned about the environment and public health in Palestine.

Assessment of the Impact of Israeli Industries on the West Bank Environment

Violet Qumsieh and Yousef Tushyeh
Applied Research Institute-Jerusalem

Introduction

Industrial pollution is considered one of the major issues in environmental protection. In the West Bank, the Palestinian industrial sector is not developed and contributes only 7% to the Gross National Product (GNP). The main industries found are quarrying and stone cutting, textile, leather, dairy, chemical, and agricultural industries. These industries contribute to pollution, especially in the absence of regulations that force the manufacturers to reduce the hazardous impact of industry on the local environment. However, Israeli settlements in the West Bank are hosting several polluting industries which may produce hazardous waste. Wastes generated from these industries are affecting different areas of the West Bank. This paper will deal with Israeli industries in the West Bank. While information is scarce, there will be an attempt to focus on polluting industries inside the Israeli industrial zones and their impacts on the West Bank environment. Two case studies will be discussed in this paper. The first deals with Barqan industrial zone where an aerial photo of the area shows industrial waste flowing into the nearby wadi. The other deals with Wadi al-Teen quarry near Tulkarem.

Israeli Industrial Zones

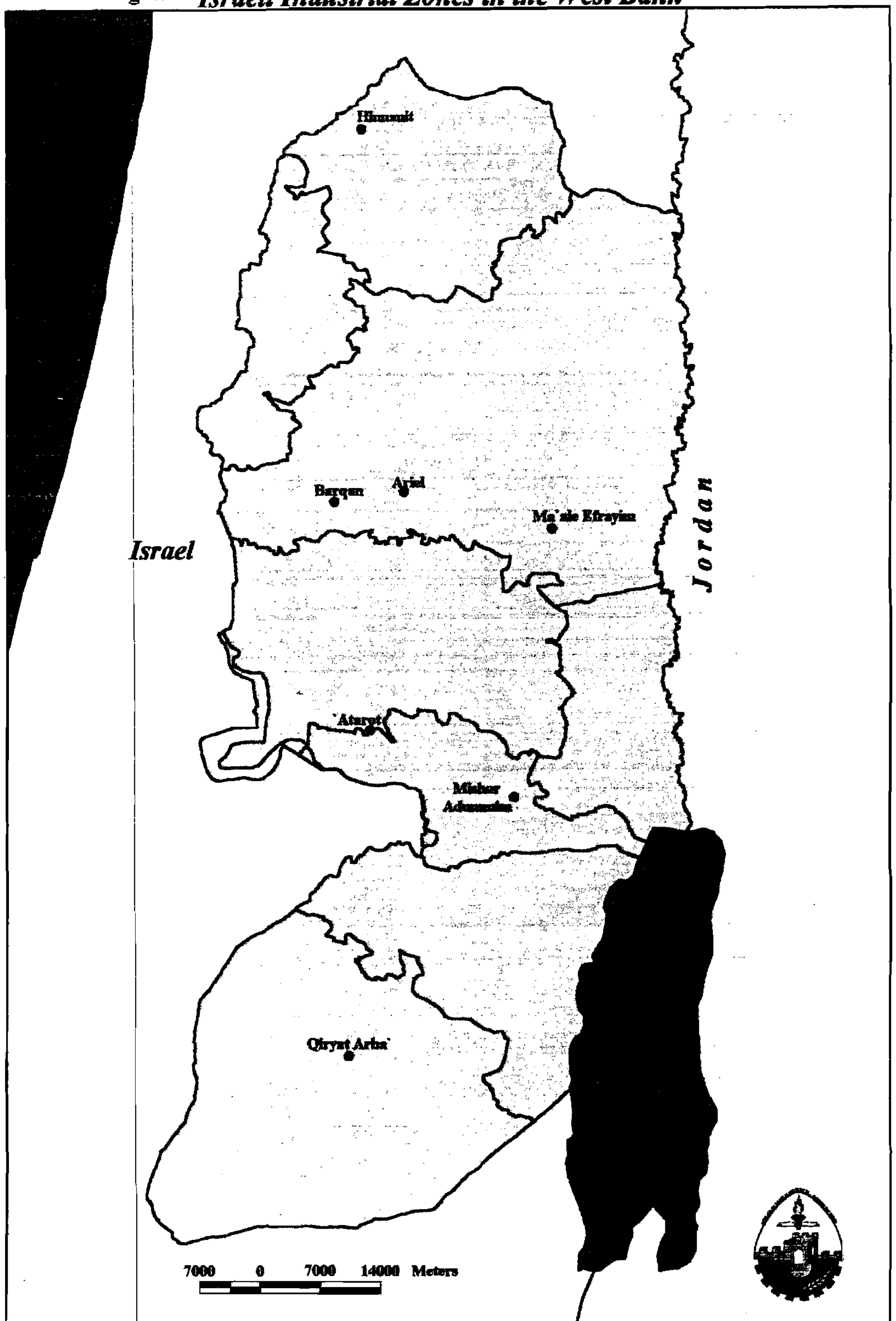
There are at least seven Israeli industrial zones in the West Bank **(Figure 1).** These industrial zones occupy an area of approximately 302 hectares. A'tarot and Mishor Adumim industrial zones are the largest Israeli industrial zones in the West Bank. Israeli industrial zones are mostly located on top of hills, resulting in the flow of industrial wastewater to adjacent Palestinian land and farms. The Israeli authorities have issued permits for the establishment of four new Israeli industrial zones in the West Bank. The purposed sites of these industrial zones are in Area C near Ramallah, Nablus, Hebron, and the Jordan Valley. **Table 1** lists the Israeli industrial zones and the area each one of them occupies.

Table 1
Israeli industrial zones in the West Bank

Industrial Zone	District	Area (hectare)
Hinnanit industrial zone	Jenin	10.9931
Barqan industrial zone	Nablus	14.8721
Ariel industrial zone	Nablus	14.8398
Ma'ale Efrayim industrial zone	Nablus	2.5818
'Atarot industrial zone	Jerusalem	145.7828
Mishor Adummim industrial zone	Jerusalem	109.9236
Qiryat Arba' industrial zone	Hebron	3.3519
Total		**302.0**

Note: GIS Unit, ARIJ.

Fig. 1 ***Israeli Industrial Zones in the West Bank***



It is estimated that at least 200 Israeli industrial facilities are located within the West Bank area (GIS Unit, ARIJ). These industries are either located in the Israeli industrial zones or inside Israeli settlements. Information about the Israeli industrial activities in the West Bank is scarce. Some of their products are identified but detailed information on quantities produced, labors, and waste generated is not available. The major industries within these industrial zones include aluminum, leather tanning, textile dyeing, batteries, fiberglass, plastics, and other chemical industries. **Table 2** lists the industries in some of the Israeli industrial zones and settlements in the West Bank.

Table 2
Israeli Industries in the West Bank

District	Industrial Zone	Industry
Nablus	Barqan	Aluminum, fiberglass, plastic, electroplating
	Allon Morieh	Aluminum, food canning, textile dying
	Shilo	Aluminum, leather tanning
Ramallah	Halmeesh	Fiberglass, leather tanning
	Givout hadasha	Rubber
	Nili	Aluminum
	Shilat	Fiberglass, plastic
	'Atarot	Aluminum, cement, plastic, food canning, and others
Hebron	Qiryat Arba'	Winery, building blocks, tiles, plastic
Jerusalem	Mishor Adummim	Plastic, cement, winery, leather tanning, detergents, textile, printing dyes, aluminum, electroplating, and others
Jenin	Homesh	Batteries, aluminum, detergents
Tulkarem	Near the Green Line	Pesticide, fiberglass, Dixon gas

Note: Gush Shalom, 1999.

The Israeli Authorities have moved many of the polluting industries from different places inside Israel to areas near the Green Line or inside the settlements. For example, a pesticide factory in Kfar Saba, which produces dangerous pollutants, has been moved to an area near Tulkarem. The wastewater from this factory has damaged the citrus trees and polluted the soil in the area in addition to the threat that it may pose to the groundwater (Gush Shalom, 1999). As a further example, the Dixon Gas industrial factory, formerly located in Nethania, has been moved into the same area. Solid waste from these industries is burned in free air. In February 1997, the Palestinian Ministry of Health tested the solid waste located at the western part of Tulkarem city and reported that fiberglass and polyester were present. All these materials are used for thermal insulation in refrigerator manufacturing. Burning of this waste results in the emission of dangerous black smoke and toxic gases. Moreover, the western winds move these fumes into community and public areas, causing health risks in Tulkarem City and the neighboring villages. It is reported that the Israeli government has moved an Israeli military camp from this area because Israeli soldiers have been affected from the fumes of these industries (al-Quds, 1997).

Industrial Wastes and their Environmental Impacts

Most of the Israeli industries in the West Bank produce hazardous liquid and solid waste. Hazardous wastes can be defined as wastes that pose a potential hazard to humans, plants, or animals. General categories of industrial hazardous waste include toxic chemicals and flammable, radioactive, or biological substances. These wastes can be in the form of sludge, liquid, gas, or solid. The impact of industrial discharge depends not only on their collective characteristics such as biological oxygen demand (BOD) and suspended solids but also on their content of specific inorganic substances.

Because its quality depends on the type of manufacturing process involved, the accurate composition of industrial waste cannot be easily determined unless laboratory analysis is conducted. Estimates of the composition of the generated waste can be made where type of industry indicates the major constituents of the hazardous material in the waste. **Table 3** shows the typical waste generated from industries found in the Israeli industrial zones as stated by the WHO report (Economopoulos, 1993).

Table 3 Typical wastes generated from some industries					
Other pollutants	**Waste Volume m^3/U**	**TSS (Kg/U)**	**BOD (Kg/U)**	**Unit (U)**	**Industry**
Al = 55 kg/U NaOH = 430 Kg/U Oil = 5 Kg/U			---	1000 m^2	Aluminum (Alkaline Pickling for Al)
N = 12 Kg/U Cr = 4.76 Kg/U Sulfide = 4.76 Kg/U	20-85	104	63.5	Ton of hides	Leather Tanning
Ni = 25 Kg/U SO4 = 33 kg/U Oil = 0.5 Kg/U Zn = 6.9 Kg/U NaOH = 50 Kg/U CN = 15 Kg/U Cr^6=37 Kg/U	--- ---	--- ---	--- ---	1000 m^2 1000 m^2	Electroplating Nickel Bright Zinc Bright Chromium Ornamental
---	---	4	68	Ton of product	Plastic (Nylon)
--- ---	16.4 13.1	3.5 8.1	13.6 17.5	Ton of raw material Ton of raw material	Food Canning Fruits Vegetable
Oil = 76 Kg/U Chlorobenzene = 38Kg/U phenol = 4.9 Kg/U	5.3 3.6	 9	 22.7	Ton of Product Ton of product	Pesticide: nsecticide, ungicides, etc Chlorinated Hydrocarbon
Dyes	50	25	60	Ton of Cotton	Textile Dyeing
---	2	0.3	1.6	on of rapes	Wine

Note: Economopoulos, A. 1993.

The generated industrial wastes from the Israeli industries in the West Bank contain toxic elements such as the aluminum, chromium, lead, zinc, and nickel. All of these inorganic substances are considered hazardous and affect the health if accumulated in the body. The following is a description of the impact of specific industries on the environment and public health.

1. **Electroplating.** The electroplating industry produces toxic chemicals, both in solid and liquid form. The generated waste contains oil and inorganic chemicals depending on the plating chemical. Nickel, zinc, lead, and chromium are found in the generated waste. Lead, for example, is highly toxic; the effects of which are usually felt after it has accumulated in the body over a period of time. The symptoms of lead poisoning are anemia, weakness, an acute diarrhea disorder, as well as liver and kidney damage (Encarta, 1997). These toxic chemicals pollute the groundwater if wastewater is discharged without treatment. Electroplating industries are found in Barqan, Meshor Adumim, Homesh, Shilo, Allon Morieh, and 'Atarot industrial zones. Since Palestinian lands are located at foothills of these sites, the mentioned toxic wastes affect the agricultural land and cause serious diseases to people living in the proximity.

2. **Leather Tanning.** The tanning industry uses many chemicals such as cyclohexane chromium salts, dyes, and finishing agents like Xylene and Toluene. These chemicals are severely toxic and affect human health and the environment. Wastes that contain such chemicals affect the agricultural land by decreasing soil fertility. Chemicals like chromium and sulfide may seep through the soil, polluting the groundwater. Biological decomposition of organic materials, as well as sulphide emissions from wastewater, affect the air quality in the area. Direct contact with some industrial chemicals can cause disability, illness, and death (UNEP, 1991). Tanning facilities are distributed in many Israeli settlements and industrial zones such as Halmeesh, Meshor Adumim, Migdalim, Shilo, and Allon Morieh. Toxic chemicals used in this industry such as chromium and sulfide also affect the groundwater quality.

3. **Batteries.** The battery industry involves the use of inorganic metals such as lead and zinc which are toxic pollutants. Cadmium, for example, is found in zinc ores and emissions from zinc smelters are a major source of environmental cadmium contamination. Emission of such toxic pollutants is linked to high blood pressure, liver disease, kidney problems, heart disease, and certain types of cancer (UNEP, 1993). In

addition to air pollutants, smelting of such metals emits hazardous liquid and solid wastes that can cause soil and water pollution. A battery production line is found in Homesh.

4. **Pesticides.** The pesticide industry poses a threat to the environment and to people since it involves the use of toxic and nondegradable materials. Chlorinated hydrocarbons and organophosphates compounds are used in the preparation of pesticides. The chlorinated hydrocarbons are slow to degrade and persist in the environment for long periods of time. Also pesticides such as organophosphates are poisonous and toxic. The toxicity of organophosphates is high and is similar to the toxicity of dangerous poison arsenic, strychnine, and cyanide. Contact with organophosphates may result in permanent damage to the nervous system. Pesticides have been linked to a variety of cancers including Leukemia and cancer of the brain (UNEP, 1993). A pesticide industrial facility is known to exist near Tulkarem city near the Green Line.

5. **Plastic Industry.** Although plastics are relatively inert, some polymers used in the manufacturing of plastics have been shown to cause cancer. Plastics are not environmentally degradable and their presence in the soil damages plants and crops (Encarta, 1997). Plastics are subject to burning when disposed of in open dumping sites. Burning of such waste produces toxic gases that cause various diseases such as lung damage and other respiratory ailments.

6. **Textile Dyeing.** The textile industry uses a wide variety of dyes and chemicals, many of which are discarded in liquid effluent discharges. Some of the contaminants likely to be found in textile plant effluents include organic chemicals, salts, surfactants, dyes, greases and oils, acid and alkaline wastes, and a number of other substances. Textile effluents are generally characterized by high concentrations of chemical oxygen demand (COD), biological oxygen demand (BOD), suspended solids, heavy metals, extreme pH, and elevated temperatures. Many of the dyes used in textile mills are known to be mutagenic and some are suspected of being carcinogenic. Untreated textile effluents may pose a hazard to human health. Direct discharge of such effluents may lead to significant

damage of agricultural land and water streams. Textile dyeing facilities are found in Allon Morieh, Edomim, and Emanuel settlements.

Palestinian lands located at the foothills of the industrial zones are highly affected by the flow of the industrial waste. It seems, as seen from the flowing waste, that pollution prevention measures are not followed inside the Israeli industrial facilities. Also, the generated industrial solid waste are collected and dumped at areas near Palestinian villages. **Table 4** shows Palestinian villages affected by industries in some of the Israeli industrial zones.

Table 4
Palestinian locations affected by Israeli industry in the West Bank

Settlements	Affected Palestinian Location
Halmeesh	al-Nabi Saleh village
Mishor Adummim	Jerusalem Desert
Homesh	Silat al-Thahir
Barqan	Kafr al-Deik, Sarta, and Bruqin villages
Shilo	Qaryout and Turmus 'Ayya
Allon Morieh	Nablus- Wadi Badan Road
'Atarot	Bir Nabala and Judeira
Qiryat Arba'	Bani Na'im
Israeli industrial zone at the Green Line near Tulkarem	Tulkarem city and agricultural areas

Note: Ministry of Civil Affairs, *Environmental damages in the West Bank Districts resulted from Israeli settlements and industries*. The Palestinian National Authority, 1997. (in Arabic)

The Barqan Industrial Zone

The Barqan industrial zone is located in the Nablus district with an estimated area of 150 dunums. It hosts approximately 80 industrial facilities of different industries such as aluminum, fiberglass, plastic, electroplating, and military industries. There are three aluminum facilities and several plastic facilities. These industries produce large quantities of liquid and solid wastes. Industrial wastewater generated from the Barqan industrial zone flows into the nearby wadi, polluting the agricultural lands belonging to the three Palestinian villages of Sarta, Kafr al-Deik, and Bruqin. It is estimated that this industrial zone generates approximately 810 thousand m3 of industrial wastewater annually (Report of the Country Investigator, 1992). In 1991 and 1992, the Israeli Regional Council (Shomron) conducted a study to evaluate the composition of the generated industrial waste. The study showed that the generated waste was not meeting standards regarding toxic and hazardous chemicals. The director of the industrial zone was informed about the results but did not work to stop this disaster.

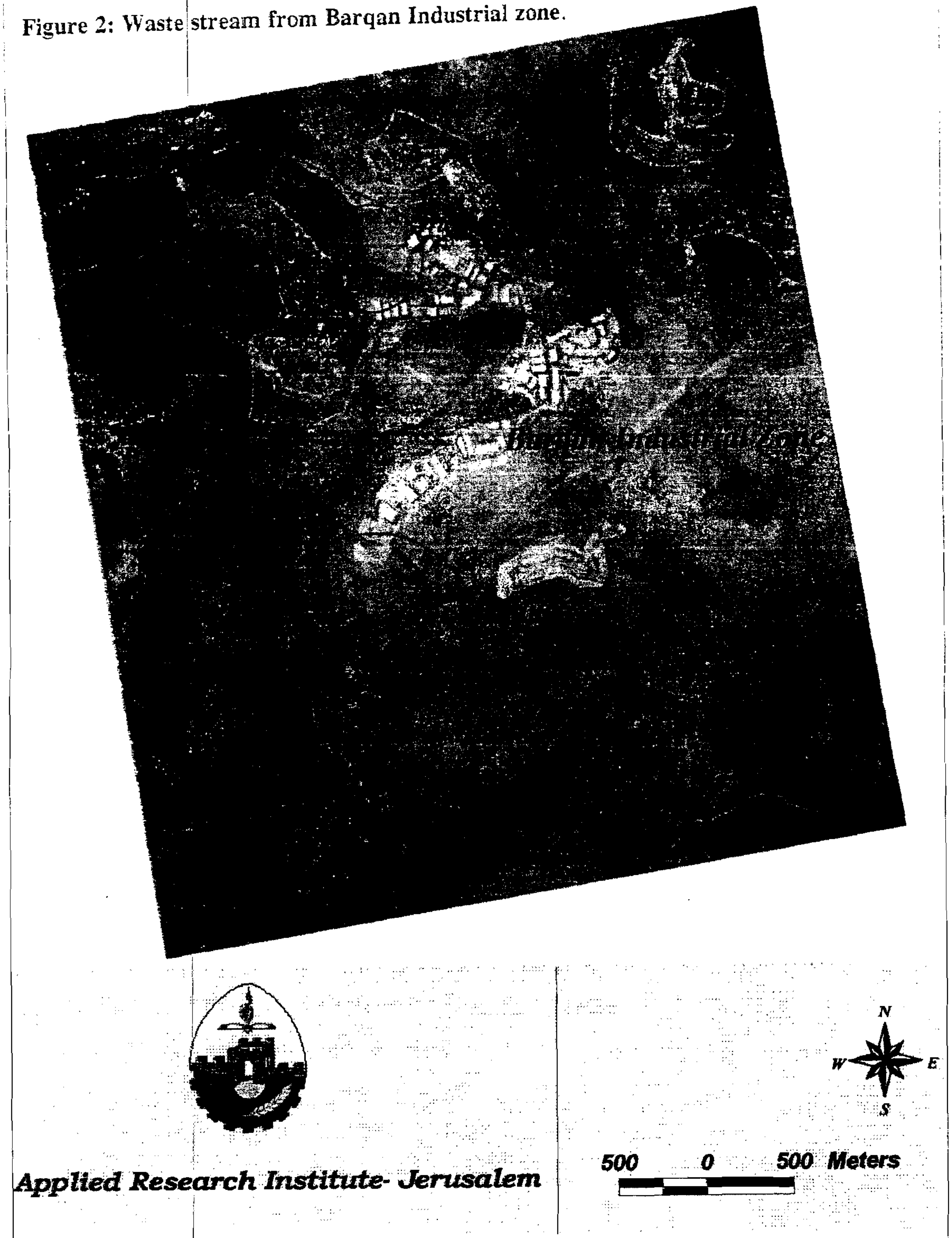
The wastewater is collected in three storage tanks. These tanks are in ill-repair, overloaded, and full of mud. Therefore, the industrial wastewater is flowing untreated into the nearby wadi. **Figure 2** is an aerial photo taken in May 1995. The figure clearly shows two wastewater streams generated from the Barqan industrial zone. The first is flowing to Wadi Rabah, damaging the agricultural lands of the nearby villages, the other is flowing towards Wadi Qana. The wastewater continues to flow as shown by the Landsat Satellite Image taken for the same area in 1996.

The wastes from the industries in the Barqan industrial zone have their dangerous effects on the land and people. In addition to the damage it causes to agricultural land, it may pollute the groundwater with heavy metals. As stated in al-Quds, hundreds of cows and sheep are drinking from the wastewater stream flowing from the Barqan industrial zone and eating the polluted plants there. It is estimated that the number of sheep and cows that drink from this polluted stream is about 500. These animals provide dairy products to Nablus and Salfeet.

Israeli Quarries

Although stones are a very important natural resource to the Palestinian economy, quarries have detrimental effects on the landscape and the environment. Quarrying causes serious changes to the topographic structure of the land. It also emits solid particulate matter which is generally referred to as dust. Particulate or dust reduces visibility by scattering and absorbing sunlight. Also, particulate can damage crops if wind direction is toward agricultural lands. These small particles are inhaled by human beings, causing health problems to the respiratory system.

Figure 2: Waste stream from Barqan Industrial zone.



Israel is continually using the West Bank quarry stones to meet its building needs. Moreover, the Israeli authority continues to confiscate Palestinian land to establish Israeli quarries in the West Bank. The Israelis have confiscated an area of at least 18,700 dunums in the West Bank to construct seven quarries, all in different locations. Three of these are under construction. The largest quarry is Wadi al-Teen Quarry in the Tulkarem district, occupying an area of 9,685 dunums of land.
In the Ramallah district, an Israeli quarry is located near Kafr Malik village, occupying approximately 2,523 dunums. Israel plans to construct another quarry in the Ramallah district on land belonging to Rantis and Shuqba.

Three more areas have been confiscated in the Hebron district for quarries. The first area is between Dura and al-Thahiriya, from which 1,744 dunums were confiscated. The second has an area of approximately 2,677 dunums which were confiscated from Tarqumiya, Dura, and Khirbet Jamroura villages. The third quarry is located on 2,077 dunums of land, belonging to Surif village. Another quarry is located on land which belongs to Majdal Bani Fadel village in the Nablus district (al-Nahar, 1994). **Figure 3** shows the location of the Israeli quarries in the West Bank.

Wadi al-Teen Quarry

Wadi al-Teen is a large valley located 5 kilometers southeast of Tulkarem city and 4.5 kilometers to the east of the Green Line. A rocky surface and sharp slopes characterize the valley, with various locations planted with orchard and olive trees. Wadi al-Teen represents an important natural grazing area, supporting many livestock farmers in neighboring Palestinian villages. It also serves as the main catchment area for runoff rainwater. The size of Wadi al-Teen catchment area is estimated at 80 km2 and collects a minimum of 18 million cubic meters of water per year, a major source of water for agricultural production in the area.

The quarry plan includes the confiscation of 968.5 hectares of land belonging to the five Palestinian villages of Shufah, Saffarin, Kur, Kafr Sur, and al-Ras. The Israeli authorities gave permits to 5 private Israeli companies to construct quarries in this area in order to move the quarries from inside

Israel to areas in the West Bank. **Figure 4** shows the location of Wadi al-Teen Quarry.

The quarry in Wadi al-Teen will undoubtedly bring environmental degradation by threatening the biodiversity and wildlife in the area, closing off major natural grazing and agricultural areas, and depriving Palestinian farmers of runoff water used for irrigation. Furthermore, the plan will adversely affect the living environment in neighboring Palestinian villages due to dust and other types of air pollution quarries produce.

Conclusion and Recommendations

The Israeli authority is polluting the West Bank environment through the large number of Israeli industries located in the West Bank. The Israeli Law for the Protection of the Environment is not applied in the Israeli industrial zones of the West Bank. The generated wastewater from most of the industries discussed in this paper are not treated and wastewater with its contaminants of heavy metals flows into Palestinian open fields. Moreover, generated solid waste is dumped without treatment onto Palestinian land. As the West Bank area is located over the recharge area of an aquifer, these practices will undoubtedly pollute groundwater in the West Bank. Strict measures have to be followed in the disposal of liquid and solid waste in order to ensure the protection of groundwater.

The confiscation policy has to be stopped and the existing Israeli industries and quarries have to be moved to areas inside Israel. Environmental awareness programs on the effect of hazardous materials on water and on health have to be initiated. Also, Palestinian scientists and officials have to inform international environmental, health, and human rights organizations about the effects of the Israeli industries on the Palestinian environment and health.

Figure 3. Location of the Existing and Planned Jewish Quarries in the West Bank.

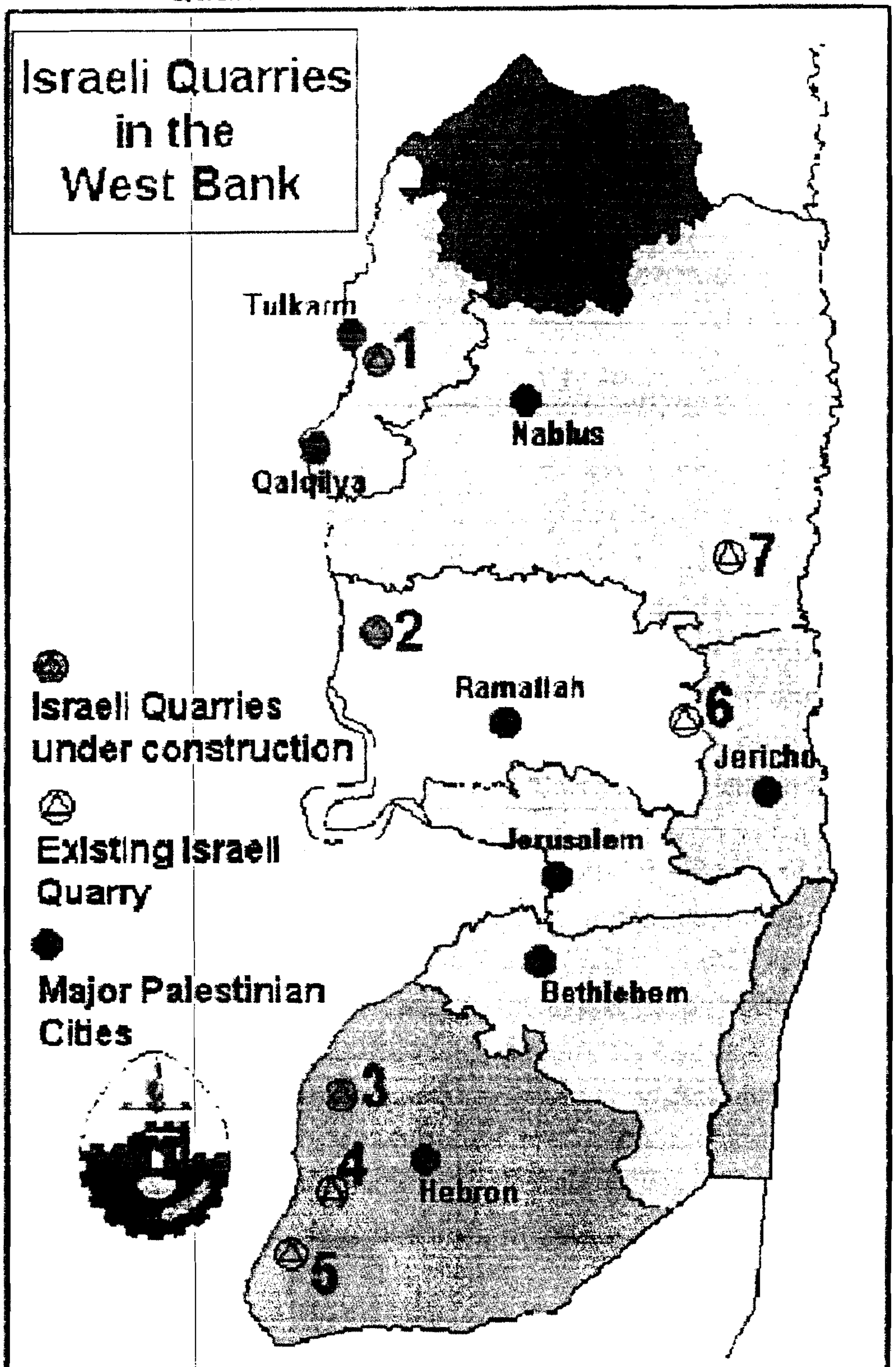
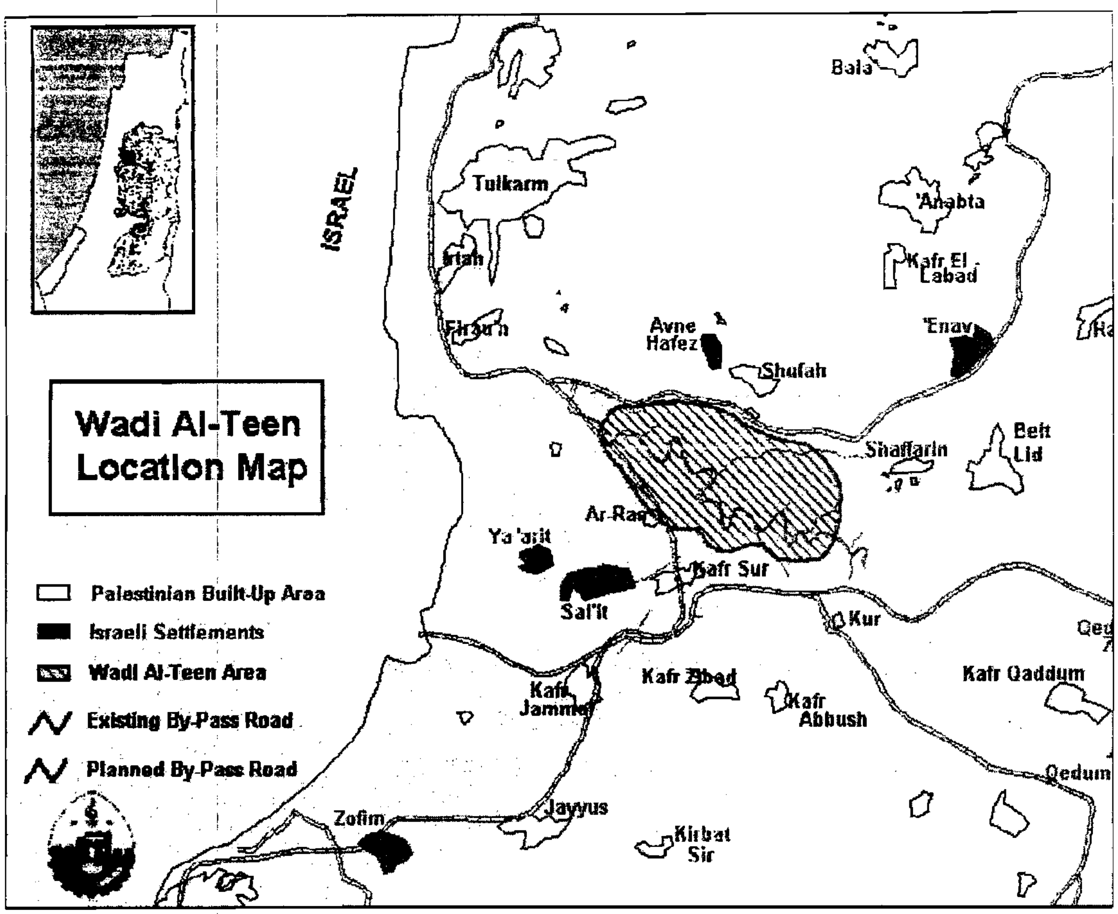


Figure 4


Wadi Al-Teen
Location Map
Palestinian Built-Up Area
Israeli Settlements
Wadi Al-Teen Area
Existing By-Pass Road
Planned By-Pass Road
ISRAEL
Tulkarm
Bala
'Anabta
Kafr El Labad
'Enav
Avne Hafez
Shufah
Shaffarin
Beit Lid
Ar-Ras
Ya'arit
Kafr Sur
Sal'it
Kur
Kafr Qaddum
Kafr Zibad
Kafr Abbush
Kafr Jammal
Qedum
Zofim
Jayyus
Kirbat Sir

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Pollution Prevention Technology

Pollution Prevention and Waste Minimization Audit: Case Study of the Electrochemical Plating and Galvanization Company Ramallah and al-Bireh District

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Abstract

This report presents the results of an environmental audit conducted at the Electrochemical Plating-Galvanization Company during a six week period from November 1 to December 15, 1997. The report provides general information about the firm, its present production activities, water supply and uses, and the current wastewater and sludge-handling practices. The characteristics of the wastewater streams are also elaborated upon, with an assessment of the environmental compliance based on the Jordanian standards and regulations. An evaluation of pollution prevention and waste minimization opportunities is delineated, along with a detailed description of how chemical wastes harm environmental, animal, and human health.

Introduction

The city of Ramallah is located 17 km north of Jerusalem and 54 km south of Nablus in the central region of the West Bank. The area within the municipal boundaries of Ramallah is 17,000 dunums, 3,800 of which are allocated to residential or industrial areas.

Although industries are beginning to appear with more frequency throughout the villages and semi-urban areas of the District of Ramallah and al-Bireh, the majority of industries lie within the cities of Ramallah and al-Bireh proper. There are two industrial areas in the Ramallah District, although not all industries and workshops are limited to the industrial zones. One industrial zone is located to the south of the city of Ramallah and the other

(Note: Evaluation, compliance, and recommendations are based upon Jordanian standards due to the nonexistence of Palestinian regulations at the time of the writing of this paper.

to the northeast of al-Bireh. Together, the two industrial areas cover approximately 134 hectares (ARIJ, 1996).

As the Oslo Accords progress, extensive industrial development is expected in Palestine, including the continued development of industries emitting harmful wastes. This expansion of industries will require a number of changes on the part of industries and municipalities in order to deal with hazardous industrial emissions.

In conjunction with changes occurring in Palestine, we are seeing a worldwide increase in the amount of hazardous wastes adversely affecting human health and the environment. However, many countries do not have the expertise to manage matters of hazardous wastes. Governmental bodies appear to lack information about the types and quantities of the pollution released by local industries, and what risk these emissions pose to people and the environment. Yet, the world is slowly realizing that minimization and treatment programs headed by governments are needed to fill this informational void in order to identify wastes and their potential effects. An environmental audit is one way of assessing basic information on a specific company or workshop within an industry, providing the vital missing information on types and quantities of pollution, and offering important solutions.

At the time of this environmental audit on an electroplating firm, no industry previously had its wastewater characterized in the District of Ramallah and al-Bireh. Therefore, hard data were not available on either wastewater quantity or quality of this firm or any other (PRIDE, 1994). This general lack of monitoring and evaluation is due to the skeletal infrastructure within the country: lack of knowledgeable staff, lack of equipment to conduct evaluations, and the inability to enforce regulations, if they were in existence.

The aim of this environmental audit is to change industrial processes primarily through setting targets for reducing the amount of hazardous waste produced per unit of manufactured goods, as well as promoting cleaner production methods. This environmental audit of an existing electroplating industry is an example of how reduction of hazardous waste is needed in light of the detrimental effects to plant and animal life.

Industrial Pollution Prevention Technologies

Industrial pollution prevention technologies require the completion of five steps. Here, they are generalized as:

1. improving plant operations,
2. implementing in-process recycling,
3. introducing process modification,
4. substituting materials and products, and
5. separating materials.

Manufacturers implement a variety of improved management or "housekeeping" procedures to achieve pollution reduction. To achieve improved plant operation, often the following techniques are used:

- conducting environmental audits,
- establishing regular preventive maintenance,
- specifying proper material handling procedures,
- implementing employee training, and
- recording and reporting data.

To minimize the generation of pollution, the best solution is to identify and correct problems associated with plant operation. Although environmental concerns may not be incentive enough for most industries to reduce the emission of pollution, reduction in operating costs often serve as the impetus to improve plant operations. Through enhanced plant operations, production costs and disposal costs can be cut simultaneously.

The Environmental Audit

An environmental audit (EA) is a basic in-plant management tool consisting of a systematic, documented, periodic, and objective evaluation of how well facility environmental management systems and equipment are performing. The concept came into being during the early 1970's under different names such as environmental reviews, surveys, assessments, and quality controls (Barthel, 1997).

The aim of an EA is to facilitate effective control of environmental practices, enabling the company to assess compliance with company policies including meeting regulatory requirements. The EA is also an extremely useful tool in diagnosing how a facility can reduce or eliminate hazardous and non-hazardous waste. Audits enable manufacturers to inventory and trace input chemicals and to identify how much waste is generated through specific processes. Consequently, they can effectively target the areas where waste can be reduced and formulate additional strategies to achieve reductions (Barthel, 1997). The practice of EA also critically examines the operations on-site and, if necessary, identifies areas for improvement to assist the management to meet requirements. In turn, the audit not only minimizes potential negative impacts of the company on the environment, but also maximizes the positive impact of an environmentally sound system on the company's other activities.

Incentives to perform EAs

The incentives for conducting EAs are many. Auditing systems can help management:

- Determine and document compliance status.
- Improve overall environmental performance at the operation facilities.
- Increase the overall level of environmental awareness.
- Improve the environmental risk management system.
- Develop a basis for optimizing environmental resources.
- Project positive concern about environmental effects and commitment, and take steps necessary to correct identified problems.
- Avoid substantial tort liability arising from personal injury, property damage, or "toxic tort" claims.
- Avoid surprise, disruption, and unplanned costs of sudden enforcement actions.
- Develop better relations with governmental agencies through the presence of a program designed to find and correct problems before they become dangerous.
- Build closer links with community and government. This not only minimizes the chance for environmental conflict, such as enforced shutdowns and product bans, but also helps better the image of the company and industry, particularly in terms of the positive role and the contribution they provide.

- Realize savings through process changes which reduce the amount of raw materials needed.
- Create less pollution to be criminally liable under the current environmental laws and regulations (Shen, 1995).

The Electrochemical Plating-Galvanization Company Plant Profile

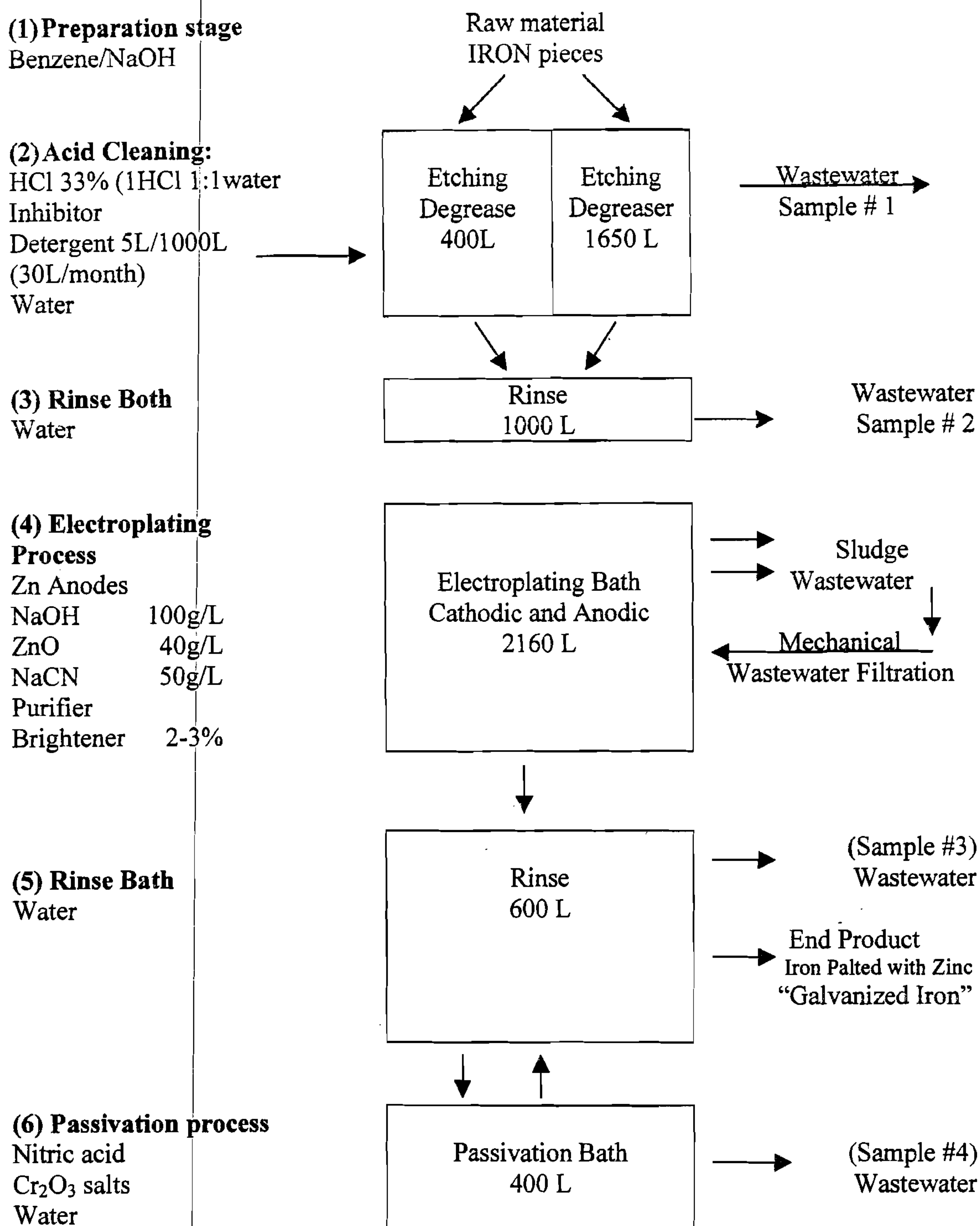
The Electrochemical Plating-Galvanization Company was established in 1987 and is located in the al-Bireh industrial area, just north of the city of al-Bireh. Cast and forged iron materials are received by the firm to be galvanized and electroplated. Once galvanized with iron and zinc the end-products are sold in Palestine and Israel for use in the making of window frames and doors. The production capacity of the firm is 6000m2 per year.

The company operates eight to ten hours a day, six days a week, and employs four workers. The firm has an area of 150m2, which is occupied mostly by its buildings **(Figure 1)**. Water, supplied by the Jerusalem Water Undertaking, is consumed at a rate of 2m3 per day for all uses. Wastewater is collected in a septic tank and disposed of by trucks to unidentified locations.

The electroplating process

One zinc electroplating line exists at the plant. A flow diagram **(Figure 2)** gives a visual representation of the material inputs and waste streams. The electroplating process follows the process below:

1. Cast and forged iron pieces are cleaned with Benzene or NaOH, on occasion. A soak for one to two hours follows using hydrochloric acid, a detergent, and an inhibitor. The pieces are then transferred to the rinsing water bath **(Figure 3)**.
2. After cleaning, the parts are introduced into a galvanization bath where the electroplating process takes place. The bath contains Zn, NaOH, ZnO, NaCN, purifier and brightening solutions **(Figure 4)**.
3. Next, the parts are rinsed in a water bath and then treated in another bath containing a mild acidic solution of HNO3 plus salts (Cr2O3) as a



Wastewater from all stages collects into septic tank
Wastewater Sample #5 taken from septic tank

Figure 2. Flow diagram of the electroplating line

passivation process (**Figure 5**).

4. Finally, the parts are transferred back to the water rinse bath and are left to dry at room temperature. Once dry, the electroplated parts are ready for sale.

Wastewater

Characteristics

Most of the industrial wastewater discharged from the electroplating plant originates from the acid and rinse baths. Acid and rinsing water are replaced after the efficiency of the solution decreases. Note, no precise criteria is followed to decide on when replacing the rinsing water baths is necessary.

The pH of the rinse water has never been checked since the firm's establishment. Chemical analyses are not performed to determine the type and concentration of contaminants in the baths, yet both tests are required to evaluate the suitability of solutions for rinsing.

Table 1

Requirements for the discharge of industrial effluents into the sanitary sewer system or disposal to wadis and rivers

Parameter	Unit	Sanitary Sewer System	Disposal to Wadis & Rivers[1]
Temp	°C	65	-
PH	SU	5.5-9.5	6.5-9.0
DO	mg/l	-	1[2]
Color	Unit	-	15
BOD_5	mg/l	800	50[3]
COD	mg/l	2100	150[3]
TDS	mg/l	-	3000[4]
TSS	mg/l	1100	50
Ca	mg/l	-	-
F	mg/l	-	1.5
Cl	mg/l	-	500
HCO_3	mg/l	-	-
NO_3	mg/l	-	12[5]
SO_4	mg/l	-	500
NH_4	mg/l	-	-
NH_3	mg/l	-	5
Na	mg/l	-	-
Mg	mg/l	-	-
PO_4	mg/l	-	15 PO_4-P
P	mg/l	50	-
FOG	mg/l	50	5
ABS	mg/l	26	25 MBAS
Phenol	mg/l	10	0.002
T-Cr[1]	mg/l	5.0	0.1
Cu[1]	mg/l	4.5	2.0
Zn[1]	mg/l	15	15
Sn	mg/l	10	0.1
Be	mg/l	5	-
Ni[1]	mg/l	4	0.2
Cd[1]	mg/l	1	0.01
As	mg/l	5	0.05
Ba	mg/l	10	-
Pb[1]	mg/l	0.6	0.1
Se	mg/l	-	0.02
Mn	mg/l	10	0.2
Ag[1]	mg/l	1	-
Al	mg/l	-	5
B	mg/l	5	1
Hg[1]	mg/l	0.5	0.001
Fe	mg/l	50	1
S as (H_2S)	mg/l	10	
Chlorinated Solvents	mg/l	0	-
Fecal Coliforms	MPN/100ml	-	1000[6]

Notes: 1-Jordanian Standards no. 202/1991 and no. 18/1988. 2-Minimum value. 3-Monthly. 4-TDS allowable limit is subject to the TDS concentration in the water supply and the affected water basin. 5-Nitrate concentrations allowed are determined by its concentrations in the affected water basin. 6-Geometric mean.

Sampling and analysis

Before the wastewater was disposed of into the wastewater streams, samples were collected on November 18, 1997 from the following five locations to determine the wastewater characteristics. Results are displayed in Table 2.

Table 2

Characteristics of wastewater generated from electro-plating stages

Analysis Parameter	Unit	Stage 2	Stage 3	Stage 5	Stage 6	Stage 7
pH	SU	-0.63[1]	1.7	12.0	1.6	2.2
BOD_5	mgO^2/l	N.A.[2]	N.A.	11.2±1.0	N.A.	N.A.
COD	mgO^2/l	14.263	789	2007	4898	514
TSS	mg/l	1763.3	23.3	510.0	173	2235
P	mg/l	<0.25	<0.25	-	0.0	2.0
Cu	mg/l	42.8	2.5	5.0	2.6	1.0
Zn	mg/l	251.0	38.0	970.0	1010	740
Ni	mg/l	34.4	-	0.2	15	♦
Cd	mg/l	-	0.2	-	0.09	1.0
Pb	mg/l	-	3.4	0.8	0.016	N.A.
Mn	mg/l	487.0	4.0	-	0.82	45
Fe	mg/l	72.0g/l[4]	540.0	22.0	32	6720
Cr	mg/l	37.0	-	-	0.42	N.A.
CN	mg/l	0.04	0.05	0.0	♦	0.4
Phenol	µg/l	110	0.0	22	N.A	N.A.
Sulfide S-2		32	0.6	0.0	♦	9.0
FOG		379	482	0.0	279	236
Ba	mg/l	-	-	0.2	N.A.	N.A.

Notes: Stage 2: Acid etching bath; Stage 3: Water rinse bath (after acid etching bath); Stage 5: Water rinse bath (after electroplating process); Stage 6: Passivation stage; Stage 7: Septic tanks. 1-Negative pH value is due to high molar concentration content. 2-N.A: not available. Unable to determine BOD5 because of very low pH values. 3-(-) Zero concentration.4-(() Below detectable limit. 5-Fe for stage 2 is in g/l.

1. **Acid etching.** As cyanide (CN) concentrations are found at very high levels in the acid etching bath sample, 0.04 mg/l, the production of

hydrogen cyanide (HCN) gas is inevitable. Even at very low concentrations HCN gas is very toxic.

2. **Rinse bath.** The first rinse bath follows the acid etching stage, therefore concentrations of CN are present. Cyanide concentrations are also found at high levels, 0.05 mg/l, in the rinse bath sample. Again, the production of HCN gas is inevitable.

3. **Rinse bath.** The second rinse bath follows galvanization. **Table 2** shows that CN was not present in this rinse bath sample due to its transference into HCN gasses when combined with mild nitric acid of the passivation process. High concentrations of heavy metals were found in all samples including Zn plating. The elevated concentrations indicate that the high rate of drag-out takes place and that rinsing is not sufficient.

4. **Passivation bath.** Results show the major pollutants in the acidic discharge point were heavy metals (Cd, T-Cr, Cu, Fe, FOG, Mn, Ni, Pb, Zn), low pH, COD, TSS, and CN. The pollutants in the alkaline discharge point included high pH, COD, TSS, Cu, Fe, FOG, Pb, and Zn.

5. **Wastewater septic tank or discharge point.** Samples drawn from the acidic and alkaline discharge points were analyzed to determine the level of major pollutants discharged into the environment after storage in the septic tanks. The mixing of the acid and alkaline streams takes place after the discharge process in a septic tank. Such practices are extremely dangerous and result in unnecessary HCN emissions.

Wastewater handling practices

There is no wastewater treatment unit at the firm; this is not uncommon here in Palestine. Wastewater from the rinse baths creates one discharge stream depositing into the septic tank. As stated before, no separation between acidic and alkaline streams is made, resulting in the mixing of the two together in the septic tank **(Figure 6)**.

Environmental compliance

The present quality of the wastewater of this industrial enterprise prevents the plant from discharging effluents into the sewer network or directly into the environment. Levels of several pollutants exceed the prescribed limits according to Jordanian regulations and standards (no. 18/1988 and 202/1991). Major violations are currently occurring based on levels of a variety of pollutants: pH, TSS, COD, Cr, Cu, Fe, FOG, Ni, Cd, Pb, Mn, Zn and CN. Yet, as no environmental or industrial monitoring and enforcement system exists, and the Palestinian Authority does not have the ability to legally enforce regulations, reducing illegal emissions is difficult. Despite this vacuum, it is of the utmost importance to develop appropriate low-cost treatment methods on-site.

Pollution Prevention and Waste Minimization Opportunities

Opportunities lie in several areas of the electroplating process and with employees to reduce pollution.

Processing

Although the rinse baths were intended to wash the dragged-out solutions, it was apparent that the rinsing process was inefficient. Modification of the rinsing process to minimize drag-out is needed.

Introducing one or more additional rinse baths would help reduce the amount of contamination due to drag-out. Efficient rinsing can be achieved by using two consecutive rinse baths operating on a counter-current basis, particularly when spray nozzles or air agitation is used in rinsing. By using two consecutive rinse baths after the electroplating process, the plating bath can eventually be supplemented with the solution of the first rinse bath, the most concentrated with chemicals. Additionally, drag-out minimization and efficient rinsing will prevent the contamination of succeeding baths. Drag-out minimization and efficient rinsing reduces water consumption and rinse water treatment costs, as well as saves the costs incurred in replacing baths.

Drag-out can also be reduced by changing solution processes to alter the viscosity of solutions, raise the temperature, or reduce surface tension.

Another potential solution is by controlling the withdrawal time of work pieces, thus allowing sufficient drainage time. UNEP/IEO (1992) estimates that draining work pieces carefully can eliminate about 70% of drag-out problems.

Chemicals

Cyanide-containing compounds should be replaced by more environment-friendly compounds with minimal toxicity to humans. There are commercially available alkaline, non-cyanide, zinc plating solutions such as pyrophosphate-based solutions for coating several materials including iron.

Handling of materials

It was noticed during the field survey that alkaline rinse bath solutions were being disposed of together with the acidic rinse without the necessary separation. This practice is highly dangerous as it can lead to significant health hazards due to the evolution of HCN gas when CN mixes with acidic solutions. This practice should cease immediately and complete segregation between the two lines must be introduced.

Several reckless habits were noted during the audit. Spillage during the drainage of baths was common and needs to be eliminated. Immersed hoses are used to drain the baths, an impractical approach to drainage, causing much of the unnecessary spillage. Drainage holes in rinse baths would prevent these mishaps and ease the process. Improving handling procedures of chemicals used in the electroplating process is also needed in the firm. Some of the reckless procedures included the collection of residual chemicals in bags left out in the open **(Figure 7).**

Air emissions

It is expected, although it was not measured during the audit, that HCN gas is emitted during any mixing between cyanide-containing solutions and nitric acid. Exhaust hoods in the electroplating workshop would reduce the chances of these deadly gases being released into the environment.

Pretreatment of wastewater and sludge handling

As mentioned before, there is no pretreatment of wastewater before it goes for holding in the septic tank, nor before its final disposal. The wastewater streams containing hazardous substances should be properly treated before arriving to septic tank and/or disposal, regardless of where the wastewater is finally expelled.

Plating solutions are filtered regularly to remove the accumulated sludge in the bath. Presently, however, the plant does not utilize a proper drying basin as a final disposal stage for the wastewater sludge. Rather the sludge is filtered from the bath and openly disposed of (**Figure 8**). Ideally, the drying basins should be made of concrete and adequately lined to prevent seepage. The dried sludge should then be disposed of to a proper hazardous waste dumping site.

Recommendations and Limitations

Recommendations

Below is a detailed description of suggested measures to improve conditions in the plant. These are also summarized in **Table 3:**

Table 3

Summary of electroplating firm and conclusions

Water uses	Major pollutants in wastewater*	Source of pollution	General mitigation measures
Production	TSS, COD,	-spills and leaks	-provide proper training to operators
Rinse and plating baths	Zn, Cr, Cu, Fe, FOG	-poor material handling techniques	-avoid spills -wastewater segregation and individual treatment -substituting less hazardous materials
Cleaning equipment and floors	Ni, Cd, Pb, Mn, and CN	-insufficient treatment -lack of know-	-improve material handling procedures -implement methods
		how in operating baths & regeneration techniques.	that prolong the plating and rinsing baths life (by minimizing drag-out) -sludge disposal to a safe controlled site

* Exceeding Jordanian Standards No. 18/1988 & 202/1991. *Name:* Electrochemical Plating Galvanization Company *Production:* Galvanized Iron. Quantity: 6000 m^2/year. *Average water consumption:* = (40 m^3/month. Source: Jerusalem Water Undertaking. *Wastewater generation:* = (40 m^3/month. *Method of disposal:* Tankers to unidentified locations

- Segregate waste, both solid and wastewater.
- Use suitable coagulants to enhance separation.
- Train the operators to run the treatment processes according to standards and upgrade their environmental awareness in hopes of practicing cleaner production.
- A regular maintenance program needs to be introduced and implemented at the plant. Training of operators is urgently needed to ensure proper pretreatment with special attention given to the optimization of operational conditions.
- The firm needs to use wastewater treatment facilities for the neutralization and precipitation of heavy metals, in addition to the oxidation of cyanide.
- Give full attention to operational parameters, such as pH levels, and to material handling of equipment.
- Perform internal environmental audits. Such procedures can greatly influence the compliance with legislative requirements, and at the same time reclaim the deficiencies in the production processes.
- Carry out a future study to examine the efficiency of on-site, low-cost treatment with local standards and regulations.
- Give utmost attention to water conservation as water was used in a variety of areas in the plant. Manage washing and cleaning so minimal amounts of water are used. One way this can be done is by implementing water recycling techniques.

Limitations

In principle, it is possible to carry out the recommendations noted above. Yet, there are recognized constraints to these pollution prevention recommendations:

- **Tenure and space.** The space the firm occupies is rented and it is not clear if the owner of the property would allow construction changes. The interior space does not appear to accommodate the needed space for additional rinsing baths.
- **Policy and infrastructure.** As of the undertaking of this environmental audit, there was no existing wastewater treatment plant in the city of al-

Bireh. This allows for the uncontrolled discharge of industrial waste to the wadis. This problem is made more acute with no presence of dumping sites for hazardous waste.

The largest obstacle to meeting the recommendations is the fact no national guidelines and standards exist dealing with industrial wastewater and sludge discharge to the environment or to the sewer system. With no information and communication procedures regarding pollution prevention and waste minimization, company managers and employees have no information or incentive to minimize harmful wastes.

Suggestions to overcome limitations

- Improve managerial skills of the personnel, placing special emphasis on the introduction of environmentally sound management policies.
- Develop and enforce industrial wastewater discharge regulations and standards, establishing a strict monitoring program for potentially dangerous facilities. These would include site visits, inspections, and linking licensing to wastewater discharges.
- Local industries should be committed to treating their liquid discharges before disposal into the sewer network or to the environment. Pretreatment will avoid interference with the operation of domestic treatment plants and prevent polluting surface and groundwater bodies.
- Perform internal environmental audits for local industries in the West Bank and Gaza Strip. Such a procedure can greatly influence the compliance with legislative requirements and at the same time reclaim the deficiencies in the production processes.
- Proper operation of the wastewater treatment plants will require that the municipalities of Ramallah and al-Bireh monitor and control industrial wastewater discharge into the sewer network, including a selective wastewater sampling and analysis program.
- Conduct campaigns to raise the level of awareness among Ramallah residents (especially housewives) about environmentally sound wastewater disposal practices.

- Train select industries in safe and environmentally sound wastewater disposal practices. The municipality, through economic incentives and positive publicity, should encourage industries to recycle wastewater and pretreat wastewater on site.
- Study the feasibility of a separate centralized treatment of industrial wastewater.
- Create a mechanism for implementation of improvements in light of the encroachment of residential areas into the industrial zones. Industrial wastewater will be a disaster unless the municipality sets and enforces rules and standards **(Figure 9)**.

Health and Environmental Hazards from Discharging Industrial Wastewater

In comparing percentages of fresh water consumption (agricultural industry, domestic sector, industrial sector, etc.), the industrial sector is the lowest consumer in the West Bank. However, the disposal of untreated industrial wastewater has one of the greatest potentials to negatively impact the environment. Wastewater containing hazardous chemicals and solids threatens plant and animal life, as well as the quality of the limited water resources.

Industrial wastewater contains both organic and inorganic waste. The organic waste is equal in its pollution potential to the untreated domestic wastewater, while inorganic industrial waste containing heavy metals and hazardous materials is potentially more hazardous and much more difficult to control (UNEP/IEO, 1991). As there are no regulations to control industrial effluents in the West Bank, most of the industrial waste is currently discharged into cesspools, wadis, or sewage collection networks without any consideration for the potential to pollute **(Table 4)**. In 1993, industrial wastewater represented approximately 10% of the total wastewater generated in Ramallah, with very few industries having on-site wastewater pretreatment or recycling procedures (PRIDE, 1994).

Table 4
Estimated percentage of the various industrial wastewater disposal methods in the West Bank

Method of disposal	Percentage
Cess pit	46.0
Sewage collection network	37.0
Reuse	12.3
Unofficial	4.7
Total	100.0

Note: ARIJ, 1996

Metals and the environment

Of the 108 elements, eighty are metals; fifty of these eighty elements have economic and industrial significance. Though often referred to as a homogeneous group, metals have different physical, chemical, biological, and toxicological properties (Williams and Burson, 1985). The classification of metals into heavy,
trace, essential, non-essential, or toxic does not reflect their environmental impact. For example, some of the essential metals such as iron, copper, and cobalt are quite toxic (Williams and Burson, 1985).
Metals identified as potentially harmful to plant growth, or as elements whose concentration in crops may reach to levels considered hazardous to humans and animals, include: Al, As, B, Cd, Cu, Fe, Pb, Hg, Mn, Ni, Se, Sb, and Zn. In general only Cd, Cu, Mo, Ni, and Zn are considered to pose a potentially serious hazard to either crops or the food chain (Banjerjee and Bishayee, 1997).

The phytotoxic tolerance of plant species to metal concentrations added to the soil and the amounts of metal concentrations accumulated by various plant species are highly variable. Tolerance is also affected by external conditions such as soil composition, pH, humidity, and the variety of soil microorganisms. For example, the acidity of the soil has proven to liberate the bound pool of metals, which may lead to increased availability and uptake of metal ions in plants. When soil becomes acidic, Cd, Zn, and Ni from contaminated wastewater can seriously reduce crop yields (Hindiyeh, 1995).
Metals do not exhibit identical patterns of mobility within plants. For example, As, Cr, Pb, and Hg may accumulate in the roots of plants but are

not translocated to the aboveground tissues. Copper exhibits limited translocation, whereas Cd, Zn, and Ni have been found to be taken up to an appreciable extent by plants, generally increasing with the increasing amounts of metal applied to soil. However, large differences in the concentrations of these metals may also be related to different plant species, different plant parts, and year to year variation. Soil pH is the most important factor affecting plant uptake of Cd, Zn, and Ni. Soil texture, caution exchange capacity, and organic matter content may also affect the uptake of these metals (Hindiyeh, 1995). Free moving in the environment, Ni induces growth retardation if accumulated in plants. It also has high mobility in certain types of soil, thus leading to a potential risk in groundwater contamination (WHO, 1988).

In general, animals have high tolerances to Cu, Zn, and Ni. Notable exceptions are Cu toxicity to sheep and possibly cattle, often occurring when there is very low Mo intake.

Metal leachate reaching the ground water aquifers may contribute to water contamination, in turn damaging plant and animal life operations (Viessman and Hammar, 1985). In addition, metals have the ability to impact domestic wastewater treatment plants (Conway and Ross, 1980).

A variety of factors influence the metal composition of industrial wastewater discharge, the most important being the proportion and combination of metals, metals interactions, and the treatment processes. Concentrations of metals in wastewater are primarily a function of the type and amount of industrial waste that is discharged into the municipal wastewater treatment system. Contaminated industrial wastewater with heavy metals may potentially cause problems of three types:

1. Interference in the operation of the domestic wastewater treatment plant, disrupting its efficiency, especially when biological treatment is being used.
2. Excessive concentrations of heavy metals in the final effluents.
3. Precipitation in the sludge, thus limiting the possible end use of the sludge (as a soil conditioner, for example).

Metals of concern with relation to electroplating

Metals of clinical concern related to the electroplating factory in the al-Bireh industrial zone include: lead, nickel, chromium, zinc, copper, iron, and cyanide. Metal toxicity is classified into acute and chronic. Acute toxicity, "is caused by a relatively large dose of metal over a short period of time" (Williams and Burson, 1985). The onset of signs and symptoms follows exposure and are often intense. Chronic toxicity, "is caused by long or repeated exposure to relatively small doses of metals" (Williams and Burson, 1985). The duration between initial exposure and onset of signs and symptoms may be months or even years and is often characterized by a gradual development (Williams and Burson, 1985).

Tables 5 and 6 show the non-radioactive metals causing tumors in man or experimental animal, and the target organ toxicity of selected metals and metalloids (Williams and Burson, 1985).

Table 5

Non-radioactive metals causing tumors in man or experimental animals

Metal	Route of exposure or administration	Type of Tumor
Beryllium	inhalation	Pulmonary carcinoma
Cadmium	sc, im, intratesticular	Sarcoma, Leydigioma, Teratoma
Chromium	sc, im, ip, intraosseous, intrapleural, intrabronchial	Sarcome, Squamous cell carcinoma Adenocarcinoma
Cobalt	sc, im, intraosseous	Sarcoma
Copper	intratesticular	Teratoma
Iron	sc, im	Sarcoma
Lead	sc, dietary	Renal cell carcinoma, Renal adenoma, Lymphoma
Nickel	sc, im, inhalation	Anaplastic carcinoma, Adenocarcinoma, Squamous cell carcinoma, Sarcoma
Selenium	dietary	Hepatoma, Sarcoma, Thyroid adenoma
Titanium	im	Fibrosarcoma, Hepatoma, Lymphoma
Zinc	intratesticular	Leydigioma, Seminoma, Chorionepithelioma, Teratoma

Notes: Williams and Burson, 1985. sc = subcotaneous, im = intramuscular, ip intraperitaneal.

Cyanide

A highly toxic and poisonous material with direct and immediate health effects, it is quickly absorbed through the skin often leading to cases of contact dermatitis. Thus, proper hygienic conditions in the workplace are a must. Signs and symptoms related to cyanide poisoning are: increased percentages of hemoglobin and lymphocyte count, punctuate basophilia, and thyroid enlargement, impairing its function (El-Ghawabi and Gaafar, 1975; Banerjee and Bishayee, 1977).

Iron

Iron is a heavy metal that takes part in disease pathogenesis through free radical formation (Montgomery, 1995). Iron toxicity involves a diversity of health disorders. In the liver, iron overload induces hepatic injury which usually progresses into liver fibrosis or cirrhosis (Zhao, 1995). In general, iron poisoning, defined as more than 15000 (g/dl, is a major cause of overdose mortality among children less than six years (Cheney and Gumbiner, 1995). Target organs involve: the nervous system, liver, gastrointestinal tract, respiratory system, hematopoietic system, and the endocrine system (Williams and Burson, 1985).

Zinc

Zinc is introduced to humans mainly through ingestion. High intake of zinc interferes with the metabolism of other trace elements such as copper utilization. Signs and symptoms related to zinc toxicity include low plasma copper and plasma caeruloplasmin levels, anemia, changes in serum lipid levels, and impaired immune response (WHO, 1996). Target organs include the gastrointestinal tract, the hematopoietic system, and skeletal system (Williams and Burson, 1985).

Chromium

Chromium is found in two forms, trivalent and hexavalent. The latter is an inorganic carcinogen associated with the various health risks related to the exposure to chromium. Chromium toxicity results mainly from inhalation or frequent skin contact; ingestion is of little threat to human health. Signs and symptoms related to chronic exposure to chromium include changes in the skin and mucus membranes, and allergic dermal and broncho-pulmonary effects. Target organs involve: the kidneys, liver, gastrointestinal tract, skin, and the nervous and respiratory systems. Chromium also acts by altering the fidelity of DNA replicate (Williams and Burson, 1985; WHO, 1988; Kuo, 1997).

Nickel

The bioavailability and toxicity of nickel is related to its chemical and physical forms. Exposure to nickel through ingestion is a minimal health risk, while via inhalation is of major concern. As with many other fumes, nickel intake often occurs with cigarette smoking. Target organs are the respiratory system (especially the nasal cavities and sinuses), the immune system, and the skin. The inhalation of nickel metal dust and some nickel compounds is associated with a carcinogenic risk and under high concentrations, can promote teratogenic or genotoxic effects (Williams and Burson, 1985; WHO, 1988).

Lead

Lead is administered to the body through ingestion or skin contact. Ten percent of the all lead ingested is absorbed by adults, while almost 50% is absorbed by children. Though distributed to all organs and tissues, 90% of the absorbed lead accumulates in bone, with the remainder in the kidneys and liver. Frequent exposure to lead is associated with a diverse spectrum of clinical signs and symptoms resulting from a variety of biochemical defects. The systems mostly affected include the gastrointestinal, hematopoetic, and nervous and neuromuscular systems. The renal and cardiovascular systems are also affected in some cases. (Williams and Burson, 1985; WHO, 1996)

Copper

Copper toxicity occurs mainly upon ingestion. Chronic copper exposure leads to hepatitis, cirrhosis of the liver, jaundice, and in few cases, to hemolytic crisis. An extensive accumulation of copper in the liver is fatal, especially among children. Target systems include the gastrointestinal tract and the hematopoietic system (WHO, 1996). Among female employees, occupational exposure to high concentrations of copper is associated with spontaneous abortion and an increased risk of offspring malformation (Williams and Burson, 1985).

Conclusion

While regulations need to be put into place to reduce the chances of metal contamination, the direct application of western or foreign guidelines is not appropriate due to the uniqueness of each region and its prevailing environmental conditions. This is due in part to metal concentrations and the physical status of the soil being influenced by soil pH and atmospheric deposition, working in conjunction, these determine toxicity levels within the environment (Hindiyeh, 1995). Soil pH and atmospheric conditions also change between and within regions, reinforcing the idea that the application of foreign standards is obsolete. This is no reason, however, for appropriate local guidelines not to be developed to prevent irreversible damage to environmental, plant, and animal health.

The description of detrimental health effects arising from the exposure to metals frequently used in electroplating plants should spur on manufacturers and legislators to improve working conditions and disposal methods of hazardous wastes. By adhering to the cost-saving and environmentally sound auditing recommendations, this electroplating firm and others like it can reduce the damage done to environmental and human health.

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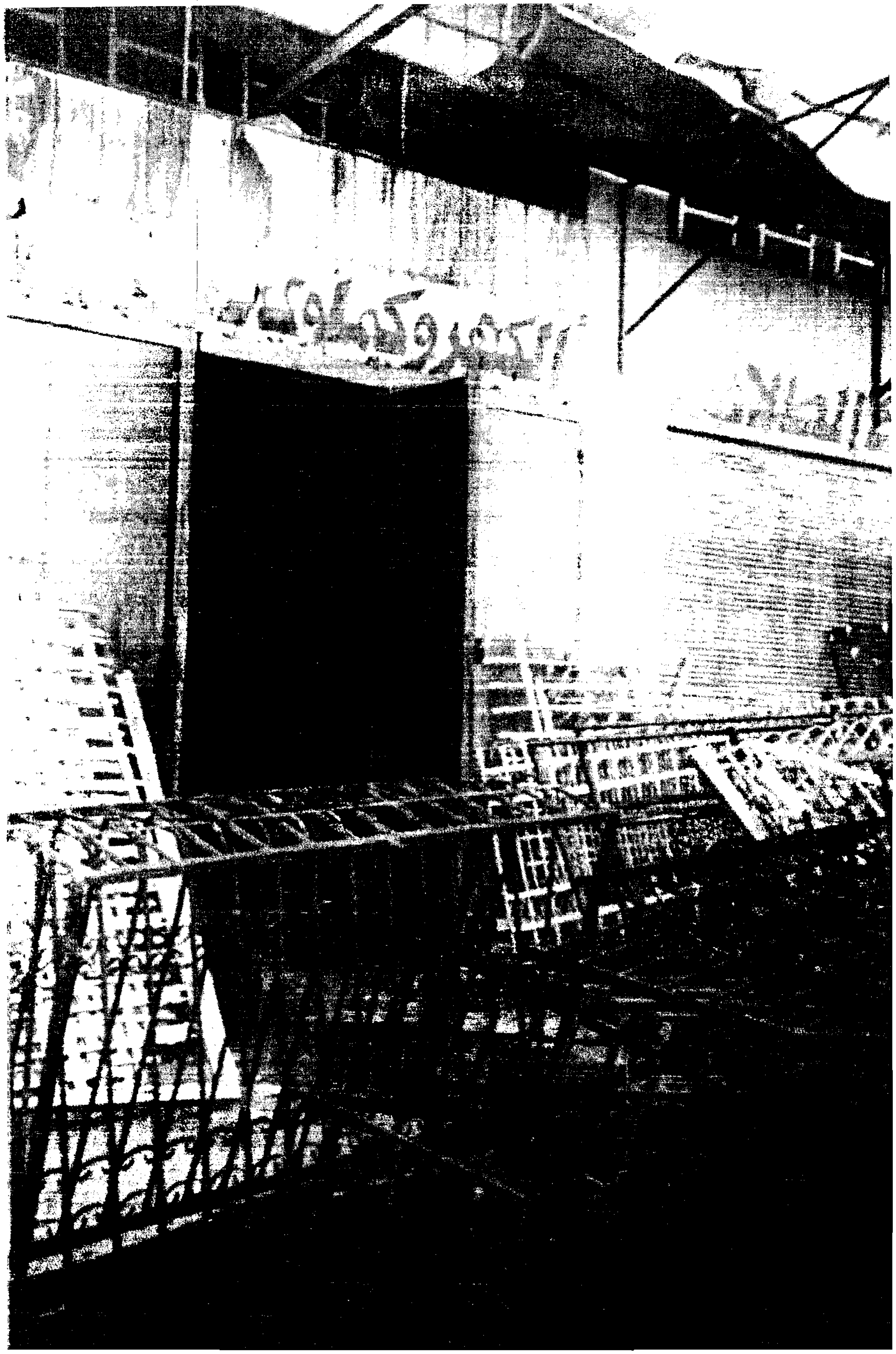

Fig. 1. General view for the entrance of the firm with the raw and end-product materials on road side.

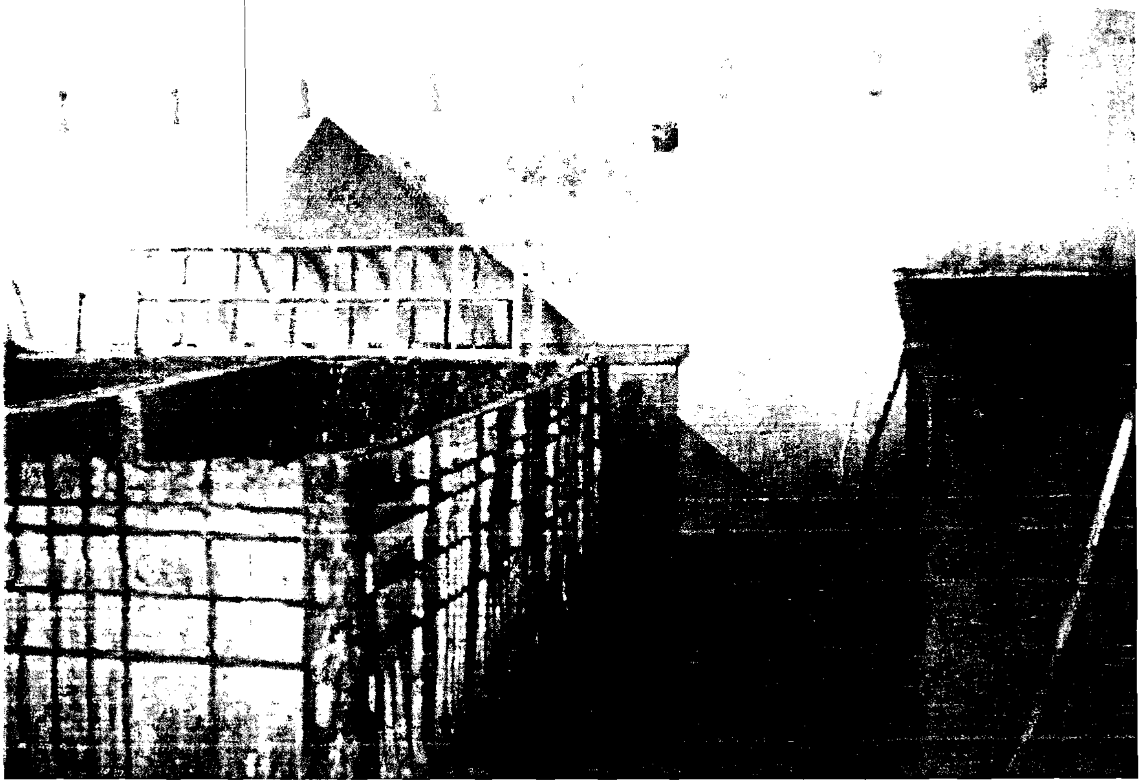

Fig. 3. Rinsing water bath after etching stage, using immersed hoses to drain the bath instead of drain holes.

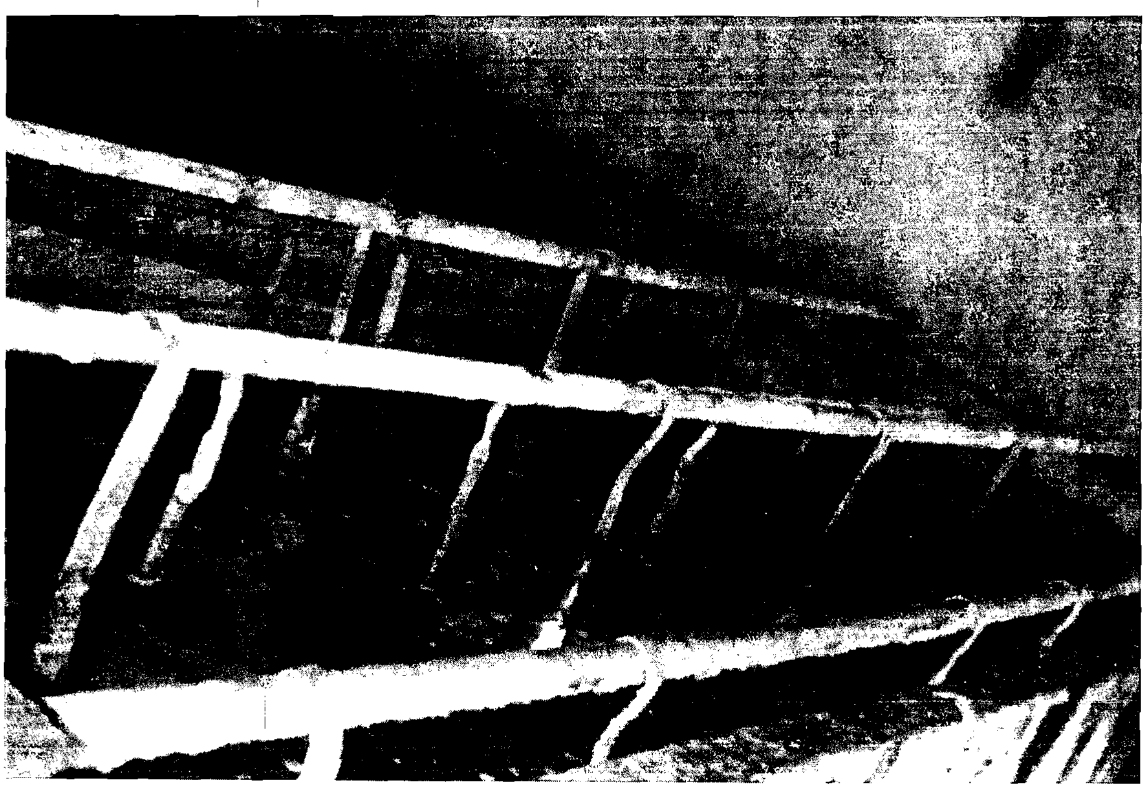

Fig. 4. Calvanization bath where the electroplating process takes place

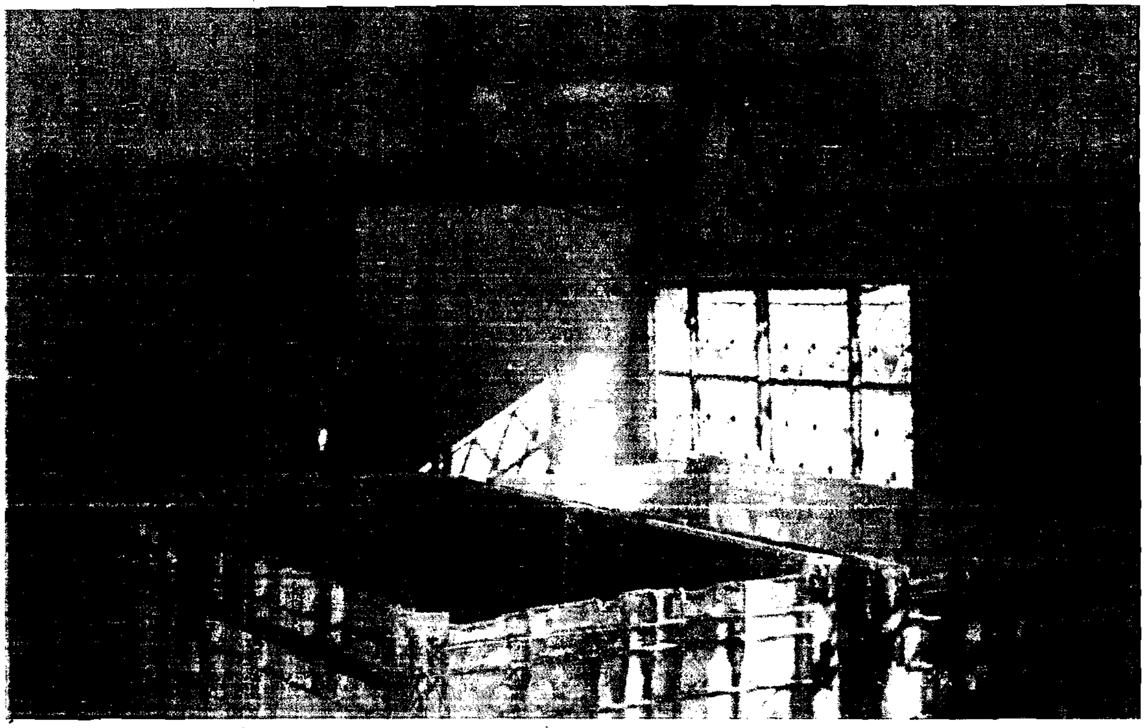

Fig. 5. The parts are rinsed in a water bath and then treated in another bath containing mild acidic solution of HNO_3 plus some salts (Cr_2O_3) as a Passivation process

Fig. 6. Wastewater from the baths is discharged to the one discharge stream ending into the septic tank.

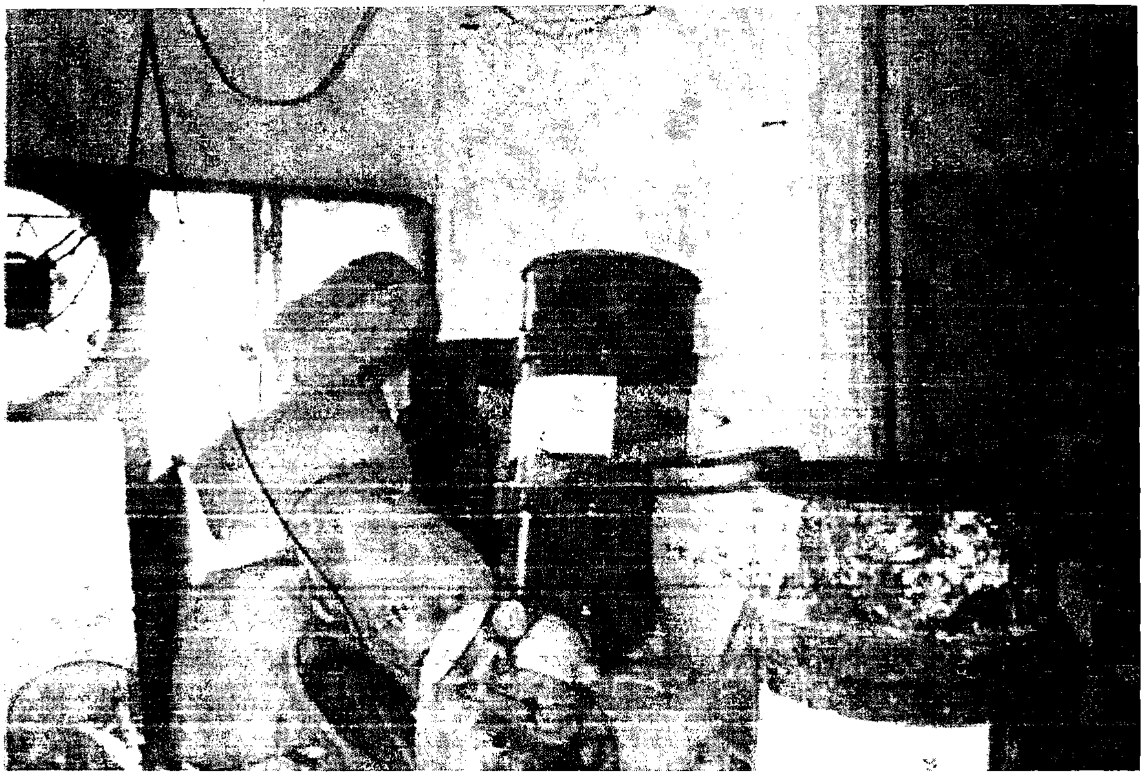

Fig. 7. Bad management for handling procedures of chemicals, and the collection of residual chemicals left in bags.

Fig. 8. Presently the plant does not utilize a proper drying basin as afinal stage of the wastewater sludge.

Fig. 9. Residential building interferes with the industrial zones.

The Possibility of Groundwater Pollution of the Shallow Aquifer in Zeimar Catchment with Industrial Effluents

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Abstract

The water extracted by most of the groundwater wells alongside Wadi Zeimar from Anabta to Tulkarem show contamination due to mixing of groundwater with the infiltrating untreated wastewater flowing into the wadi. The contamination is observed in the form of high values of total dissolved solids, sodium, nitrate, and chloride. The unconfined, fractured, and karstic rock sequence of the unsaturated zone makes the aquifer system sensitive to pollution. The presence of industries disposing their industrial wastewater into the stream of municipal wastewater is a potential source of industrial pollutants of groundwater in the area.

Introduction

The water of several groundwater wells in the Nablus-Tulkarem Area (Figure 1) is of poor quality. This can be recognized by the relatively high EC values and high concentrations of chloride (Cl-) and nitrate (NO3-) measured. The polluted groundwater wells lie along the wastewater stream (Wadi Zeimar), beside the wastewater collection pools in Tulkarem, and within the populated areas (Abdul-Jaber, in Press). It is well known that wastewater disposal causes contamination of shallow perched water aquifers in the West Bank (Abdul-Jaber, 1994 and Abdul-Jaber et al., 1997). The pollution of groundwater in Nablus area, due to the effect of wastewater, was mentioned by Abdul-Jaber and Eliewi (1995) and Eliewi (1997).

There are a lot of industries in the catchment area of Zeimar. These industries lie mainly alongside the wadi from Nablus to Tulkarem. These industries include plastic, stone cutting, and leather tanning industries. All these industries dispose of their industrial wastewater directly into the stream without any pretreatment. Any pollutant found in this industrial wastewater may find its way to the underlying groundwater.

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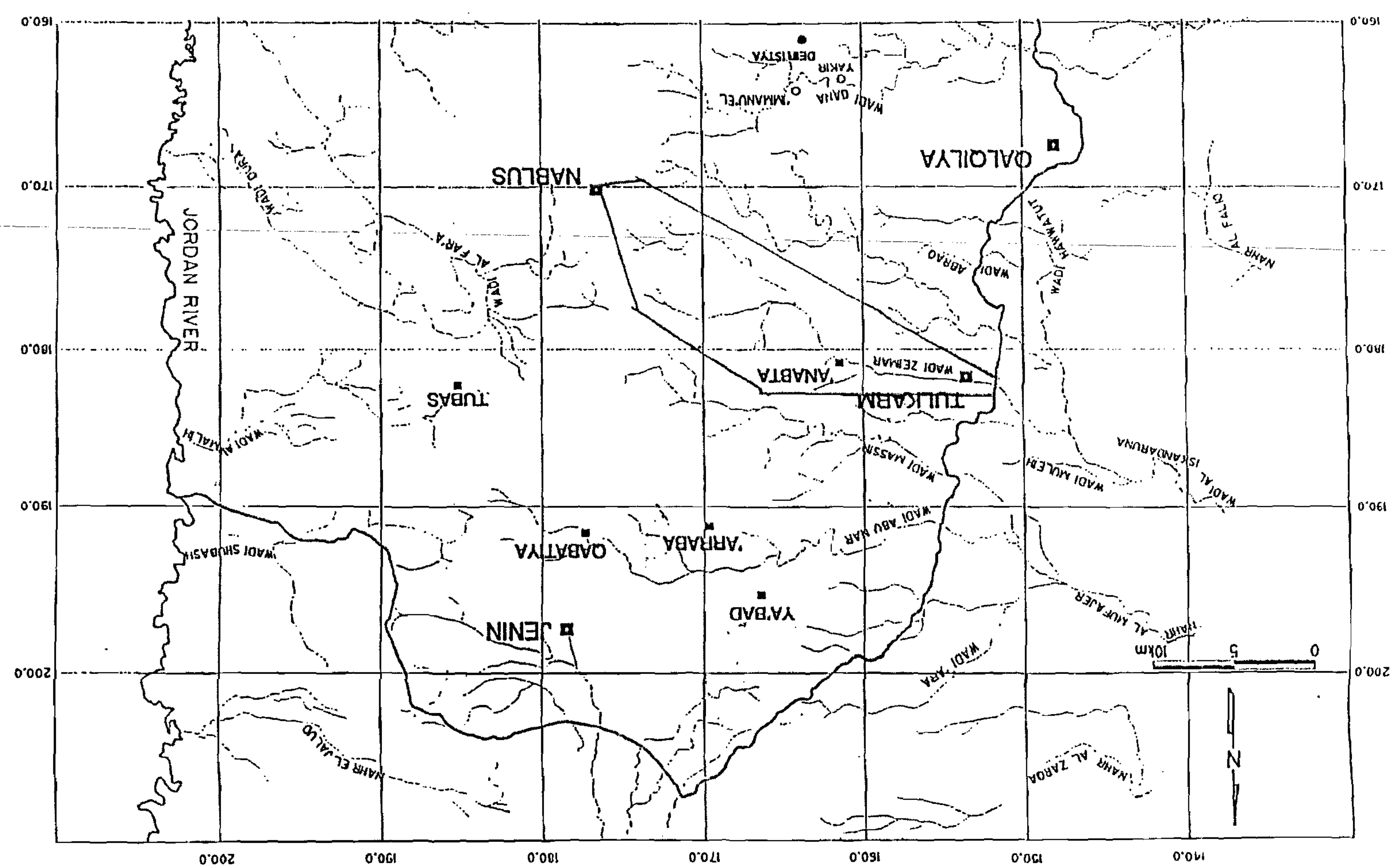


Figure. 1. Location map of Nablus - Tulkarem area.

This study aims at chemically evaluating the degree of pollution in selected water resources in the northern West Bank and relating the pollution to the local hydrogeological conditions and the wastewater disposal systems in the area.

Geology

Stratigraphy

The outcropping rocks of the studied area range in age from Upper Cenomanian (Upper Cretaceous) to Recent **(Table 1).** These rocks are marine sediment composed of limestones, dolomites, chalks, and marls (Rofe and Raffety, 1965).

Table 1

Columnar section showing the outcropping formations and the formations encountered by drilling in study area

AGE	FORMATION		LITHOLOGICAL DESCRIPTION	THICKNESS (m)	HYDROLOGICAL CHARACTERISTICS
	Israeli terminology	**Rofe and Raffety, 1963 terminology**			
Eocene	Undivided	**Jenin Subseries**	Limestone, chalky limestone, limy chalk, chalk and marl with flint	**325**	**Aquifer in limestone zones; aquiclude in chalk zones.**
Senonian	Gharib Takia Meishash Menuha	**Chalk Undivided**	Chalk, chalk with flint, limy phosphatic and bituminous, chalk, marl and shales	**50-500**	**Aquitard**
Turonian	Bina	**Jerusalem (Ktj)**	Hard limestone, fine crystalline. Chalky limestone, occasionally with flints	**75-100**	**Very good aquifer**
	Weradim	**Beit Lehem (Kcb)**	Hard dolomite, generally coarse crystalline	**40-100**	**Very good aquifer**
	Kefar Sha'ul		Dolomite, limestone, chalk and marl		**Generally aquiclude**
	Amminadav	**Hebron (Kch)**	Limestone, dolomite, dolomitic limestone; medium to coarse crystalline, karstic, porous	**200-250**	**Excellent aquifer**
Cenomanian	Moza marl	**Yatta (Kcy)**	Marl, greenish yellow	**5-20**	**Aquitard**
	Bet Meir		Chalky limestone, chalk, limestone. Some dolomitic strata, some flint	**30-80**	
	Kesalon Dolomite	**Upper Beit Kahil (Kcubk)**	Dolomite and limestone, sometimes karstic	**120-250**	**Good aquifer**
	Soreq		Limestone and dolomite, chalky limestone and marl		**Partial aquifer**
	Giv'at Ye'arim Dolomite	**Lower Beit Kahil (Kclbk)**	Dolomite, crystalline, sometimes karstic. Some limestone beds	**230**	**Good aquifer**

Some chert bands and nodules are present, especially in the Tertiary Rocks. Lower Cenomanian Rocks were encountered by drilling.

Structures

The area is very close to major geological structures such as the Jordan Graben and Nablus-Beit Qad Syncline. Faults are also present within the area (Rofe and Raffety, 1965). The Tectonic activities of the area have caused fracturing and jointing of the hard carbonates.

Karstification is developed locally. The joints and fractures were enlarged due to the relatively high rainfall. Karsticfication features are found in all Cenomanian rocks in the area. They can be seen on the surface and some were encountered through the drilling of Deir Sharaf 2a well (Aliewi et al., 1995).

Hydrogeology

Three main aquifer systems occur in the study area:

1. The Lower Cenomanian Aquifer System. This system consists of the Lower and Upper Beit Kahil Formations and the lower part of Yatta Formation. It is considered to be a good to fair confined aquifer in most of the study area. In the area of study, this system was encountered by Deir Sharaf 2a well.

2. The Upper Cenomanian-Turonian Aquifer System. This aquifer system is considered to be a good to excellent aquifer consisting of Hebron, Bethlehem, and Jerusalem Formations. It has a regional extension. Most of the wells in the study area extract their water from this unconfined aquifer system which is subjected to direct infiltration from wadis.

3. The Eocene Aquifer System. This system is not included in the study because it forms a perched aquifer that lies higher than the wastewater bearing wadis.

Wastewater and Industrial Wastewater in the Area of Study

The wastewater is disposed of untreated in the area of study, either in the wadis (in Wadi Zeimar) or directed into cesspools. Wadi Zeimar, as other wadis, represents a recharge area for the underlying, shallow, unconfined aquifer system. The wastewater in Tulkarem is collected in two pools northwest of the city. The pools are not sealed and the wastewater directed into them infiltrates directly into the shallow water table.

All industries in the area dispose of their wastewater untreated. The industrial wastewater, with its load of dangerous pollutants, is disposed of into wadis. Such wastewater may contain dissolved and suspended organic and inorganic pollutants. The main probable pollutants present are mineral and rock particles from the stone cutting industry, trace element (Cd and As) from leather tanning, organic substances (BOD, fats, dyes) from other industries, and domestic wastewater. High concentration of major ions as well as high TDS may be caused by industry and domestic effluents.

The rock sequence between the beds of the wadi and the water table is mostly fractured, jointed, and karstic limestones and dolomites which enables the above mentioned pollutants to reach the water table rapidly.

Discussion

Water samples were collected by the author from the groundwater wells along Wadi Zeimar in 1994. The water samples were analyzed for major ions in the laboratories of Water and Soil Environmental Research Unit (WSERU) of Bethlehem University. The pH-value and EC were measured at the sampling sites. Due to technical problems, the trace elements, dissolved organics, and suspended solids (SS) were not measured. The contamination from major ions (especially chloride (Cl^-) and nitrate (NO_3)) and high value of EC were taken as indications of mixing of the groundwater with wastewater. Because other pollutants from industrial origin accompany the major ions in the wastewater stream and may behave in the same manner during infiltration of the water table, the pollution with chloride or nitrate may indicate industrial pollution.

Water Quality

The wells of Nablus -Tulkarem mainly extract water from the unconfined shallow aquifer with a static water level of about 100 m or less below ground level (bgl). The absence of a real confining strata and the fractured and karstic nature of the rock sequence above the static water level make these wells sensitive to pollution.

The water from the wells of Anabta -Tulkarem can be divided into the following types (**Figure 2**):

1. Earth alkaline water with prevailing bicarbonate. This water type has relatively low EC values such as the wells of Sa'id Jaber, Najeeb Musa, and Khalid Hannun. The EC-value does not exceed 750 (s/cm, their Cl- and NO3- content is less than 70 mg/L and 45 mg/L respectively. These wells lie outside the residential areas and far away from the wadis discharging wastewater. It is a recharge water type.

2. Earth alkaline water with increased portion of alkalis and prevailing bicarbonate. This water type has a higher EC values and Cl- and NO3- concentrations than the previous type. It is represented by the wells of Anabta Municipality-2, Khadouri, Ra'fat Qubbaj, Tulkarem Municipality wells, and Quzmar. They lie beside the wastewater stream, Wadi Zeimar, such as Anabta Municipality -2 and Qubbaj and/or within the residential area such as the wells of Anabta Municipality-2, Tulkarem Municipality wells, and Quzmar. This water type shows pollution by mixing with wastewater from both Wadi Zeimar and cesspools.

3. Earth alkaline water with increased portion of alkalis and prevailing chloride. This type is represented by the wells of Iqab Freij and Mustafa Sa'id. It shows the highest TDS values and the highest concentration of Cl- (up to 350 mg/l) but NO3- is lower than expected. This may be due to a nitrification process which occurs due to the presence of organic matter. This water type is highly affected by wastewater pollution infiltrating from the municipal wastewater collection pools in Tulkarem, located very close to the wells.

On the expanded Durov Diagram (**Figure 3**) most of the wells lie alongside the mixing line while the unpolluted wells are located in the top left square (i.e., recharge water). The polluted wells lie along the mixing line in the middle square and the right low corner square, indicating the mixing with different portions of wastewater.

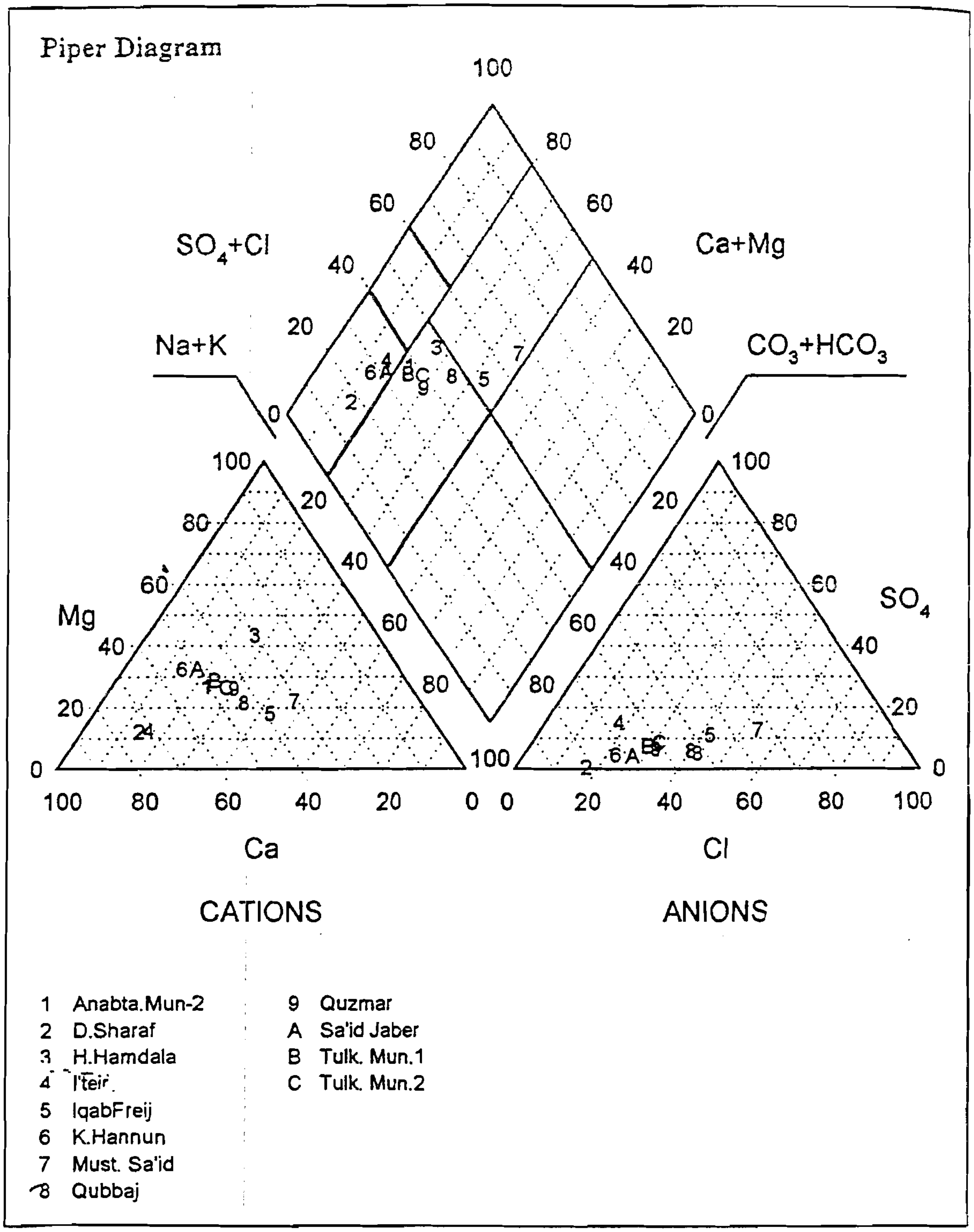
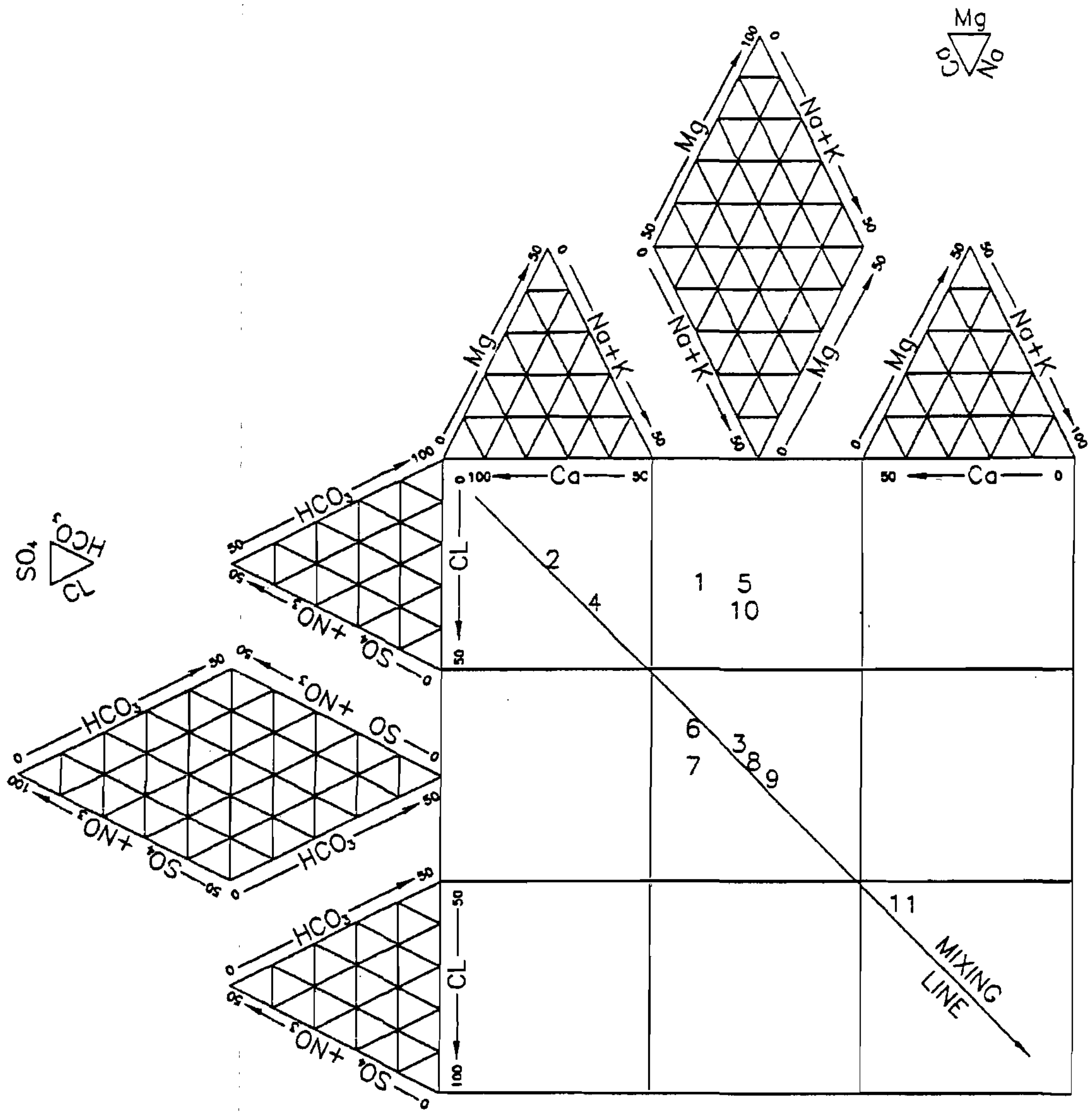


Figure 2: Piper presentation of some wells from the study area



1. Sa'id Jaber
2. Khalid Hannun
3. Hafez Hamdala
4. Anabta Municip-2
5. Tulkarm Municip-1
6. Tulkarm Municip-2
7. Tulkarm Municip-3
8. Ra'fat Qubbaj
9. Iqab Freij
10. 'Quzmar
11. Mustafa Sa'id

Figure 3: Durov presentation of some wells from the study area

Table 2

Chemical analyses of the water of some wells in the study area

(Abdul-Jaber, in Press and Abdul-Jaber et al., 1997)

Sample Identification	Date	pH	EC µS/cm	Cations (mg/L)				Anions (mg/L)			
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	SO_4^-	Cl^-	NO_3^-
Sa'id Jaber	1.8.94	7.69	710	72.1	29.2	28.2	2.8	287.9	.14.0	66.0	39.5
Khalid Hannun	2.8.94	7.15	650	73.8	28.2	20.8	1.7	290.4	11.0	50.0	35.0
Najeeb Musa	2.8.94	7.76	720	77.0	30.1	30.0	2.4	295.2	20.0	68.0	25.8
Deir Sharaf 2a	7.9.94	7.6	593	68.9	26.9	16.7	1.7	292.8	9.0	44.0	18.8
Anabta Municip-2	11.8.94	7.80	815	86.6	28.2	41.8	5.0	280.9	24.0	84.6	71.9
Jamil Awartani*	20.11.95	7.70	1186	127.5	31.4	100.0	0.2	402.4	28.5	151.4	100.0
Ra'fat Qubbaj	7.9.94	7.40	862	68.6	23.3	70.2	1.8	258.2	24.0	114.0	68.0
Hafez Hamdalla	1.8.94	8.25	730	41.1	36.0	38.0	5.3	190.3	15.0	90.0	65.0
Tulkarem Municip-3	1.8.94	7.73	1080	104.0	36.0	63.0	10.0	336.7	34.0	152.0	74.0
Tulkarem Municip-1	11.8.94	7.62	1026	99.4	36.9	46.7	27.1	341.1	32.0	91.0	116.5
Tulkarem Municip-2	11.8.94	7.60	1156	109.0	38.2	55.3	33.9	356.5	42.0	111.0	127.2
Kadouri	11.8.94	7.60	966	91.4	40.0	51.8	4.6	358.7	30.0	104.0	49.6
Iqab Freij	1.8.94	7.33	1160	101.0	28.2	125.4	2.0	346.5	65.0	187.9	54.0
Quzmar	7.9.94	7.40	1116	105.8	37.9	71.4	17.8	400.2	34.0	118.0	106.0
Mustafa Sa'id	7.9.94	7.50	1827	118.6	51.5	203.5	4.3	378.2	112.5	353.9	28.6

* This analysis was compiled from WSERU and PHG files

Conclusions and recommendations

Conclusions

1. Wells located in the study area extract water from the unconfined shallow aquifer system which is very sensitive to pollution. The presence of any pollutant of industrial origin within the wastewater are likely to cause serious pollution problems in the underlying aquifer.

2. The unpolluted wells extract water with good quality, showing Ca-Mg-HCO3 type (earth alkaline water with prevailing bicarbonate). It is a typical water type for recharge areas.

3. The wells of good quality water extract (unpolluted) are located far away from wastewater streams and collection pools. The unpolluted water has relatively low values of EC, NO3, and Cl-.

4. The polluted wells with poor water quality extract show Ca-Mg-Na-HCO3 type (earth alkaline water with increased portion of alkalis and prevailing bicarbonate) to Ca-Mg-Na-Cl type (earth alkaline water with increased portion of alkalis and prevailing chloride).

5. The wells with poor water quality extract (polluted) are located either alongside the wastewater streams or beside wastewater collection pools. The polluted water has relatively high values of EC, NO3, and Cl-.

6. The disposal of untreated wastewater into wadis or collection pools pollutes the underlying shallow unconfined aquifers. This pollution is caused by a mixing process of recharge type water with wastewater of different ratios.

Recommendations

1. The wastewater flowing in wadis between Nablus and Tulkarem cities should be piped to prevent infiltration of pollutants into the underlying, shallow, sensitive aquifer system. This wastewater should be treated and reused properly to minimize or to get rid of the effect of pollution.

2. The wastewater collected in Tulkarem cesspool should be treated and reused to a level where it is harmless to the water quality of the aquifers in the region.

3. The industries within the study area should be obliged to properly treat their industrial wastewater on-site and develop a recycling system to reuse their own industrial wastewater.

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Industrial Wastewater in the Ramallah and al-Bireh District*

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Abstract

This paper describes the industrial status in the Ramallah district from an environmental aspect with an emphasis on industrial wastewater. The information was obtained from the records of the Ministry of Health for the time period of end of 1994 to beginning of 1995. The information includes: the location of the industrial site, licensing of the factory, dangerous materials used in the factory, water use, wastewater generation, and treatment. The analysis of this information can be utilized as baseline information for future research and studies. The results indicate a high level of water consumption by industries and a severely under-developed wastewater disposal system, posing a hazard to public health and the environment.

Introduction

This paper aims to provide a broad overview of industrial wastewater in the Ramallah District. It forms part of a bigger and more comprehensive investigation which includes a variety of environmental issues relevant to industries in Ramallah. The baseline information contained in this paper is of importance because of the following reasons:

- This is the first time that such data has been gathered and summarized in the area;
- It provides the template around which further investigation on this particular topic will be made.
- Despite its broad nature, officials can utilize this information for decision making purposes regarding the future development of industry and environmental health.

* This paper is a part of a larger research project, for more information refer to "Urbanization and Industrialization: The case of industries of the District of Ramallah and al-Bireh".

Background

Industrial Wastewater

Industrial wastewater is a main effluent produced by industrial sites and, if not properly treated or handled, may adversely affect the environment and in turn health. By implementing sustainable development principles and practices, the emission can be controlled, ensuring its treatment and safe disposal.

Industrial wastewater status in the Ramallah District

As the Oslo Accords progress, extensive industrial development is expected to continue. This heightens concerns about industries producing harmful sewage which, in turn, will require separate treatment to ensure "homogeneity" in the composition with the domestic sewage. ARIJ (Applied Research Institute - Jerusalem) surveyed approximately 70% of the industrial facilities in the Ramallah District and found that nearly 206,000 m3 of industrial wastewater is generated by these facilities (ARIJ, 1996). Industrial wastewater composed about 10% of the total wastewater generated in Ramallah in 1993 (ANERA, 1994). This wastewater is disposed of into cesspits, the sewage collection network, reused, or disposed of in open areas near the industrial facility (ARIJ, 1996). Very few industries have on-site wastewater pretreatment or recycling (ANERA, 1994).

There are a growing number of small- and medium-sized industrial plants discharging wastewater into the municipal sewers of Ramallah. Almost all factories in the city's industrial area are connected to the wastewater treatment plant, except those located in the northern part of the industrial area which is not served by a sewer network. Only a few industries have some form of pretreatment or wastewater recycling on-site (ANERA, 1994). In the al-Bireh industrial area, a collection network exists but no regulations or standards exist to allow connection to the system (al-Bireh Municipality, 1998).

The Ramallah District includes two major urban areas, Ramallah and al-Bireh, as well as 99 villages and towns. Ninety-three villages may be classified as rural due to the presence of a village council or local committee. The remaining six towns are urbanizing or semi-urban communities defined as having a local municipal council, as well as other social, commercial, and industrial activities. Examples of these urbanizing communities are Beitounia, Birzeit, and al-Ram.

Methodology

In the end of 1994 and the beginning of 1995, the Environmental Health Department under the auspices of the Ministry of Health (MOH), took the initiative and surveyed a large majority of the factories operating at that time in the Ramallah District. One hundred and eleven factories were surveyed. The data was collected using a questionnaire designed by the MOH. The data was computer coded, analyzed, and cleaned by the Department of Community and Public Health, Birzeit University.

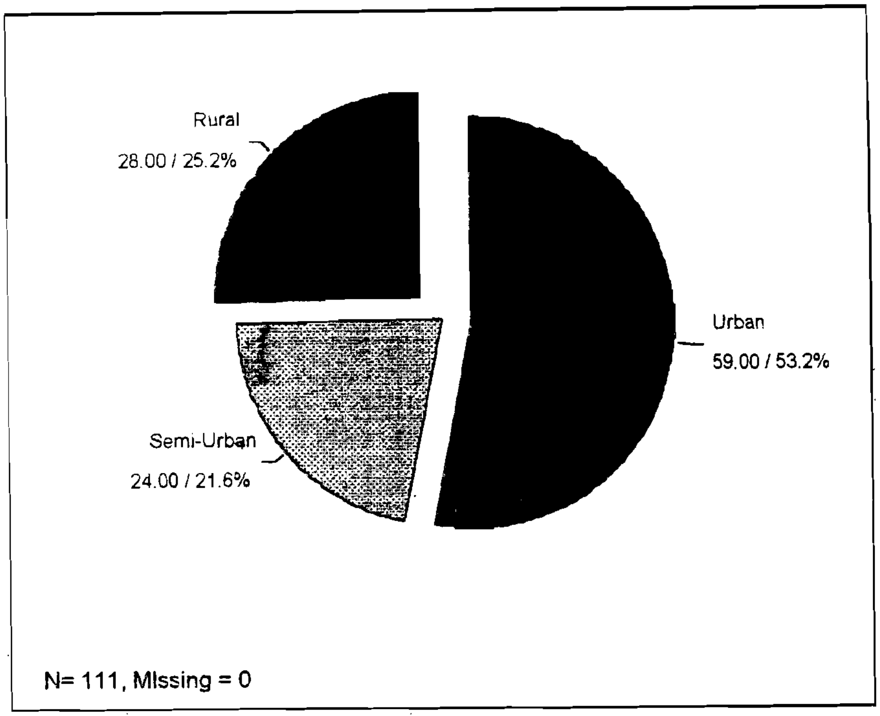
It became apparent after initially viewing the data that much of it was inconsistent due to the way the questionnaire was designed and answered. Despite this problem, it was possible to obtain important and generally reliable information from the questionnaires, whereby a general presentation of the findings became possible. Although the questionnaire covered a wide array of information on each facility, only information on the location of the industrial site, licensing of the factory, dangerous materials used in the factory, water use, and wastewater generation and treatment were analyzed for the purpose of writing this paper.

Industry Profile

Urban, semi-urban, and rural distribution

The study shows that 59 (53%) factories are located in the two urban areas of the District of Ramallah and al-Bireh, with the remaining 52 (47%) factories located in semi-urban and rural communities. In the semi-urban areas, there are 24 factories (22%) distributed throughout the six communities in this district. The remaining 28 factories (25%) are scattered throughout the 93 rural communities (see **Chart 1**).

Chart 1
Urban/Semi-Urban/Rural distribution
of industrial sites in the Ramallah and Al-Bireh District, 1995



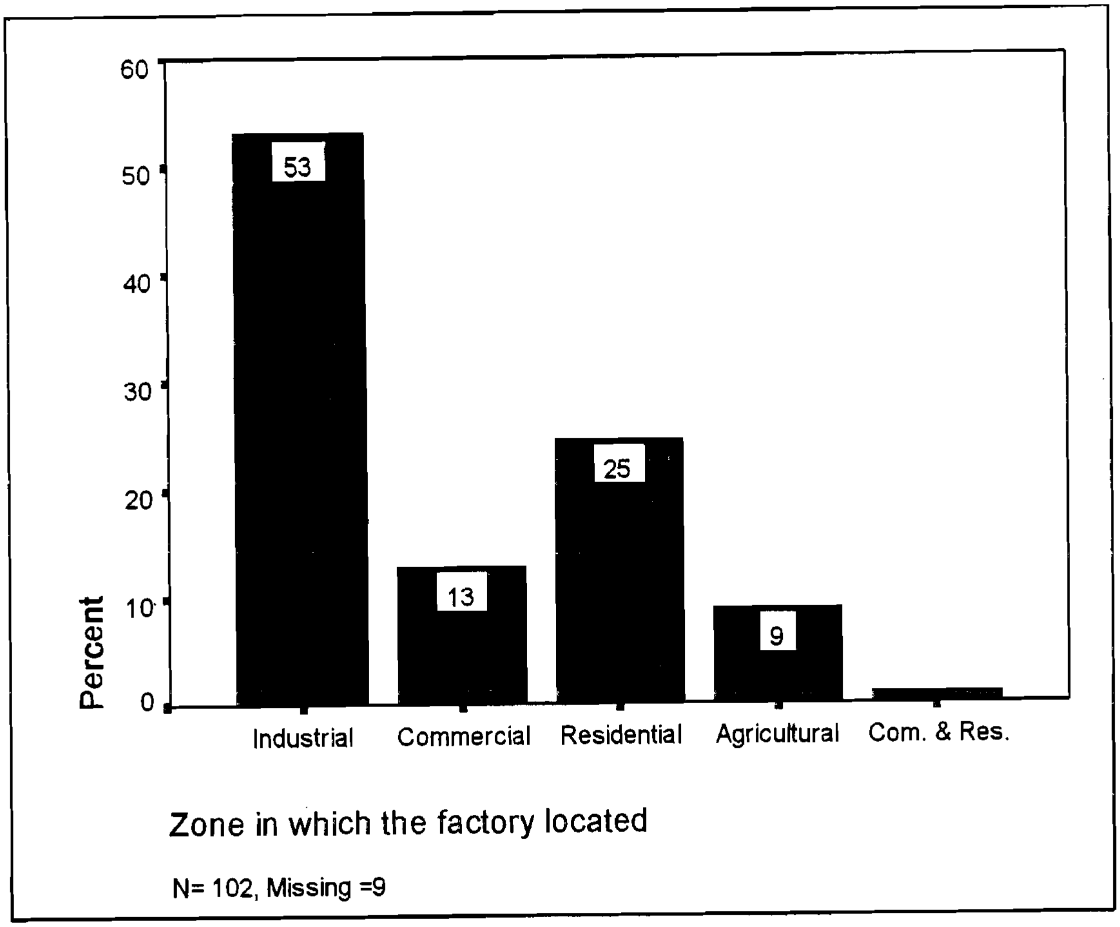
Zone distribution

There are primarily four types of zoning areas: industrial, residential, agricultural, and commercial. For the purpose of this research, all the different residential zones (residential, rural residential, and agricultural residential) are categorized as residential zones. Agricultural zones are all the zones that are not designated for other purposes in the structural plan or are designated for agricultural use (al-Natour, 1998). Industrial zones include collecting big industries, industries, and the workshop and light industrial areas. Other zones are not included in this research as they represent lands on which hospitals, parks, offices, and public services are located and, thus, are not used for residential housing. All four zones appear in urban areas and in some circumstances, in semi-urban areas, while only residential and agricultural zones are present in rural areas.

Of the one hundred and two factories which responded, 54 (53%) are located in industrial areas, 13 (13%) in commercial areas, 25 (25%) in residential areas, and 9 (9%) are located in agricultural areas (see **Chart 2).** One factory (1%) was defined as both residential and commercial according to the owner of the factory.

Chart 2

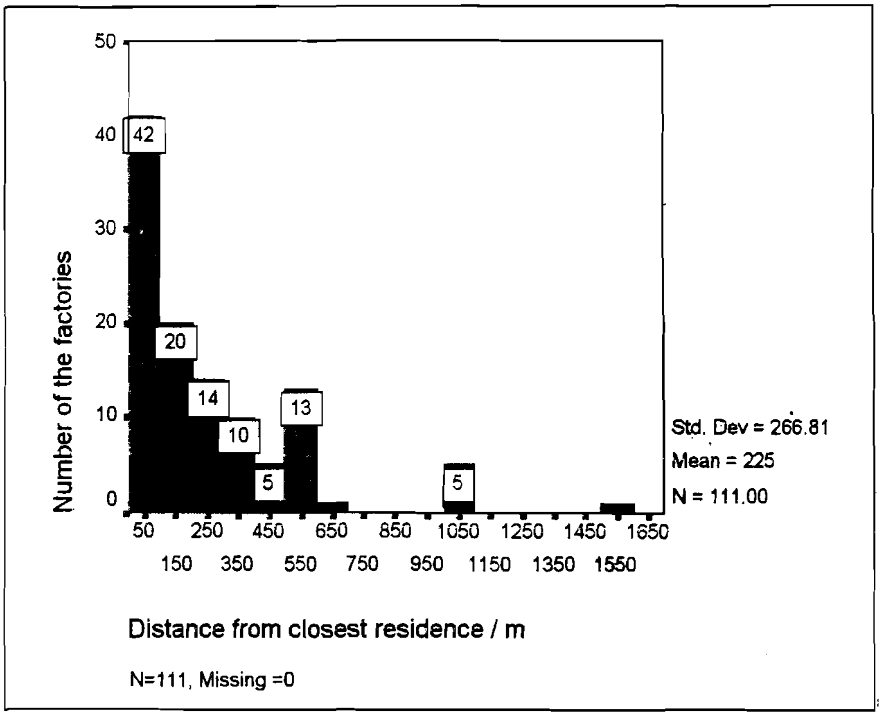
Distribution of factories by zone in the Ramallah and al- Bireh District, 1995



Location of factories in relation to residences

The distance between residences and factories is important to examine because health risks increase as the distance between the two decreases, especially when factories have hazardous emissions or effluents. Chart four shows 38%, or 42 factories, are within a diameter of less than 100 meters from the closest residences. Thirty-four factories (18%) are between 100-299 meters from the nearest residences, 15 factories (14%) are within the 300-499 meters, and 14 factories (13%) are within 500-699 meters (see **Chart 3**).

Chart 3
Distribution of factories by the distance
to the closest residence in the Ramallah District, 1995



Licensing of factories

In Palestine there are three forms of licenses required to be a legally registered factory: Municipal Building license, a license from the Ministry of Industry, and a license from the Ministry of Health.

1. Licenses from the municipalities for the building itself. Eighty-five percent of the factories have a building license, however this is not the license to legally run a factory. Fourteen percent of these 83 factories do not have a license to operate as a factory, while 13 factories did not respond to this question. There are 15 factories that do not have a municipal building license and are distributed as follows: 12 in rural areas, one in semi-urban areas, and two in urban areas (see **Table 1).**

The building liscence is usually granted by the Ministry of Local Government (Article 4, Law number 30, August, 1996), or municipalities. Article 3 of Law number 30 allows construction of residencies in industrial zones which has led to the creation of residences in industrial zones and workshops and factories in residential zones.

Problems also arise when rented buildings with a municipal license are used for industrial purposes without obtaining permission from the Ministries of Industry and Health.

2. License from the Ministry of Industry (MOI). The MOI gives licenses based upon the industrial site having approval of the Ministry of Health's Department of Environmental Health, approval of the municipalities, approval of the other ministries directly affected by or involved with this type of industry, and the approval of the government's Archeology Department.

   Sixty-four (58%) factories and workshops have an industrial license to run as a factory while 38% do not (see **Chart 7**). Of the 38 factories that have no license from the MOI, six are located in urban areas, 14 in semi-urban areas, and 18 in rural areas.

3. License from the Ministry of Health, Environmental Health Department. This license is crucial as it allows inspectors from this department to check the factory for hazardous emissions, enforcing their conditions, and giving their permission if they see fit. The factories sampled in this survey are divided nearly evenly in their possession of an environmental license. Almost half of the factories have an environmental license at 44% (49), while 47 % (52) do not.

Table 1
Distribution of factories by having different liscenses in the Ramallah District, 1995

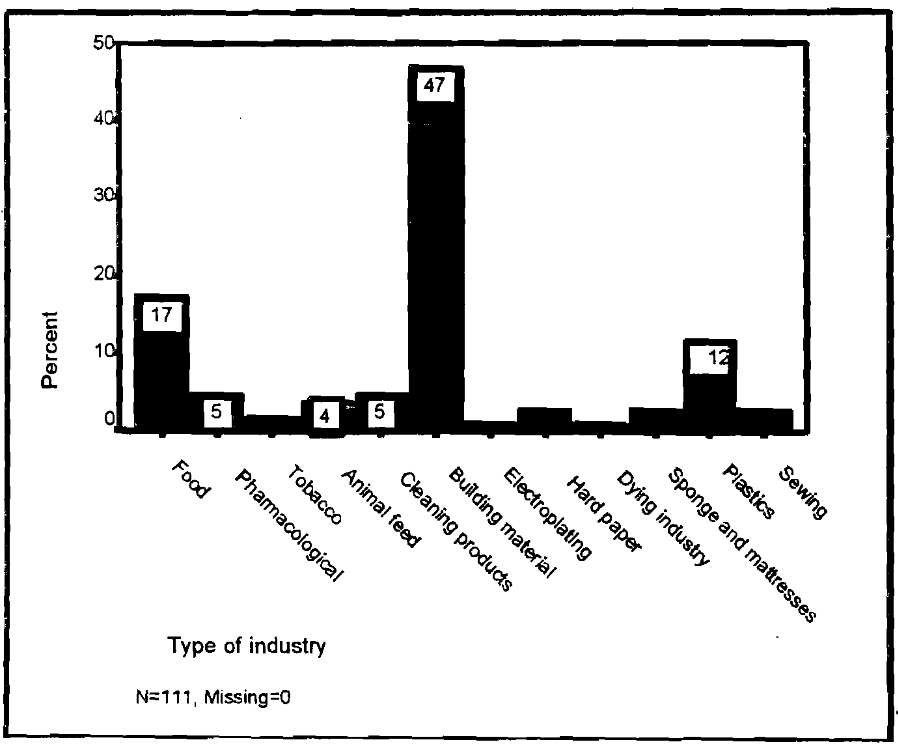
Type of License	Number of factories	% of the total factories in the survey
Do not have any license	15	13.5
Only Municipal Building License	83	74.8
Only one license from the Ministry of Health (MOH)	49	44.1
Only one license from the Ministry of Industry (MOI)	64	57.6
Having at least one license	96	86.4
Having at least two licenses	83	74.8
Having all the three licenses	32	28.8
Having two licenses from MOI and MOH	40	36.0
Having only one license from either MOI or MOH	73	65.8
Do not have neither the MOH or MOI license	38	34.2

Table 1 emphasizes the gap in the implementation of the existing guidelines as some factories have one license, others have another. But as some guidelines exist, this helps us point out a gap in the licensing implementation of the guidelines.

Distribution of factories by type of industry

Chart 4 depicts the 12 major types of industries in the Ramallah District. Forty-seven percent of the factories produce building materials such as stone cutting and block manufacturing. The second major industry in the Ramallah District is the food industry, followed by the plastics industry.

Chart 4
Distribution of the factories by type of industry
in the Ramallah District, 1995



For a number of reasons, the category "building material industries" comprises a large percentage of the total number of industry types in the Ramallah District. First, the raw materials necessary for these factories are locally available. Secondly, industries such as stone cutting are traditional in this area and have a long history. And thirdly, the increase in the building movement has created a huge demand for the basic supplies necessary to meet the need, so it is an industry which is economically feasible as well.

Consumption of water by Ramallah District's factories

Data about water consumption was collected for 99 factories, or 89% of those factories that participated in the study. Of the factories responding, the industries in Ramallah District consume about 18443 m 3 per month or 221,316 m3 per year. **Table 2** shows the distribution of factories by water consumption.

Table 2
Distribution of the factories by monthly consumption of water in the Ramallah District, 1995

Number of factories	99	**Maximum**	6000
Missing	12	**Sum**	18443
Mean	186.29	**percentiles (25)**	24.00
Median	50.00	**percentiles (50)**	50.00
Minimum	1	**percentiles (75)**	150.00

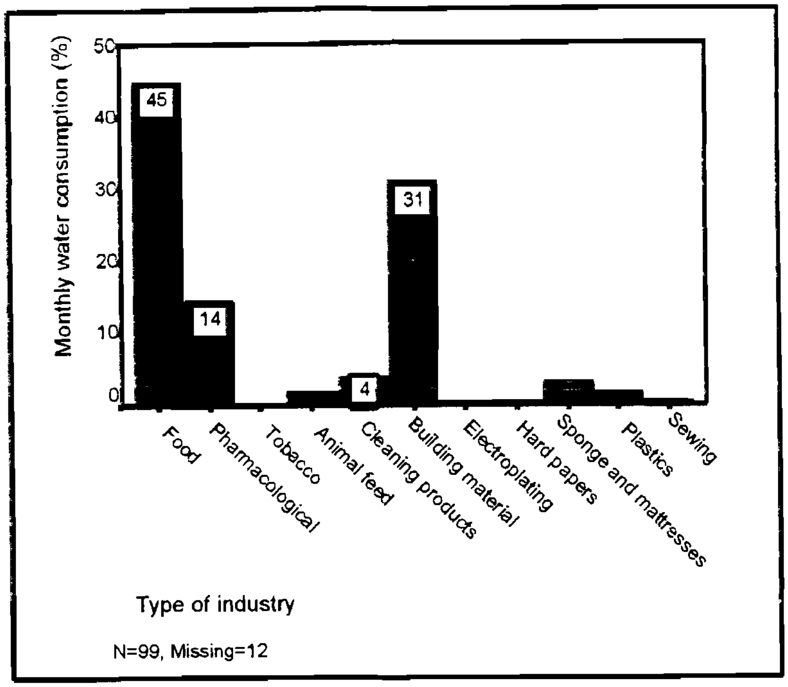
Consumption of water by type of industry

Of the total quantity of water used for industrial purposes in the Ramallah District, the food industry is the largest consumer at 8110 m3 or 44% (see **Chart 5**). The second largest consumer is the building material industry which uses 31% of the water (5652 m3). The pharmacological industry consumes the third largest amount of water at 14% (2633 m3). The last consumer of industrial water worth noting is the cleaning materials industry which consumes about 4% of the water (680 m3).

Two factories, specifically, consume the largest amount of water. The first one, located in Ramallah city, is a food industry factory which consumes 6000 m3 per month. The second major consumer of water is a pharmaceutical factory, located in Beitunia.

Chart 5

Consumption of water (m3) in factories by type of industry



The total consumption of water is 18443 m3 for 90% of the factories; water consumption is concentrated in urban areas; and the major consumers of water are food industries and building material industries. It is interesting to note that the dyeing industries did not respond to the questions pertaining to water consumption although we know that the dyeing industry consumes more than other industries.

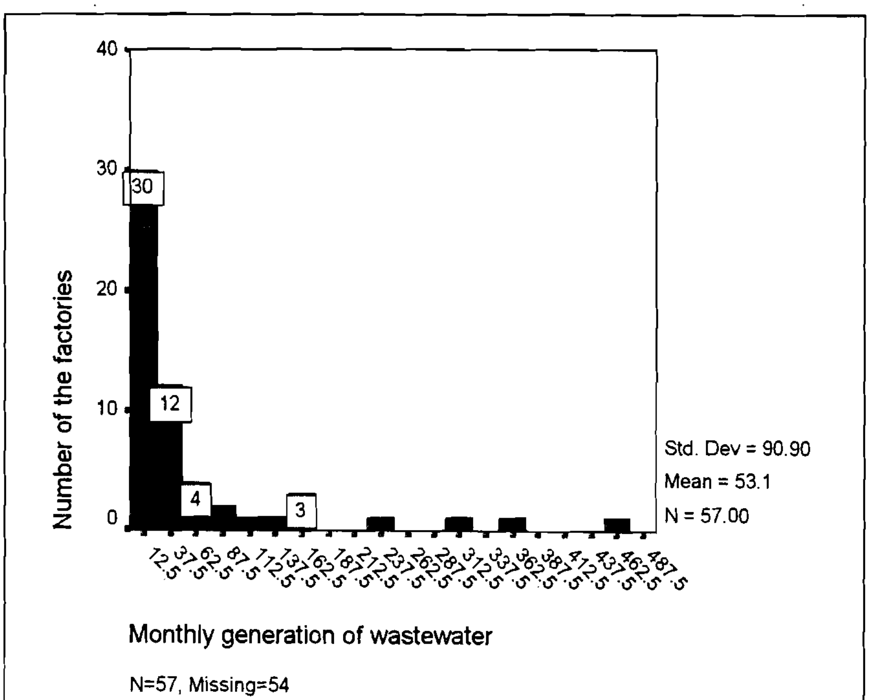
Generation of industrial wastewater

Knowing the quantities of wastewater generated by industries is necessary to evaluate the real danger that is threatening public health. Wastewater has been used for irrigating crops without any crop restriction or treatment. Potentially, wastewater may reach the groundwater aquifers because of its haphazard disposal into the environment. Although there are some steps that have been taken by different ministries to control irrigation by wastewater, the problem is far from solved.

The danger from industrial wastewater is higher than that of domestic wastewater due to its high pH-level and chemical composition, and if disposed into wadis without proper treatment, it can potentially affect the quality of soil and water aquifers. These considerations are easier to manage and control once the amount of the water used by industries is determined by type. Similar industrial types use almost the same materials for production and their wastewater has similar characteristics which makes it possible to handle problems generated by wastewater.

In this survey, information related to water consumption was collected on a monthly basis. Thus the data that will follow pertains to the monthly generation of wastewater. **Chart 6** shows the distribution of factories by wastewater generation in the Ramallah district. It must be noted that only 57 factories responded to this question, 51% of all the factories sampled. Their mean generation of wastewater is 53 m3 and the mode is 30 m^3. Thirty of the fifty-seven responding factories generate less than 25 m3 per month, with 12 factories producing between 25-50 m^3 monthly, and 4 factories producing between 50 - 75 m3 monthly. The total quantity of wastewater generated from the 57 factories is 3025 m^3. It is worth mentioning that this number is less than exact, due to under-reporting, especially the under-reporting of major industrial generators of wastewater such as the dyeing industry.

Chart 6
Distribution of the factories by generation of wastewater (m3) in the Ramallah District, 1995

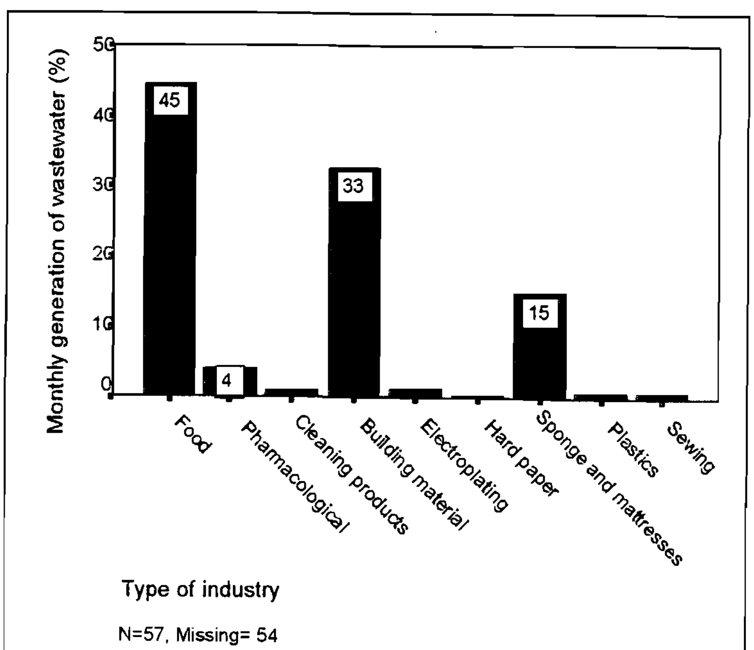


Distribution of wastewater generation by type of industry

The food industry, for example, produces heavy organic pollution. The dyeing industries utilize large quantities of water in the dyeing process, producing wastewater with high chemical, high pH, and color content. The plating wastes are also dangerous, especially if they use cyanide or other heavy metals. All the chemical and pharmaceutical industries usually have toxic effluents (Carinocross and Feachem, p. 40).

The food industry, consisting of 14 factories, is the major generator of wastewater, producing 45% of the total wastewater generation. This is the equivalent to 1347 m^3 per month. The 27 factories in the building materials industry generate the second largest amount of wastewater at 33% (985 m3 per month). The one sponge and mattress production factory generates 15% of the industrial wastewater (450 m^3 monthly), while the four factories in the pharmaceutical industry generate 4 % of industrial wastewater (125 m3/ month). It is worth mentioning that the dying industry is the major generator of wastewater but did not report their amounts of wastewater generated.

Chart 7
Distribution of wastewater generation (m3)
in the factories of Ramallah District by type of industry, 1995



Sewage Treatment

Fifty-eight percent, or 63 of the factories surveyed, have a local treatment plant, while 39% of the factories are connected to the municipal sewage system directly, which is potentially a serious problem for some industries as no guidelines exist when connecting to the sewage system. Three factories, or 3% of the factories surveyed, treat sewage locally before connecting to the municipal sewage system. One of the three factories described their treatment plant as a sedimentation pool.

Fifty-one factories, or 81% of those who have local treatment plants, use cesspits. Sixteen percent, 10 factories, use sedimentation pools. These ten factories did not provide information as to where the treated water and sludge is then disposed.

Utilization and Disposal of Hazardous Materials Used for Production

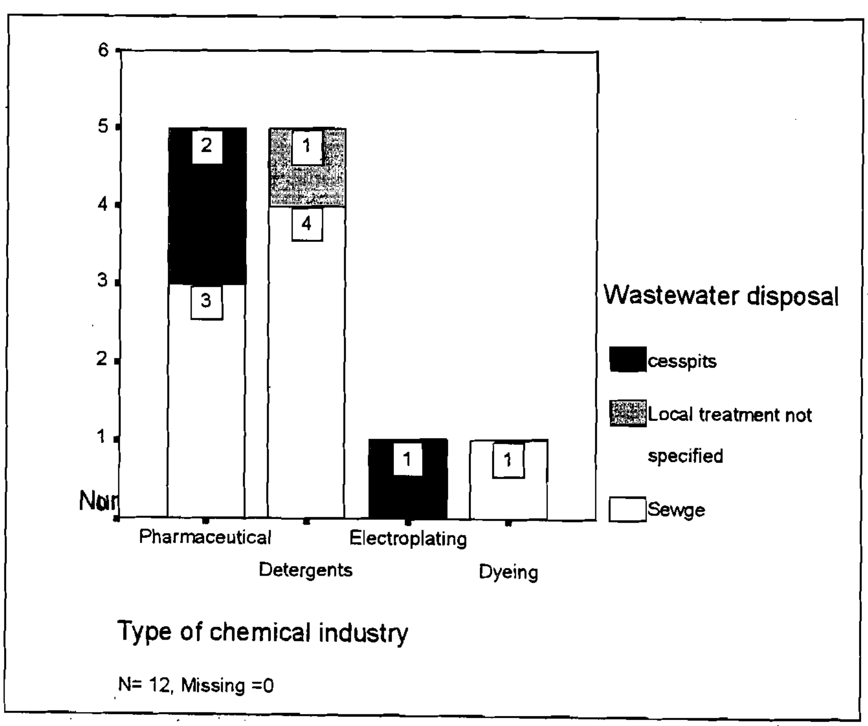
Three problem areas need to be addressed in discussions regarding hazardous wastes: to whom this material is hazardous (people, plants, environment), the nature of hazardous material (toxicant, flammable reactive), and when is this material hazardous in the factory, in the environment, or in certain conditions (Conway, 1980). It is, therefore, not enough to say waste is hazardous. It is necessary to define why it is hazardous, situations where it may be hazardous, and conditions when it is hazardous such as concentration, form, and degree.

The existence of dangerous materials in factories may affect the quality of wastewater, in turn creating further damages to soil, vegetation, ground water, sewerage pipes, and treatment plants. Therefore, interest lies in detecting the prevalence of dangerous materials in the Ramallah District factories. A number of questions were included in the questionnaire regarding different dangerous materials in terms of their availability and type, be they poison, fuel, caustic or oxidant materials, or others. From these questions a new variable was created in hopes of indicating the existence of dangerous materials in the factories during production and waste disposal. In 12%, or 13 of the factories, dangerous materials exist such as poison, toxicants, oxidants, caustic materials, and other toxic chemicals which may be found in the form of raw materials, additives, or products.

Hazardous materials could also be microorganisms. Four factories use microorganisms in their factories. In general terms, the low quality of disposal (lack of a good treatment or lack of treatment) is a question that needs to be addressed, especially in relation to the pharmaceutical industries. "The effluent from these facilities (chemical industries including the pharmaceutical) contains many toxic and biologically active constituents" (ARIJ, 1996).

From our survey we found that out of the five pharmaceutical factories, three are connected to the sewage system and two have cesspits. **Chart 8** shows the distribution of chemical industries by type and by wastewater disposal. We can see that eight factories are connected to the sewage system, one has a local treatment plant without any specification to what kind, and three use cesspits. The lack of knowledge concerning when these wastes are dangerous, why they are dangerous, and where, were not discussed here because of the lack of information in the survey regarding these issues.

Chart 8
Distribution of chemicals industries by type and by wastewater disposal



Conclusions

1. The concentration of factories is in the urban areas, as well as some smaller concentrations in the semi-urban and rural areas.

2. The major concentration of factories are in the building materials industry.

3. A problem arises from the Law number 30 Article 31, which allows residential occupation in industrial zones which generates a major public health problem.

4. Licensing systems have a poor record of implementing the guidelines for licensing factories and workshops. Industrial building licenses must not be issued unless it can be determined that the building is environmentally and occupationally safe. This gap could be dangerous to the community and environment.

5. The results indicate a high level of water consumption by some industries. Given regional water scarcity, water use in industry needs to be systematically examined.

6. The wastewater disposal system in these industries and workshops are severely under-developed and pose a hazard to health and the environment.

7. There is a lack of information regarding hazardous materials, especially regarding their type.

8. Industries that use dangerous materials, including chemicals and microorganisms, do not treat their wastewater to prevent contamination of the environment, adding to the potentially serious problem and pollution.

Recommendations

1. Ministries need to develop policies and guidelines for industrialization with an emphasis on wastewater that can ensure development with minimal damage to the environment and to people.

2. At the national level, a system for waste disposal including industrial wastewater is needed.

3. Intersectional collaboration between different governmental and NGOs is much needed to ensure the implementation of policies and guidelines.

4. More investigations are needed, including environmental auditing, to help these factories to find solutions to environmental pollution.

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Features of Industrial Wastewater Discharged into the Sewerage System: Case Study of the Northern Governorate - Gaza Strip

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Introduction

Industrial wastewater generation is considered an environmental problem in all of the Palestinian Governorates. The connection of industrial wastewater to the treatment plant (TP) is a matter of a case evaluation. The first concern is whether the industrial wastewater can be treated at the TP without any disturbances to the operation of the plant or deterioration to the quality of the effluent or sludge. The second concern is the size of industrial wastewater flow in relation to the plant capacity. The final disposal of the industrial effluent has to be defined to avoid damaging the treatment process and to protect public health and the ecological system. Additionally, quality needs to be identified for reuse in irrigating agriculture crops. This provides an example of the Northern Governorate - Gaza Strip.

Existing Situation

Sewerage system and treatment plant

The Northern Governorate consists of three municipalities: Jabalia, Beit Lahia, and Beit Hanun, with a population of about 150, 000 persons. The sewage plant which serves these municipalities is located in Beit Lahia. About 60% of the households are connected to the community sewage system.

Beit Lahia treatment plant was originally built by the Israeli Civil Administration in 1976 to treat the sewage from Jabalia and Nazla villages. The system was designed as four aerated ponds of 5000 m2 surface area each with a capacity of 29,000 m3. Two more lagoons were added in 1985 with a surface area of 10,000 m2 each. The capacity of the first pond was 34,000 m2 and 12,000 m^3 for the second pond. In 1993, another 34,000 m^3 pond was added to the system. The sewage flow to the treatment plant, as reported by the village council engineer, is estimated at approximately 7000 m^3/day with a possible increase to 15,000 m^3/day in winter.

The original purpose of the project was to recycle water for reuse in agriculture and for aquifer recharge. The irrigation part of the project was not completed due to the refusal of the farmers to use the effluent, as they were worried about the sociocultural acceptability of their products. In addition, the effluent quality does not fulfill the reuse requirements recommended by the World Health Organization or the Israeli standards that require effluent with BOD5 less than 20 mg/l and SS less than 30 mg/l.

The final disposal from the ponds is discharged directly into the sand dunes where it infiltrates into the ground. The sludge removed from the ponds is deposited in areas adjacent to the treatment plant without any type of treatment. This plant, as in the case of other plants, does not operate properly.

According to the terms of reference of the Swedish project "Upgrading of Beit Lahia Treatment Plant", the major objectives are to improve the environmental situation and to treat wastewater for recharging the aquifer and for reuse in agriculture.

The future connection of industrial wastewater to the treatment plant should consider the quantity and the quality of generated wastewater. The first concern in this matter is whether the industrial wastewater can be treated at the plant without causing any disturbances in operation or deterioration of the effluent quality or the sludge. The second is the total flow in relation to the plant capacity.

Industrial Wastewater Quantity

In the year 1996, 287 industrial establishments were registered in the Northern Governorate - Gaza Strip. Most of them (83%) belong to the clothing branch. Through field visits conducted by DRC-Gaza team in the period of 19-28 June 1997, a list of 16 firms with major wastewater discharge was compiled. The other firms were excluded due to low discharge and negligible amount of wastewater.

Table 1 summarizes the relative water demand and possible wastewater generation of different types of industrial activities in the Northern Governorate. Garment, construction, and woodwork industries were excluded because no significant water or wastewater was consumed or generated. In the plastic firms, water is being used for cooling and is recycled. All types of metal work were excluded for the same reason except for iron galvanization.

Table 1
Water demand and wastewater generation of different types of industrial activities in Northern Governorate of Gaza Strip

Type of Industrial Activities	Water Demand	Wastewater Generation	Recycling
Garment , wood work and metal work	not significant	negligible amount	
Plastic firms		negligible amount	100%
Construction	High	negligible amount	
Jeans washing and laundries	High	High	
Tiles industry		low	
Textile dyeing	High	High	
Soft drink filling	High	low	
Iron Galvanization	High	High	

Note: DRC Study, June 1997.

Note: DRC Study, June 1997.

The daily industrial wastewater generation is limited according to the data provided by the Development Research Center study (1997). The discharge quantity is about 250- 300 m3 daily, less than 5% of the total wastewater amount connected to the sewage system in the northern area. The total quantities of water demand and wastewater generated from the five industrial types shown in **Table 2.**

Table 2
Water consumption and wastewater generation of the main industrial type produced wastewater

Type	Number of factories	Water demand m^3/year	% wastewater generation	Total wastewater generation m^3/year
Washing/laundries	8	28,850	100	28,850
Tiles Industry	4 *	19,800	10	1,980
Textile dyeing	2	16,800	92.3	15,600
Soft drink filling	1	24,000	7	1,680
Iron galvanization	1	1,800	100	1,800
Total	**16**	**91,250**	**54.70**	**49,910**

Note: DRC Study, June 1997. * Three factories working

The generated wastewater is discharged directly, in most cases, from these factories into the sewer system without any treatment.

Industrial Wastewater Quality

Table 3 shows the results of the analysis program conducted in October 1996 by the Environmental and Rural Research Center at the Islamic University. The results showed that the quality of the treatment plant influent (industrial and municipal wastewater) has the typical character of communal wastewater. The COD/BOD - Ratio is less than 3, indicating that the biological activities of treatment process will be not effected.

Table 3
Average of effluent and influent quality in the Beit - Lahia Treatment plant, October 1996.

Parameter	**Unit**	**Influent**	**Effluent**
Electrical Conductivity	mS/cm	1.55	1.90
pH	-	7.82	8.15
Total Solids	g/l	2.104	1.244
Dissolved Solids	g/l	1.114	0.996
Suspended Solids	g/l	0.990	0.074
Volatile Solids	g/l	1.00	0.27
Fixed Solids	g/l	1.104	0.974
Biochemical Oxygen Demand (BOD_5)	mg/l	590	140
Chemical Oxygen Demand (COD)	mg/l	1570	272
Imhaff	ml/l	18	<0.1
Total Kjeldahl Nitrogen (TKN)	mg/l	115.2	76.0
Fecal Coliform	per 100 ml	10^8	10^5
Chloride	mg/l	285	275

Concerning the industrial effluent in the northern area, there is a limit information about possible contamination compounds (organic and heavy metals) which may be founded in the wastewater of industrial units. However, a previous wastewater analysis program was done for industrial units in Khan Yunis area in the southern part of Gaza Strip by Japan International Cooperation Agency (JICA). Because of the similarities of industries operating throughout the Gaza Strip, this data is enough to give an impression of the industrial wastewater characteristics in Gaza.

The JICA survey results indicated that the concentration of cyanide and heavy metals, such as zinc and chromium, were relatively high in wastewater but the wastewater quantities generated from the industrial unit was low. Nonetheless, the presence of this toxic compound may limit the reuse of effluent for irrigation or groundwater recharge.

Future guidelines

Generally, attention has to be paid to the quality of wastewater discharged into the network, as the quality of raw sewage will effect the biological activities of treatment plants. At the same time, industrial effluent may contain heavy and toxic elements which do not get any treatment in the conventional wastewater treatment process, preventing any applicable use of the treated wastewater and sludge.

As part of the Swedish project for the upgrading of the Beit Lahia treatment plant in the Northern Governorate, the wastewater treatment plant should be operated to treat the effluent for both sectors, municipal and industrial. Regional guidelines, Egyptian and Israeli, are recommended for the connection of the industrial effluent to the network and treatment plant.

Basic requirements

1. The total amount of industrial wastewater must not exceed 10% of the design flow of the northern TP.

2. The daily total organic pollution, expressed as BOD5, must not exceed 10% of the plant load and the concentration must not exceed 500 ppm BOD5.

3. The wastewater should be as easy to treat as the municipal wastewater. This is expressed as a ratio of COD: BOD_5, that should be <3:1 with the total amount of SS not exceeding 10% of the design amount.

4. Liquid wastes should contain pH less than 6.0 or greater than 9.0. and the temperature of the wastewater shall be within the range 5 - 40^{o} C.

5. The total heavy metals should be limited to less than 10 ppm.

Industrial waste guidelines

1. Industrial waste should not include gasoline, benzene (C6H6), oil solvents such as carbon tetrachloride, chloroform, methyl chloride, tri-chloro-ethylene, halogenic ethanes and their kink, combustible oils, and any liquid, solid, or gas that may cause flammable conditions or explode in the sewerage system.

2. Solids of viscous matter in size and quantities likely not to flow smoothly and in so doing cause problems in the purification process, such as: residuals of filter cakes, asphalt, animal carcasses, rubbish, ashes, sand, mud, straw, remnants of industrial chiseling, tree trunk residue, metal parts, glass, rags, feathers, plastic, wood, plastic bags, and other disposable paper or plastic goods should not be connected to the treatment plant.

3. Fats and greasy material such as animal oils, milk, vegetable oils, any kind of mineral oil, and wastes with a concentration below 100 milligrams per liter are likely to cause damage to the sewerage system.

4. Mineral oil or oils with a mineral base for cutting machines known as "soluble oil", creating stable suspension in water, any other kind of oil that is not biodegradable, or any other distillates constituting oil products over 20 milligrams per liter should not be disposed of in the treatment system.

5. Industrial waste should not include cyanides such as CN and other compounds likely to produce hydrogen cyanide in acidic solution in a concentration greater that 20.0 milligrams per liter.

6. Total inorganic and mineral solids dissolved or not dissolved with concentrations greater that 3,500 milligrams per liter and wastes in concentrations less than 3,500 milligrams per liter are likely to cause damage to the sewerage system.

7. Dissolved sulfides in concentrations greater than 0.1 milligrams per liter, chlorohydrocarbon compounds or organophosphorus compounds in concentrations greater than 0.02 milligrams per liter, chlorine or other active halogen in concentrations greater than 3.0 milligrams per liters, and phenols and cresols in concentrations greater than 3 milligrams per liter should not be disposed of into the treatment system.

8. In addition to the above, waste should not include the following stated substances in concentrations greater than those indicated below in **Table 4.**

Table 4
Threshold Level of Heavy Metal Concentrations in Industrial Wastewater (Based on Israeli recommendations)

Substance	Maximum Concentration (mg/1)	Substance	Maximum Concentration (mg/1)
Zinc	5.00	Arsenic	0.25
Boron	3.00	Beryllium	0.50
Vanadium	0.50	Aluminum	25.00
Silver	0.05	Mercury	0.005
Chromium	0.25	Lithium	0.30
Molybdenum	0.05	Manganese	1.00
Copper	1.00	Nickel	1.00
Selenium	0.05	Lead	0.25
Cadmium	0.05	Cobalt	0.25

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Environmental Impact of Tanning Industry in Nablus Area

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Abstract

To identify the composition of wastewater disposed by the tanning industry in the Nablus area, samples of wastewater from two factories were collected and analyzed. The samples were taken from points prior to the disposal of the factories' wastewater into the public wastewater. Without prior treatment, this wastewater is disposed of directly into lowlands and mixes with public wastewater where it reaches and pollutes fresh water resources such as springs and aquifers. Despite this level of pollution, some farmers use these water resources to irrigate their crops. Another potential hazard of such wastewater is the penetration through cracked rock layers, enabling it to drain and pollute ground water. Ultimately, these hazardous substances may reach the human body either directly through contaminated water, or indirectly through the food chain.

Introduction

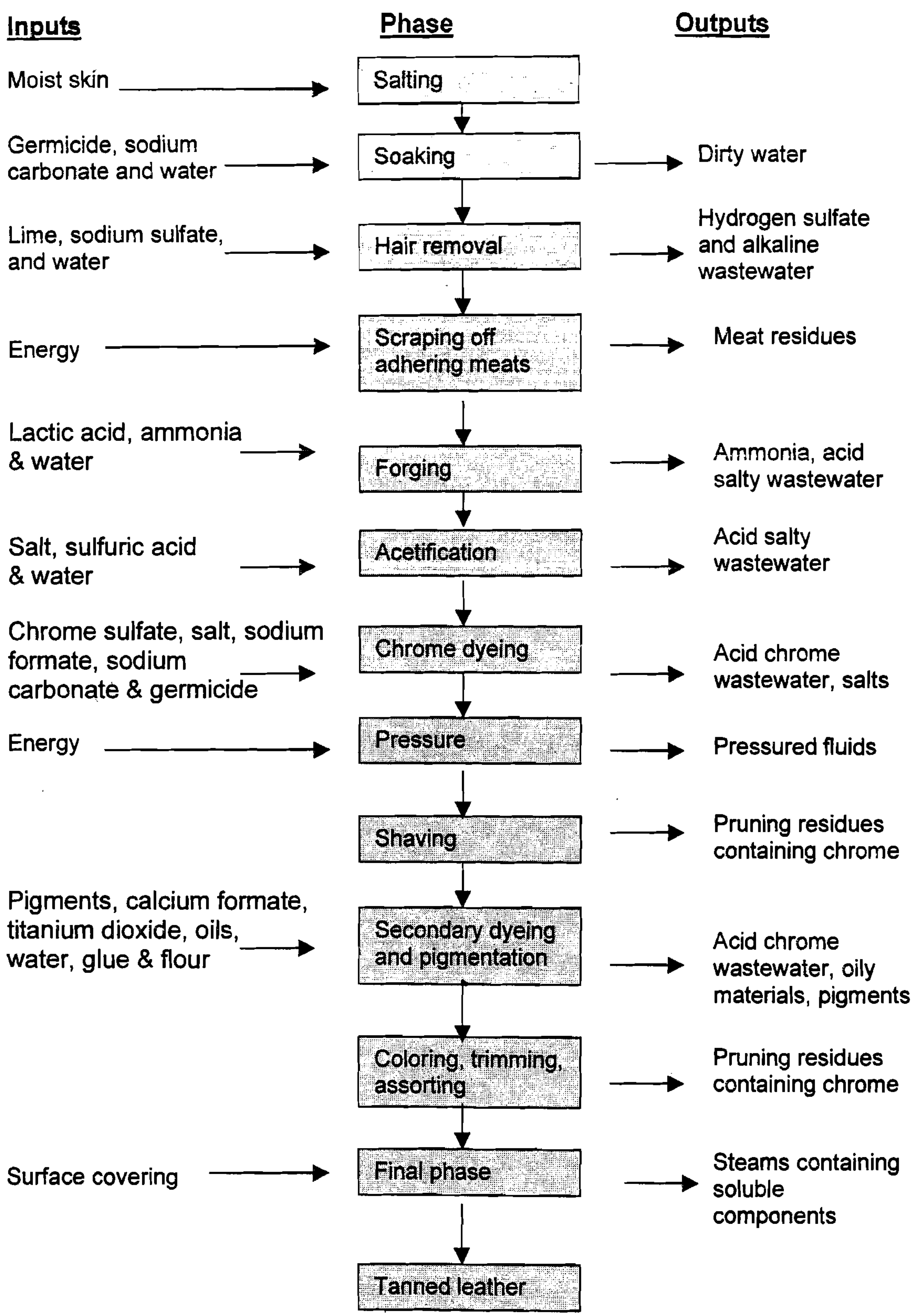
Domestic and industrial wastewater is largely disposed, with or without treatment, into main water resources. The pollution of these resources leads to a change in their quality. Such change can be significant, causing serious damage to the water resource, or mild and insignificant. Length of pollution effect may vary as well, depending on the resource type and level of pollution. Some polluting agents can be easily eliminated by natural processes within the resource while others are more stable and may last for decades.

For ages, surface water resources such as rivers, lakes, and floods have been the most available and accessible water resources for various types of human use. At the same time, they are the most affected by waste disposal. Groundwater has also been exploited for human use as a source of clean water. Although it exists deep under the ground, it too has been exposed to polluting agents that reach it through cracked rock layers.

Generally, all kinds of wastewater have adverse effects on the environment. However, industrial wastewater has the most damaging effect. The process of leather production and tanning has a significant role in adversely affecting the environment, as it employs the use of some poisonous chemicals. In this process, raw animal skin, a renewable natural resource, is transformed into leather through a number of phases. Phases of leather production include cleaning, tanning, and dyeing. Each of these phases produces polluting agents such as acid wastewater, hazardous solid wastes, and hazardous emissions, all of which are released directly into the environment. Overcoming the environmental problems resulting from these agents may prove very difficult. **Figure 1** illustrates the different phases involved in the production process, including inputs and outputs of each phase.

Surface and groundwater systems in the West Bank depend on the geological conditions and composition of the setting in which water runs or collects. In ancient geological ages, seawater overflowed the area several times, causing a number of recessions and alterations in the seashores. In addition, the earth's activity in the area caused the formation of large crevices, depressions, various folds, and volcano eruptions. The formation of the geological depression in Jordan Valley and Dead Sea has a significant effect on the situation of groundwater and surface water in the West Bank. This depression acts as a natural drainage system for water resources. The continuous earth activity caused the formation of a number of earth crevices with secondary fissures. These fissures increased the permeability of the rock layers containing groundwater and facilitated the formation of natural flood systems.

Figure. 1. Phases of tanning industry



Area of Study

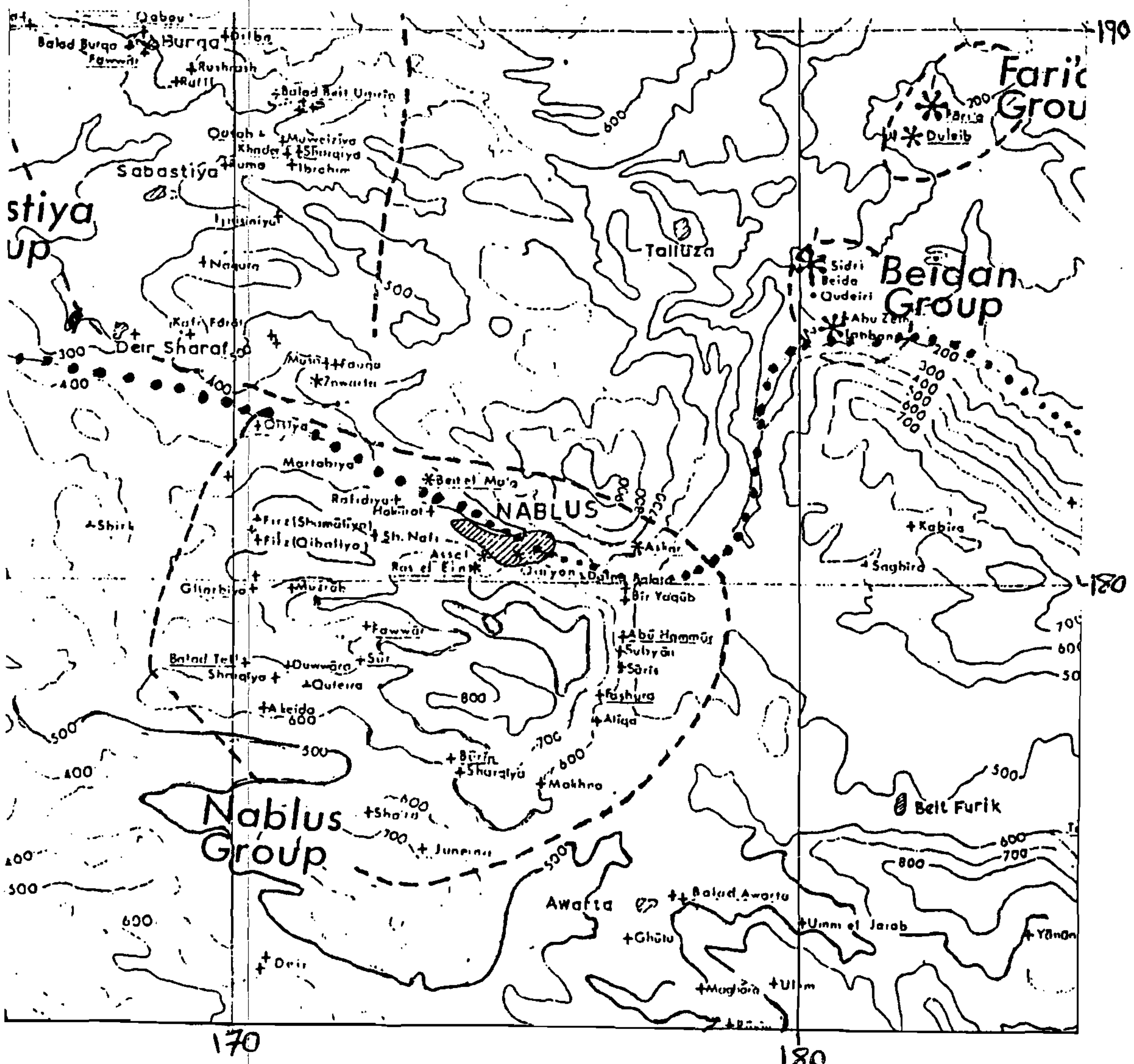
Nablus city, the most populated Palestinian city and the main commercial center for the West Bank, is located in a valley between Jerzim and 'Eibal mountains on an altitude of 425-900 m above sea level (**Figure 2**). The municipality borders include the areas of Balata, 'Askar, Kufr Qalil, and Rafidia. The city hosts many factories and workshops of various industries such as tanning, textile, oils, and others.

The area is covered with carbonic precipitate rocks that go back to the times between the lower Cretaceous period (area of Far'a Valley) and the Eocene. These rocks are formed mostly of calcareous stones, dolomite, cretaceous rocks, and marl with some elements of mudstone. The geological map of the area is presented in **Figure 3**. In terms of its geological composition, the area is located within the southern borders of the Nablus-Jenin concave, enclosed between Far'a convex in the east and 'Anabta convex in the west. These folds are the most important geological features of the area, largely influenced by fissures and cracks. Some of the geological compositions form groundwater systems, especially Jenin Subseries and the Higher and the Lower Senomany. Exposed areas of these compositions are their main feeding points where parts of rainwater drain to groundwater through cracked and fissured rocks. Parts of this water system appear in the form of springs such as Far'a, Beidan, Nablus, and Sabastia springs. Other parts are drawn out through wells.

According to natural surface runoff systems, the city is divided into two drainage areas, the eastern and western basins. Water in the eastern basin runs through valleys and lowlands in the city center to the east, while mixing with spring water of Far'a, Beidan and others, eventually streaming into the Jordan River. Water in the eastern basin runs from the western part of the city through Zimar (Tuffah) Valley and through the towns of 'Anabta and Tulkarem to the west.

Although both drainage areas are fed directly by fresh spring water scattered in the area, they also mix with domestic and industrial wastewater. Thus, spring water becomes polluted and unsuitable for human use, whether as drinking water or in agriculture. Despite these risks, some area farmers still use this water in irrigating their crops.

Fig. 2. Topographical Map (after Rofe and Raffety, 1965)

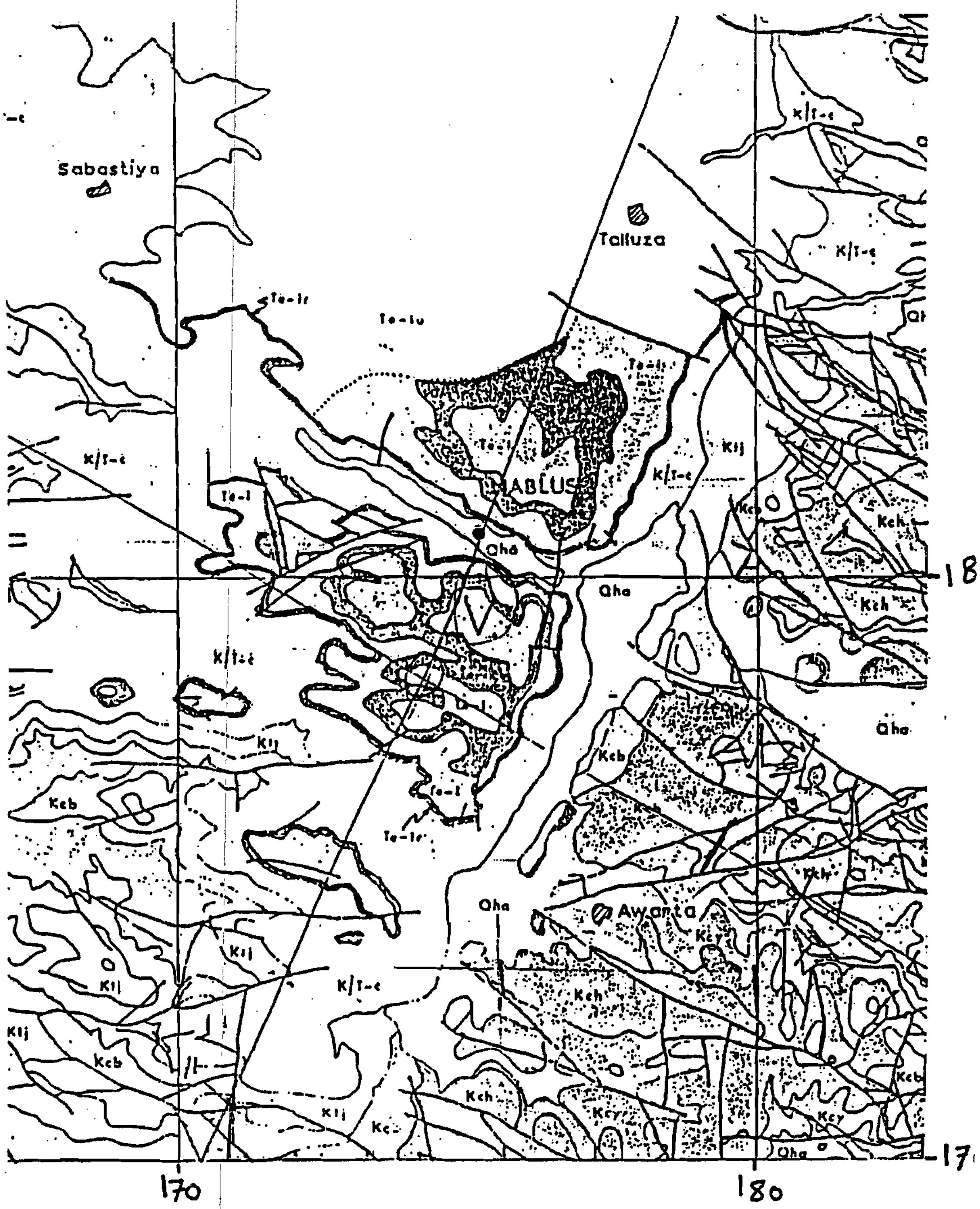


Legend:

* Spring

.... Main Valley

Fig. 3. Geological Map (after Rofe and Raffety, 1965)



Legend:

Te - lu :	Jenin Subseries.	Kcp	: Hebron Formation.
K/t-c :	SenonianChalk.	kCY	: Yatta Formation.
Ktj :	Jerusalem Formation.	Qha	: Alluvium.
Kcb :	Beithlehem Formation.		

Purpose of the Study

The aim of this study is to identify sources of pollution in floodwater in the valleys. The tanning industry was selected because of its use of chemicals that can be identified and measured through its wastewater. For this purpose, two tanning factories were selected for testing their wastewater. The first factory is located in the eastern part of the city and carries out all phases of the tanning process, disposing its refuse in valleys running to the east. The second one is based in the western part and carries out the initial phases of tanning only, disposing its wastewater in Zimar Valley running to the west.

Discussion

Water resources' pollution may occur from a variety of sources. Industrial wastewater is considered one of the main causes of such pollution. Disposing hazardous components of industrial wastewater, such as those of tanning industry, into water resources has serious impact on humans — although indirectly, through food chain — as well as on other uses of surface water. Main components of this industrial wastewater were analyzed, including electrical conductivity, soluble salts, pH, calcium, magnesium, sodium, potassium, chloride, sulfates, bicarbonates, and nitrates. Additionally, analysis was conducted on common hazardous elements of industrial wastewater including zinc, chrome, cadmium, nickel, cyanides, manganese, phosphates, and ammonia. Concentration of these elements in direct wastewater from the two factories is shown in **Table 1.**

Table 1
Concentration level of some chemicals in wastewater of tanning factories in Nablus (mgm/l)

Element	First Factory	Second Factory
EC	55,400	1,342
TDS	22,180	959
P.H	3.57	7.32
Ca	54.2	4.2
Mg	9.8	1.6
Na	42.15	8.45
K	1.78	0.11
Cl	424.63	8.37
SO_4	65.98	0.27
HCO_3	0	5.32
NO_3	15.02	0.19
Zn	7.88	0.13
Cr	0.09	0.01
Cd	0.129	<0.005
Ni	0.896	<0.005
As	0.896	<0.005
Mn	<0.005	<0.005
PO_4	102.56	0
NH_4	681.72	1.19

Results indicate that wastewater from the first factory contains very poisonous elements that are unsuitable for human use. Such elements should not be released into valleys, floods, or other water collections. Any use of such elements may cause serious effects and diseases that are difficult to treat. This is in addition to their adverse effect on the environment. **Table 2** shows the Jordanian standards for allowed concentration of some elements in industrial wastewater.

Table 2
Jordanian standards for industrial wastewater disposed in valleys and floods (mgm/l)

Element	Reuse in irrigation	Natural feeding of groundwater	Disposal to the sea	Disposal to floods, rivers, valleys and water collections
TDS	2000	1500	---	3000
P.H	6.5-8.4	6.5-9.0	5.5-9.0	6.5-9.0
Ca	<400	<400	---	<400
Mg	<60	<60	---	<60
Na	<230	<230	---	<230
K				
Cl	350	500	---	500
SO_4	400	500	---	500
HCO_3	500	---	---	---
NO_3-N	30	12	---	25
Zn	2	15	---	15
Cr	1	0.05	0.3	0.1
Cd	0.01	0.02	0.07	0.01
Ni	0.2	0.1	0.02	0.2
As	0.1	0.05	0.1	0.05
Mn	0.2	0.2	0.2	0.2
PO_4	---	---	---	15
NH_4	5	5	12	5

Note: Center for Water and Environmental Research, 1993.

Furthermore, the drainage of this wastewater to groundwater basins through cracked rock layers poses a serious risk of contaminating groundwater which is considered the main water resource for the area.

Results

Based on the above, the main points of this study are:

1. Industrial wastewater is considered among the most serious cause of water pollution in the area.

2. When surface water is mixed with industrial wastewater, the water becomes largely polluted and unsuitable for any kind of human use.

3. Draining of these polluting agents to groundwater destroys the main reservoir of water resources in the West Bank.

4. These hazardous agents may reach human body through the food chain.

Recommendations

1. Elements that have hazardous potential and adverse impact on the environment should be monitored in terms of their introduction to the area, their use, and disposal.

2. A special treatment system should be installed within factories that utilize dangerous chemicals, with proper follow-up by relevant bodies.

3. Research on crops irrigated by wastewater is needed.

4. When wastewater treatment plants are installed, consideration should be given to the environmental conditions of the area and type of wastewater to be treated.

5. When treatment plants are available, studies will be needed to identify the types of crops that can be irrigated by the treated wastewater and the long-term impact of treated wastewater on soil and groundwater.

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Summary of Discussion

- Different papers presented contradictory figures regarding the number of industries, water quantities, and resources. Although it looks odd, participants argued that this can happen as the area is new and as there is not a Palestinian information referral body that assures the validity and reliability of figures. The issue of concern for Palestinian researchers and professionals becomes how to judge the validity and reliability of data.

- The issue of industrial wastewater can not be separated from the issue of water scarcity in Palestine. In fact, we can not neglect the Israeli control over Palestinian water resources but we have to look at the different usage patterns of available water to plan for present and future projections. As related to water use in industry, classification of industries according to their water demand is not available, particularly because almost all industries utilize potable water supplies. Some industries may not require such water. Research and information is limited in the area of water quality needed for different industries.

- Some papers calculated amounts of industrial waste but the conceptual and theoretical considerations were not clear.

- The papers that presented case studies of pollutants and possible treatment measures were of benefit. However, the application of these measures on a larger scale faces many obstacles related to political, economic, awareness, and legislative factors. Yet, the research and pilot treatment projects are positively valued.

- Pollution generated by Israeli industries in West Bank settlements was the topic of importance at the political advocacy levels. More case studies on this topic are needed for both environmental management and political concerns. Additionally, it is important to note that some of the areas surrounding settlements are used for grazing without the farmers knowing the pollutants' effect on their cattle and sheep, as well as on themselves.

Recommendations

The topic of industrial wastewater and its impact on the environment and public health is not isolated from general Palestinian environmental and public health concerns. In order to overcome the existing environmental and public health problems attributed to industrial wastewater impact on the environment and public health, we can not neglect the general Palestinian situation. In this respect some of the recommendations proposed by the participants were general, addressing the general situation in Palestine.

The recommendations were classified into three main areas:

1. **Environmental Policies.** By which we mean the general national policies that exert a basis for disposition and practical measures.
2. **Practical measures.** Defined by the steps which are taken aiming at damage control on the basis of special decisions until laws are approved and the basis of their execution are developed.
3. **Facilitating mechanisms.** The measures and actions that facilitate the implementation of practical measures and improvement in performance.

1. Environmental Policies

The approval of the Palestinian Environmental Law and the development of environmental guidelines and standards are considered the main issues for Palestinian Environmental Policy.

Palestinian Environment Law

Importance: The presence of laws and legislation concerned with the protection of the Palestinian environment is recognized as the basis to assure environmental safety in Palestine. What is faced now from environmental destructive actions can be overcome upon the approval of the law and the suitable mechanisms to apply it.

Present situation: More than one institution participated in the development of the Palestinian Environment Law. The law was revised and went for a third reading by the Palestinian Legislative Council (PLC). It is expected approve this law.

Responsible bodies: PLC, (Diwan al-Fatwa and al-Tashrie‘) and the Ministry of Environmental Affairs.

Guidelines, specifications, and standards

Importance: Emphasis on establishing procedures to cope with industrial waste. Palestinian appraisal and review of what has been developed regionally and internationally. The law and standards are related. The law states the principles and the standards specify the maximum limits allowed, considering the impact on the environment and public health. Thus the standards can be one important tool in stressing the law.

Present situation: The main body responsible for developing and approving standards is the Palestinian Institution for Standards and Specifications. This institution coordinated with different bodies. The draft of the specifications and standards of industrial wastewater has been prepared by the Palestinian Institution for Standards and Specifications and the technical specifications of disposal systems was developed by the Water Authority.

Responsible bodies: Palestinian Institution for Standards and Specifications, Ministry of Industry, MEnA, Water Authority, Ministry of Health, research institutions.

Expectations: Continue working on the development of standards and specifications through a review of what was developed regionally and internationally with emphasis on the Palestinian situation.

2. Practical Measures

Damage control in dealing with dangerous materials

Importance: By dangerous materials, we mean the materials that are hazardous, either containing dangerous compounds or producing them through reactions with other materials or those wastes generated from industries.

Present situation: MEnA is following dangerous materials imported to the Palestinian areas as stated in peace agreements. At present, MEnA is in the process of developing a unit to monitor industries. This unit is to be responsible for inspecting and monitoring dangerous materials.

Expectation: Suitable follow-up and appropriate measures until the approval of the law. Additionally, development of human resources in the area of monitoring dangerous materials. It is important to focus on finding means and tools to control dangerous materials entering the Palestinian areas through Israel. Additionally, constructing environmentally and public health safe sites for dangerous material disposal.

Concerned bodies: MEnA, Ministry of Industry, Ministry of Health, National Security Forces.

Considering environmental concerns in approving licenses

Importance: Minimize environmental problems resulting from industrial development in Palestine.

Present situation: Environmental concerns have not been considered in the licensing process for industrial projects. The past practice of the Department of the Civil Administration was to grant licenses to industrial projects regardless of their environmental impact in order to promote the growth of Palestinian economy. This was an attempt to oppose the unofficial Israeli policy of preventing the development of an independent Palestinian economy. As a result, licenses were given to firms within residential areas, or for industries that seriously pollute the environment without stipulating waste treatment. This is the case at present. Additionally, some Palestinian industries are connected to Israeli industries through sub-contracting. Also, the Israelis moved some industries that are hazardous to the environment and public health to Palestinian areas in the West Bank and Gaza Strip. This has resulted in some negative impacts of industries on the environment and public health such as:

- Environmental Impact Assessments are conducted on a limited scale.
- Environmental Audits for existing industries are not conducted at all.
- There is no evaluation for the quality and quantity of industrial waste.
- There is no on-site treatment for industrial liquid waste. The waste is discharged either through the municipal sewerage networks or into septic tanks. Contents are disposed of into open valleys without any consideration of environmental and public health impacts.

In order to overcome such problems, it is important to focus on:

1. Stipulating Environmental Impact Assessments for newly proposed industries.
2. Stipulating Environmental Audits as a prerequisite for license renewal.
3. Enforcing zoning classifications.
4. Coordination among different bodies concerned with licensing to incorporate environmental requirements.
5. On-site waste treatment.
6. Concentrating similar industries in one area to make treatment easier and economically feasible, enabling several firms to share one treatment plant.
7. Work towards improving and upgrading laboratory facilities for testing and studying industrial wastes in the Palestinian areas.

Expectation: Human resource development in conducting environmental impact assessment and environmental audits. Joint efforts of concerned bodies and industries to construct appropriate on-site waste treatment plants. The responsible bodies would provide technical assistance in the beginning to encourage industries to construct and operate such plants. Training of human resources in environmental impact assessment and audits has already started at MEnA.

Responsible bodies: MEnA, Ministry of Industry, Ministry of Health, Industrial managers.

Raising awareness of the policy makers

Importance: Informing policy makers and the public about the environmental impact of industrial projects promotes sound policy decisions and strengthens sustainable development.

Present situation: The concept of sustainable development is relatively new in the Palestinian context. Efforts have been made to raise the awareness of policy makers to the environmental dimension of sustainable development. At the level of industries, it is neglected. Public awareness projects have been launched through mass media but these projects are limited and in need of further development.

Responsible bodies: MEnA, NGOs, mass media institutions.

Restricting irrigation with untreated wastewater

Importance: Irrigation with untreated wastewater is still practiced on a large scale in the Palestinian areas. This is attributed to two main reasons, first limited water resources available for irrigation due to Israeli control over water resources. Second, there is no wastewater treatment plants in large Palestinian communities and where they do exist, the plants are not operating properly. Wastewater irrigation is a major cause of crop contamination.

Present situation: Both the Ministries of Health and Agriculture stated a decision that restricts wastewater irrigation. However, monitoring and follow-up procedures are still not regular.

It is important to focus on: Follow-up and monitoring the execution of decisions related to restricting wastewater irrigation.

Responsible bodies: MEnA, Ministry of Health, Ministry of Agriculture, NGOs working in agriculture and environment.

Israeli industries in the Palestinian areas

Importance: A variety of Israeli industries located in Israeli settlements and bordering Palestinian areas generate dangerous wastes that are disposed of in Palestinian areas, among the Palestinian communities, leading to environmental destruction and imposing public health risks.

The areas of waste disposal are agricultural, grazing, and even residential. There is no precise estimation of the quantity and quality of such wastes at the national level. However, some Palestinian institutions have already conducted case study research for some locations. The results revealed that these wastes contain high amounts of hazardous materials.

Expectation: This issue may be solved through Israeli- Palestinian negotiations. Nonetheless, it is totally neglected by the Israeli side.

It is important to focus on: Advocacy campaigns at the local and international levels. The campaigns need to focus on the environment and Palestinians' public health. Awareness campaigns should target farmers and cattle and sheep raisers regarding the use of polluted and contaminated areas.

Responsible bodies: MEnA, Ministry of Agriculture, environmental and public health research institutes, Media, and NGOs.

Development of an environmental database

Importance: The initiation of a database on environmental issues and concerns would provide planners and policy makers with reliable information. Additionally, this body can mitigate the generation of contradictory figures related to environmental issues.

Present situation: A number of governmental and non-governmental organizations conduct different pieces of research on environmental and environmental health issues. Yet there is no referral body to assess the validity and reliability of these studies. Recently, the Palestinian Central Bureau of Statistics (PCBS) developed a unit specializing in generating environmental statistics and has produced a number of publications in 1998-99.

It is important to focus on: Collecting the different pieces of research on environmental issues and make them accessible to researchers and planners. This requires the development of an environmental research network among the local institutions so as to coordinate research activities and the sharing of information.

Responsible bodies: PCBS, MEnA, MoPIC, Water Authority, Ministry of Health, Ministry of Industry, research institutes, and universities.

3. Facilitating mechanisms to execute recommendations

- Accelerating collaboration among the different governmental and non-governmental institutions concerned with the environment and public health.
- Working towards human resource development in the different areas raised in the recommendations.
- Encouraging and developing research on industries and environmental concerns. Seeking funds for research.
- Review the available information and data on industrial wastes and classify them.

Concluding Remarks

It was clear that different researchers and professionals in the area of industrial pollution and management worked in isolation from each other. Some worked as governmental officials, NGO researchers, or university academics. Others conducted their research as part of certain infrastructure development projects. The vision of research and studies into this area is thus related to the type of work and mission each does and does not refer to a national vision and strategy.

This raised an important question related to research into this area involving research subject, question, methodology, and most importantly, how to have reliable and valid data in developing present and future research, not only in relation to industrial wastewater, but also to research concerned with environmental and public health issues.

Even so, raising the issue of industries and environmental management with the participation of professionals from different backgrounds and work experience opened the gate towards more extensive discussion and joint efforts towards a clearer vision and strategy development in the future.