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The Impact of Gishouri Factories on Soil Pollution in Tulkarm Area: A Case Study

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Abstract Gishori Industrial Complex is considered the most significant source of pollution in Tulkarm. Industrial by-products including gas, solid and liquid wastes are being released continuously in the region, affecting not only the health of more than 75000 people, but also agriculture and environment in the governorate. In recent years, several studies were conducted to highlight the impact of Gishori Industrial Complex. The aim of this work is to highlight and provide an indication of the negative environmental impact of Gishori Industrial Complex on Tulkarm city. This work represents an impact of Gishori Industrial Complex pollutants, such as heavy metals for example (B, Ni, Pb, Cu, Cd, Fe, Cr, Mn, Co and Zn) on soil. Eight soil samples were collected on July 3, 2015 from different sites within the target area to describe the effect of Gishori Industrial Complex on soil pollution. The results showed that the concentrations of these elements were higher than allowed in areas close to the factories. Pb, Ni and Zn were highly detected in soil samples (29.3, 51.3 and 218.1 p.p.m (part per million) per kilo gram, respectively). In conclusion the Gishori Industrial Complex have a negative impact on soil and environment. It is recommended to extend the study for taking into consideration the number of samples, the season of the year and the peak time during which the factories are in operation.

Keywords Soil, Pollution, Tulkarm, Heavy metals

1. Introduction

1.1. Background

The city of Tulkarm is located in the northwest of the West Bank, south to Jenin, west to Nablus and adjacent to the "Israeli segregation wall". The current population for the Tulkarm municipality, which includes the city, the localities and the Tulkarm refugee camp, is estimated at approximately 86,312. Population increase is a fundamental parameter that will affect future municipal, industrial, and agricultural water needs [1].

One of the most environmental hazards in the city stems is from the Nitzanei Shalom industrial zone known as Gishori Industrial Complex that located in between Tulkarm and the Israeli village on the eastern side of the Green Line in the West Bank (Figures 1&2).

These factories have become the source of continuous nightmare to the surrounding Palestinian communities due to the environmental and health disasters it is producing on daily basis. [2].

Since the 1980s, several factories for the production of pesticides, insecticides and agriculture fertilizers that cause pollution have been relocated from Israel to areas in the Occupied Palestinian Territory (OPT). Most prominent of these is Gishori, a privately owned Israeli agrochemicals company operating in Tulkarm, West Bank.

Results of several empirical studies suggest that due to proximity to industrial zones, Gishori and other factories that cause pollution, residents of Tulkarm are among those with the highest rates of cancer, asthma, and eye and respiratory health anomalies compared with residents in other districts. Because of the paucity of qualitative data to show the effect of polluting industries, our aim is to build a framework to understand the perceived adverse role of industrial pollution on the environment, economy, and public health of Tulkarm residents [4].

These pollutions and the general unhealthy conditions are very likely to be responsible for a variety of some of the most severe diseases of residents living in direct proximity to the factories. A survey-based study from 2009 found that the amount of individuals living in direct neighbourhood to the factories suffer from respiratory diseases at a more than 3-fold rate of that in the control group, and that the occurrence of eye- and skin-related diseases was increased as well [5]. An alarming number is the fact that out of all affected individuals roughly one in four is between 0-10 years of age.

Indeed, an overall adverse health situation of the entire population of the Tulkarm area as a whole can be observed. The population of the city of Tulkarm is drastically suffering

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from various chronic diseases, the causes of which are still unknown, but there is a great suspicion about environmental pollutants emitted by the Israeli in the region for more than 24 years [6].

A study conducted by An-Najah National University, Palestine investigated the cancer incidents between 2005–2008 and found that the cancer rate in Tulkarm district is 28% above the average in the West Bank [7].A second study found that the rate of lung cancer, in particular, in Tulkarm is 28% above the West Bank average as well [8]. The authors link the increased cancer rates to the high prevalence of industrial fumes caused by the Gishori factories.

1.2. Problem Statements

Soil pollution is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health [9]. Or an undesirable change in the physical, chemical and biological characteristics of soil, which affect human life, lives of other useful living plants and animals, industrial progress, and living conditions.

There is an urgent need to control the soil pollution in order to preserve the soil fertility and increase the productivity of the land near Gishori industrial Complex.

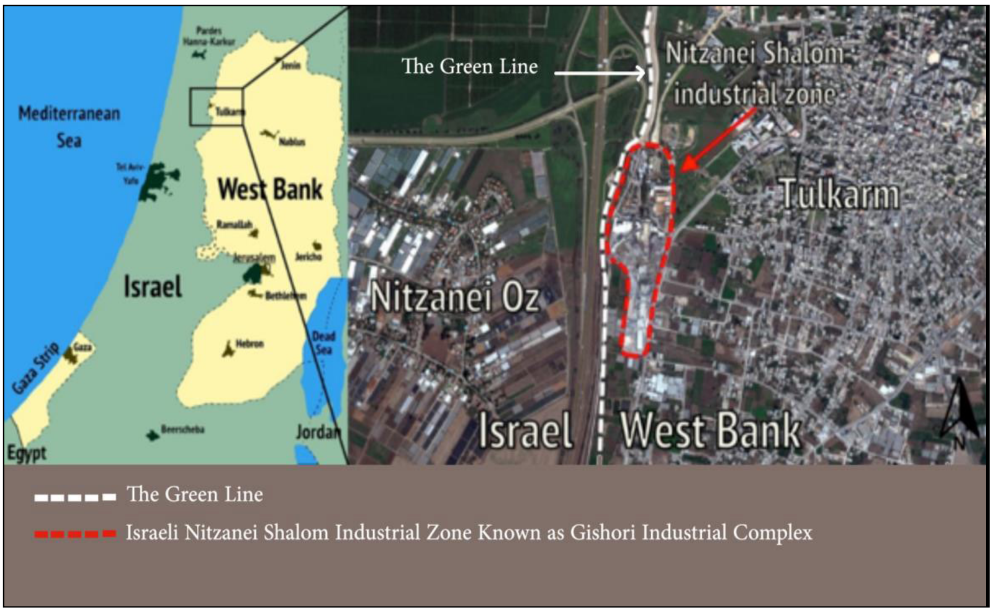

Figure 1. Geographical location of the Gishori Industrial Complex (Nitzanei Shalom industrial zone). Source: [2]

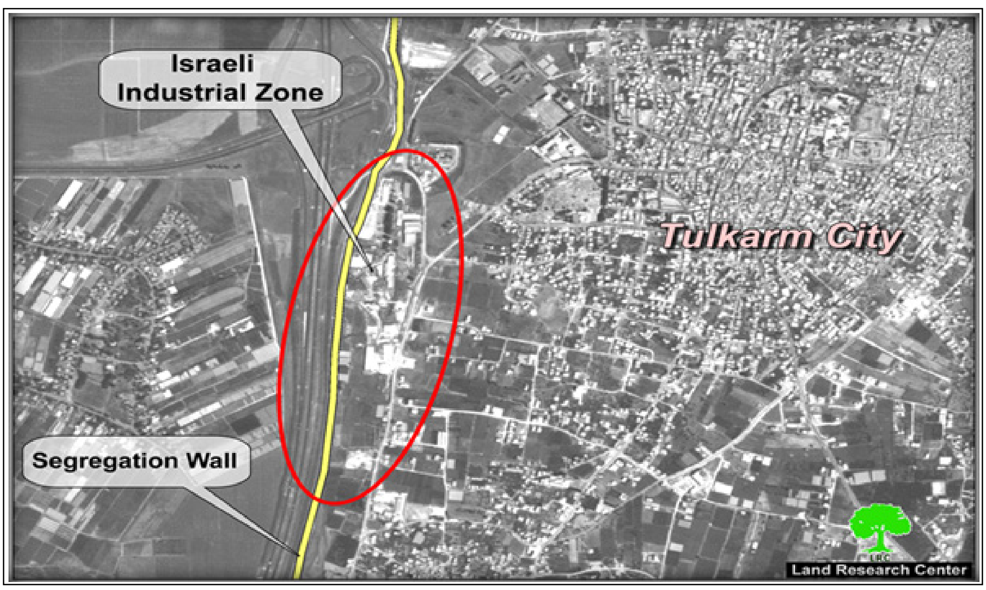

Figure 2. Airplane image for Gishori industrial zone. Source: [3]

About one fifth of the agricultural land in this area is being chemically contaminated. Nearby areas suffer from low productivity, soil being contaminated where its fertility and productivity decreased because of hydrocarbon pollutants, acid rain, and wastewater plants that pour untreated sewage into surrounding agricultural land. The liquid waste from Israeli factories is released freely to the valleys thus lead to leakage of these residues into the groundwater and contaminating the groundwater resources (Al-Khalil, 2009). Inorganic residues in industrial waste cause serious problems as a result of their disposal to the environment. They contain metals which have a high potential for toxicity. Industrial activity also emits large amounts of arsenic fluorides and sulfur dioxide (SO_2) [10].

1.3. Sewage and Sludge

Soil pollution is often caused by the uncontrolled disposal of sewage and other liquid wastes resulting from domestic uses of water, industrial wastes containing a variety of pollutants, agricultural effluents from animal husbandry and drainage of irrigation water and urban runoff [11]. Irrigation with sewage water causes profound changes in the irrigated soils. Amongst various changes that are brought about in the soil as an outlet of sewage irrigation include physical changes like leaching, changes in humus content and porosity, chemical changes like soil reaction, base exchange status, salinity, quantity and availability of nutrients like nitrogen, potassium, phosphorus, etc. Sewage sludge pollutes the soil by accumulating metals like lead, nickel, zinc, cadmium, etc. This may lead to the phytoxicity of plants [12].

1.4. Heavy Metal Pollutants

Heavy metals are elements having a density greater than five in their elemental form [11]. They mostly find specific absorption sites in the soil where they are retained very strongly either on inorganic or organic colloids. They are widely distributed in the environment, soils, plants, animals and in their tissues. These are essential for plants and animals in trace amounts. Mainly urban and industrial aerosols, combustion of fuels, liquid and solid from animals and human beings, mining wastes and industrial and agricultural chemicals are contributing to the heavy metal pollution. Heavy metals are present in all uncontaminated soils as the result of weathering from their parent materials. In agricultural soils, however, the concentration of one or more of these elements may be significantly increased in several ways, like through applications of chemicals, sewage sludge, farm slurries, etc. Increased doses of fertilizers, pesticides or agricultural chemicals, over a period, add heavy metals to soils which may contaminate them. Concentrations of heavy metals in soils and plants are given in Table 1.

1.5. The Objectives of This Research are

- Study the effect of Gishori Industrial Complex on general land quality in the Tulkarm area, especially in adjacency to the factories.
- To assess the heavy metal concentration (B, Ni, Pb, Cu, Cd, Fe, Cr, Mn, Co and Zn) and accumulation on soil that results from different wastes (gas, solid and liquid) of Gishori industrial Complex Study the effect of Gishori industrial Complex on soil pollution and soil deterioration in the study area.

2. Material and Method

Eight soil samples were collected on July 3, 2015 from different sites within the target area to describe the effect of Gishori Industrial Complex on soil pollution as shown in Figure 3. Each sample consisted of 500 g as a representative sample; it was taken from a soil depth of about 0-20 cm and filled in plastic bottles to evaluate the concentration and accumulation of (B, Ni, Pb, Cu, Cd, Fe, Cr, Mn, Co and Zn) heavy metals.

Table 1. Heavy metal concentration in the lithosphere, soils and plants (µg/gm dry matter)

Sl. No.	Heavy metal	Lithosphere	Soil range	Plants
1.	Cadmium (Cd)	0.2	0.01-0.7	0.2-0.8
2.	Cobalt (Co)	40	1-40	0.05-0.5
3.	Chromium (Cr)	200	5-3000	0.2-1.0
4.	Copper (Cu)	70	2-100	4-15
5.	Iron (Fe)	50,00	7000-5,50,000	140
6.	Mercury (Hg)	0.5	0.01-0.3	0.015
7.	Manganese (Mn)	1000	100-4000	15-100
9.	Nickel (Ni)	100	10-1000	1
10.	Lead (Pb)	16	2-200	0.1-10
11.	Tin (Sn)	40	2-100	0.3
12.	Zinc (Zn)	80	10-300	8-100

Figure 3. Soil sampling sites

Table 2. Heavy metal results for analyzed soil samples in the study area

Soil No.	1	2	3	4	5	6	7	8
Part per million (ppm)								
B	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ni	38.4	51.3	49.9	48.7	38.3	33.3	43	27.2
Pb	29.3	10.2	12.3	22.4	22.6	13.5	12.4	8.3
Cu	36.1	28.7	31.6	46.4	29.4	34.3	38.6	15.1
Cd	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Fe g/kg	24.94	29.83	28.83	30.47	19.48	20.38	17.73	17.75
Cr	59.7	72	70.4	76.6	50.4	55	63.5	39.1
Mn	747.8	914.4	1010	911	631.2	547.1	552.6	475.6
Co	16.5	21.3	22.6	21	13.1	12.2	11.5	10.9
Zn	218.1	169.1	124.9	21.3	122.7	125.6	114.2	57

n.d: not detected

After sampling, the soil samples were spread out on a metal tray and subjected to the following preparation steps:

- Removing stones
- Large aggregates were broken up
- Pieces of organic matter were discarded

After this preliminary preparation procedure, the samples were air-dried, crushed and sieved through a 2 mm sieve. Finally, the prepared samples were potted in plastic bowl for analysis.

The analysis of the soil samples was carried out according to the ICP-method in the environment unit at Birzeit University testing laboratories on September 12, 2015 [13].

3. Result and Discussion

The results in Table 2. Show the analysis for eight soil samples by ICP method. Different data for the heavy metal concentration and accumulation in the area under study contain are shown:

Boron (B) and Cadmium (Cd)

The results in Table 2 show that there is no B nor Cd detected in the soil samples collected from the area under study which means that there is no effect from the two heavy metals on soil or pollution occurred in the target area.

Nickel (Ni)

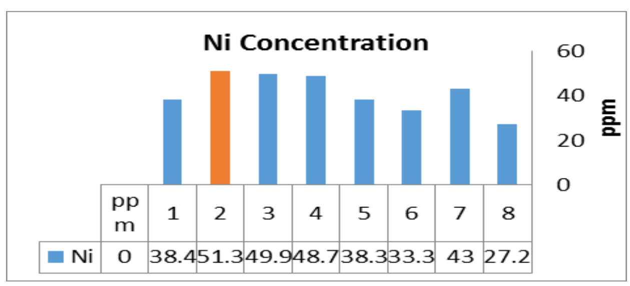

Figure 4. Nickel (Ni) accumulation for soil samples under study

The result in Table 2 show that there an effect for the Ni concentration in all soil Samples analyzed. The data show that there is high concentration in the soil samples were collected from the land besides and near the Gishori factories; especially in sample 2. Ni decreased in the soil samples analyzed in the far area from Gishori factories; especially in the last sample 8, as shown in figure 4.

Lead (Pb)

The soil samples analyzed show that the Pb concentration was increased in the land that belongs to Gishori factories; especially in the first sample, and decreased in the far area of our study; especially in the last and far sample. This means that there is a pollution with lead in land near Gishori Industrial Complex as shown in figure 5.

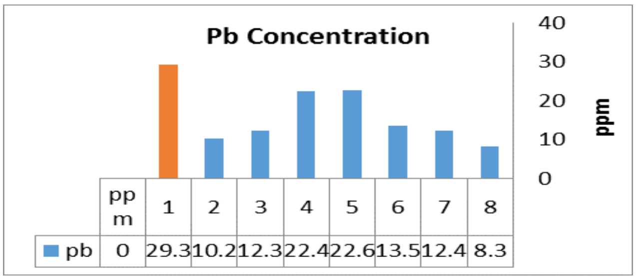

Figure 5. Lead (Pb) accumulation for soil samples under study

Copper (Cu)

Copper concentration in soil samples analyzed show different results. It was significantly high in all samples; especially in sample number four. The last and far soil sample has a decreased value which means that there is an effect on the soil in the area under study; hence the higher Cu concentration detected as shown in figure 6.

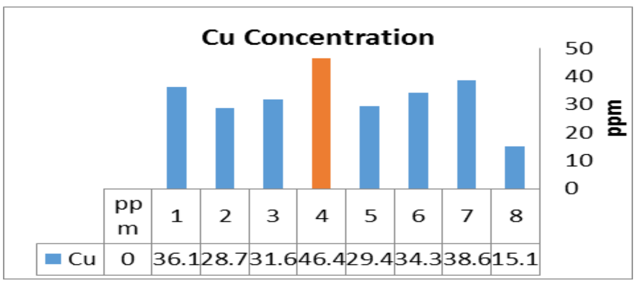

Figure 6. Copper (Cu) accumulation for soil samples under study

Iron (Fe)

Fe concentration was taken from two ranges: in the first four samples obtained from the land close to Gishori factories, the values were high in concentration. The concentrations for the other four samples were decreased depending on the distance from Gishori Industrial Complex where the final point under study gave the lowest value among all results, which means that there is an influence for the factories on the increase of Fe concentration in the area under study, as shown in figure 7.

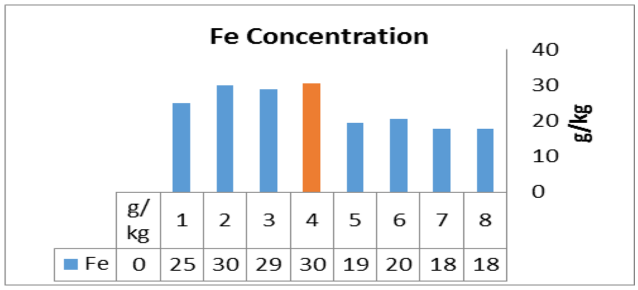

Figure 7. Iron (Fe) accumulation for soil samples under study

Chromium (Cr)

Cr concentration was taken two evaluation: in the first four samples obtained from the land close to Gishori factories, the values were high in concentration; specifically soil number four which contained the highest concentration. The concentrations of the other four samples were decreased with more distance from Gishori factories, where the final point under study gave the lowest value in the result. That means there is cause to increase Cr concentration in area under study, as shown in figure 8.

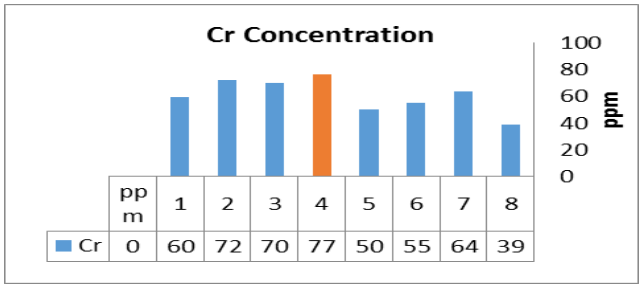

Figure 8. Chromium (Cr) accumulation for soil samples under study

Manganese (Mn)

Mn concentration was increased in the first four samples obtained from the land close to Gishori factories. Measured values were high and soil number three gave the highest concentration. The other four samples showed a decrease concentration with more distance from Gishori Industrial Complex was, and the final point under study gave the lowest value in the results which means that there is a cause for the increase of Mn concentration in the area under study, as shown in figure 9.

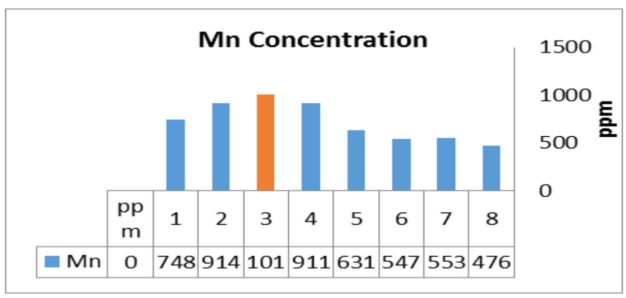

Figure 9. Manganese (Mn) accumulation for soil samples under study

Cobalt (Co)

Co concentration was increased in the first four samples obtained from the land close to Gishori Industrial Complex where the measured values were high and soil number three displayed the highest concentration. The values of the other four samples were decreased the more the distance from Gishori Industrial Complex and the final point under study gave the lowest value in the results which means that there is a cause for the increase of the Co concentration in the area under study, as shown in figure 10.

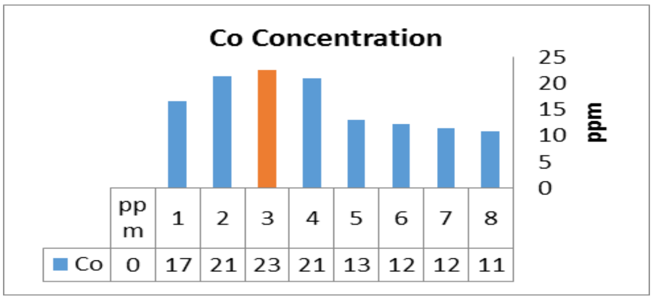

Figure 10. Cobalt (Co) accumulation for soil samples under study

Zink (Zn)

Zn concentration was increased in the first sample obtained from the land close to Gishori factories, whereas the other values were low in concentration and soil number four gave the lowest value. The values were decreased for the other four samples the more the distance from the Gishori Industrial Complex was. The final point under study gave the lowest value in the results which means that there is a cause for the increase of the Zn concentration in the area under study; especially in sample number one as shown in figure 11.

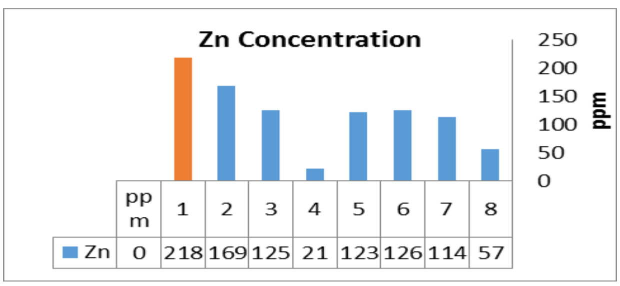

Figure 11. Zink (Zn) accumulation for soil samples under study

4. Discussion

Soils may become contaminated by the accumulation of heavy metals and metalloids through emissions from the rapidly expanding industrial areas, mine tailings, disposal of high metal wastes, leaded gasoline and paints, land application of fertilizers, animal manures, sewage sludge, pesticides, wastewater irrigation, coal combustion residues, spillage of petrochemicals, and atmospheric deposition [14, 15]. Heavy metals constitute an ill-defined group of inorganic chemical hazards, and those most commonly found at contaminated sites are lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu), mercury (Hg), and nickel (Ni) [16]. Soils are the major sink for heavy metals released into the environment by aforementioned anthropogenic activities and unlike organic contaminants which are oxidized to carbon (IV) oxide by microbial action, most metals do not undergo microbial or chemical degradation [17], and their total concentration in soils persists for a long time after their introduction [18]. Changes in their chemical forms (speciation) and bioavailability are, however, possible. The presence of toxic metals in soil can severely inhibit the biodegradation of organic contaminants [19]. Heavy metal contamination of soil may pose risks and hazards to humans and the ecosystem through: direct ingestion or contact with contaminated soil, the food chain, drinking of contaminated ground water, reduction in food quality (safety and marketability) via phytoxicity, reduction in land usability for agricultural production causing food insecurity, and land tenure problems [20-22]. The adequate protection and restoration of soil ecosystems contaminated by heavy metals require their characterization and remediation. Contemporary legislation respecting environmental protection and public health, at both national and international levels, are based on data that characterize chemical properties of environmental phenomena, especially those that reside in our food chain [23]. While soil characterization would provide an insight into heavy metal speciation and bioavailability, attempt at remediation of heavy metal contaminated soils would entail knowledge of the source of contamination, basic chemistry, and environmental and associated health effects (risks) of these heavymetals. Risk assessment is an effective scientific tool which enables decision makers to manage sites so contaminated in a cost-effective manner while preserving public and ecosystem health [24].

5. Conclusions

According to the results shown in Table 2 and the Figures above, we conclude the following:

- B and Cd: both metals were not detected in soil samples collected from the area under study which means that there is no effect by the two heavy metals on the soil or the pollution happening in the target area.
- Ni, Pb and Zn in p.p.m (part per million): there is a high accumulation of the three heavy metals in the samples, as shown in measurements 1&2, where concentrations were increased in the land close to Gishori factories; which means that there is a source for pollution that has a direct effect on the soil.
- Fe in g/kg: was found to be highly accumulated in the four samples collected from the land close to Gishori factories, whereas the concentrations in the other four samples were decreased the more the distance from Gishori Industrial Complex which means there is a

pollution taking place in the area under study.

- Cu, Mn, Cr and Co in ppm: there is a high accumulation of the four heavy metals in the samples (values 3&4) and it is more in the samples closer to Gishori Industrial Complex than in the further ones, which means that there is a source for pollution that has a direct effect on soil.
- Finally, we conclude that there is a heavy metals accumulation in the area close to Gishori Industrial Complex more than in the farther area. This confirms that there is a heavy metals pollution occurring in the area under study.

6. Recommendations

According to the results and conclusions mentioned above, were all the analyses and results showed heavy metals accumulation especially in the area closed Gishori factories, the following consideration must be taken into consideration:

- Remediation the soil pollutants in area under study by using a friendly Environmental remediation as phytoremediation and bioremediation processes.
- Extend and increase advance research in the target area to limit the sources of pollutants.
- More monitoring in the threated area from pollutants.

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