



# The Effect of Industrial Activities on the Heavy Metals Contamination of Irrigation Waters, Soils, and Plants in Kafr El-Dawar District, Egypt

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# Overview

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# Introduction

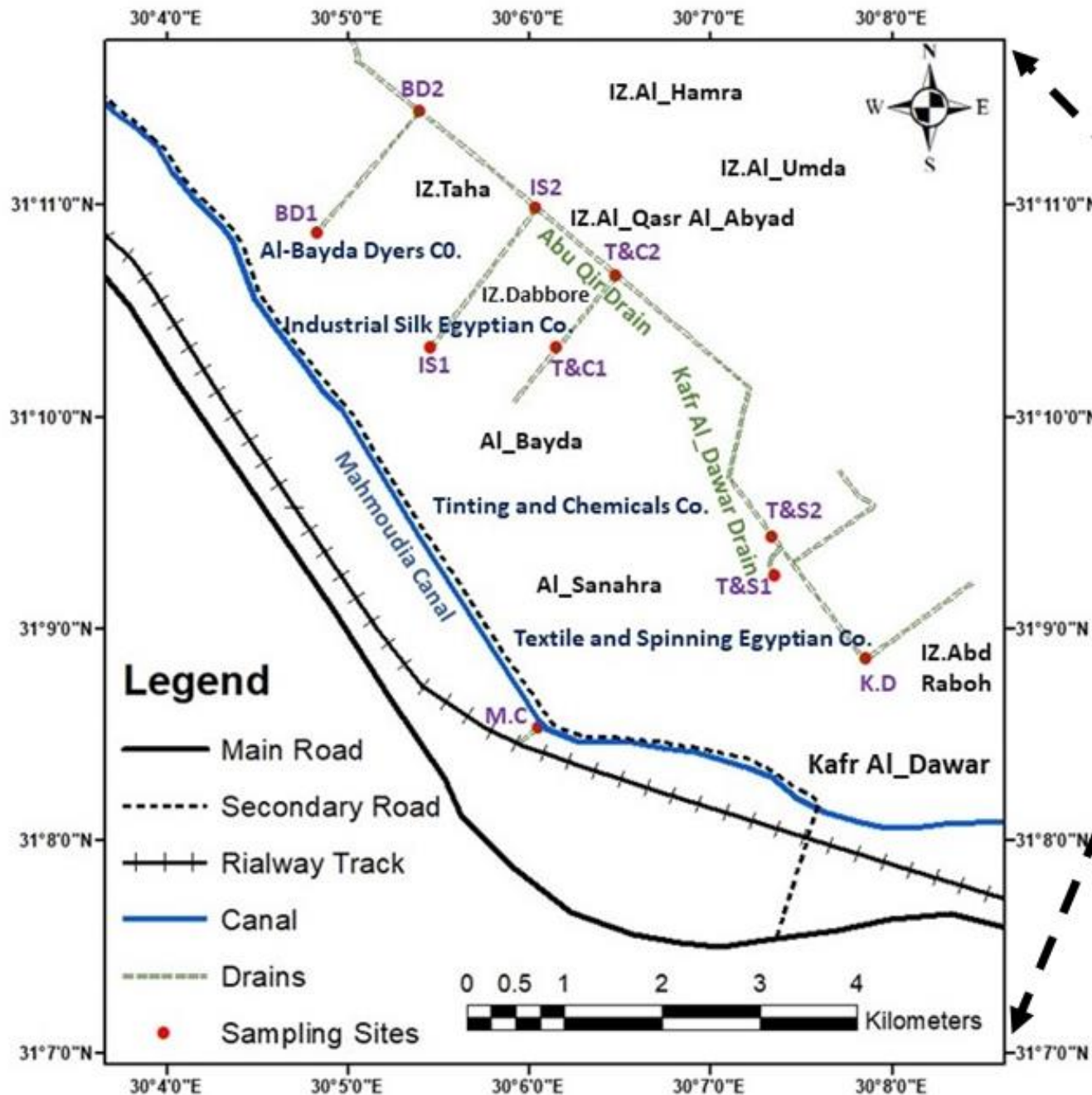
- Kafr EL-Dawar district, El Beheira Governorate, Egypt, is an agricultural area, but with extensive industrial activities.
- It contains four major industrial companies, i.e., Textile and Spinning Egyptian (T&S), Tinting and Chemicals (T&C), Industrial Silk Egyptian (IS), and Al-Bayda Dyers (BD) companies.
- These companies unfortunately have been using the agriculture drainage system to dispose their waste effluents, which in most cases contain heavy metals.
- Kafr EL-Dawar agriculture soils suffer from a shortage in irrigation water resources as a general case in north Egypt.

- Agricultural drainage water is currently being utilized as a main or supplementary source of irrigation water in this area.
- The use of such polluted water in soil irrigation raises the risk of contaminating soils with different industrial contaminants such as heavy metals.
- Therefore, the objective of the present research is to evaluate the effect of industrial activities on heavy metals contamination of irrigation water, soils, and growing plant in Kafr El-Dawar district, Egypt.

# Methodology

## Kafr El-Dawar Industrial area samples

- The samples of water, soils, and plant were collected from sites adjacent to four major industrial companies in Kafr EL-Dawar area (i.e., Textile and Spinning Egyptian Company (T&S), Tinting and Chemicals Company (T&C), Industrial Silk Egyptian Company (IS), and Al-Bayda Dyers Company (BD)). The locations of these Industrial companies are illustrated in Fig (1).



**Fig. 1: Water sampling sites on the drainage network adjacent to industrial Kafr El-Dawar area.**

# Results and discussion

**Table 1. Recommended maximum concentration of studied heavy metals in irrigation water.**

<b>Metal</b>	<b>Unit</b>	<b>Recommended maximum concentration<sup>a</sup></b>
<b>Cadmium (Cd)</b>	<b>mg.l<sup>-1</sup></b>	<b>0.01</b>
<b>Cobalt (Co)</b>	<b>mg.l<sup>-1</sup></b>	<b>0.05</b>
<b>Nickel (Ni)</b>	<b>mg.l<sup>-1</sup></b>	<b>0.20</b>
<b>Zinc (Zn)</b>	<b>mg.l<sup>-1</sup></b>	<b>2.00</b>
<b>Lead (Pb)</b>	<b>mg.l<sup>-1</sup></b>	<b>5.00</b>

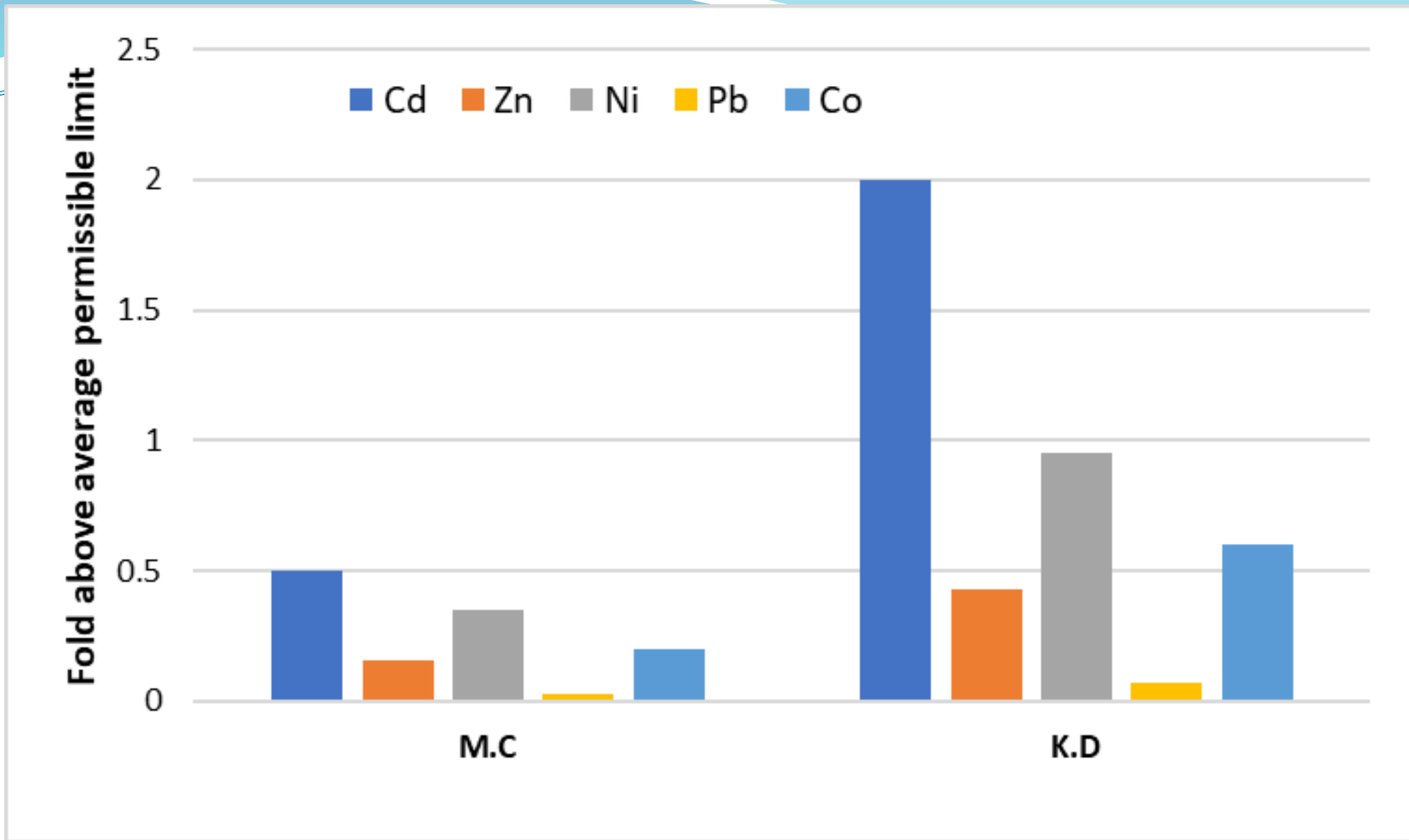
<sup>a</sup> according to law 48/1982 (Egypt); FAO, 1985; USEPA, 1992; and WHO, 1992; EPA 2004; Kabata-Pendias and Mukherjee (2007).

**Table 2: Heavy metals contents (mg.kg<sup>-1</sup>) of Mahmoudia canal water (M.C), Kafr EL-Dawar drain water (K.D), the outlet effluents of industrial companies (1) and their mouth effluents discharge on agriculture drainage water (2).**

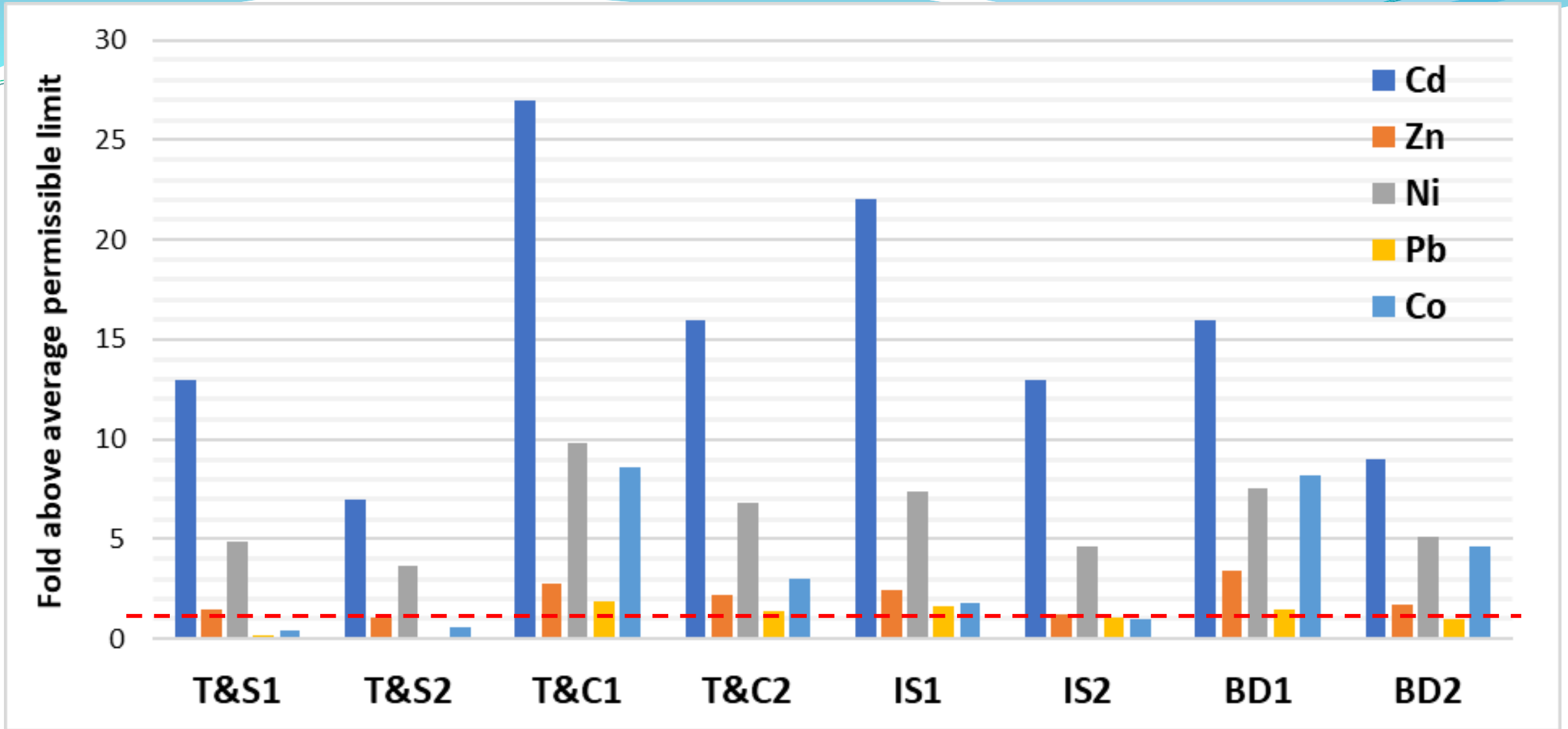
	<b>Cd</b>	<b>Zn</b>	<b>Ni</b>	<b>Pb</b>	<b>Co</b>
<b>M.C</b>	0.005 e	0.31 f	0.07 d	0.13 d	0.01 e
<b>K.D</b>	0.02 e	0.86 f	0.19 d	0.34 d	0.03 de
<b>T&amp;S1</b>	0.13 c	2.95 de	0.97 c	0.72 d	0.02 e
<b>T&amp;S2</b>	0.07 d	2.08 e	0.73 c	0.42 d	0.03 de
<b>T&amp;C1</b>	0.27 a	5.58 b	1.96 a	9.53 a	0.43 a
<b>T&amp;C2</b>	0.16 c	4.36 c	1.37 b	7.11 b	0.15 c
<b>IS1</b>	0.22 b	4.85 bc	1.47 b	8.21 b	0.09 d
<b>IS2</b>	0.13 c	2.41 e	0.92 c	5.43 c	0.05 de
<b>BD1</b>	0.16 c	6.79 a	1.51 b	7.53 b	0.41 a
<b>BD2</b>	0.09 d	3.48 d	1.03 c	5.09 c	0.23 b

M.C: Mahmoudia canal; K.D: Kafr EL-Dawar drain; T&S: Textile and Spinning Egyptian Company; T&C: Tinting and Chemicals Company; IS: Industrial Silk Egyptian Company; BD: Al-Bayda Dyers Company. <sup>a</sup> Within columns, values followed by different lowercase letters are significantly different at  $\alpha = 0.05$ .





**Fig. 2: Heavy metals contents of Mahmoudia canal water (M.C), Kafr EL-Dawar drain water (K.D) expressed as fold above permissible limit.**



**Fig. 3: Heavy metals contents, expressed as fold above permissible limit, of the outlet effluents of industrial companies (1) and their mouth effluents discharge on agriculture drainage water (2).**

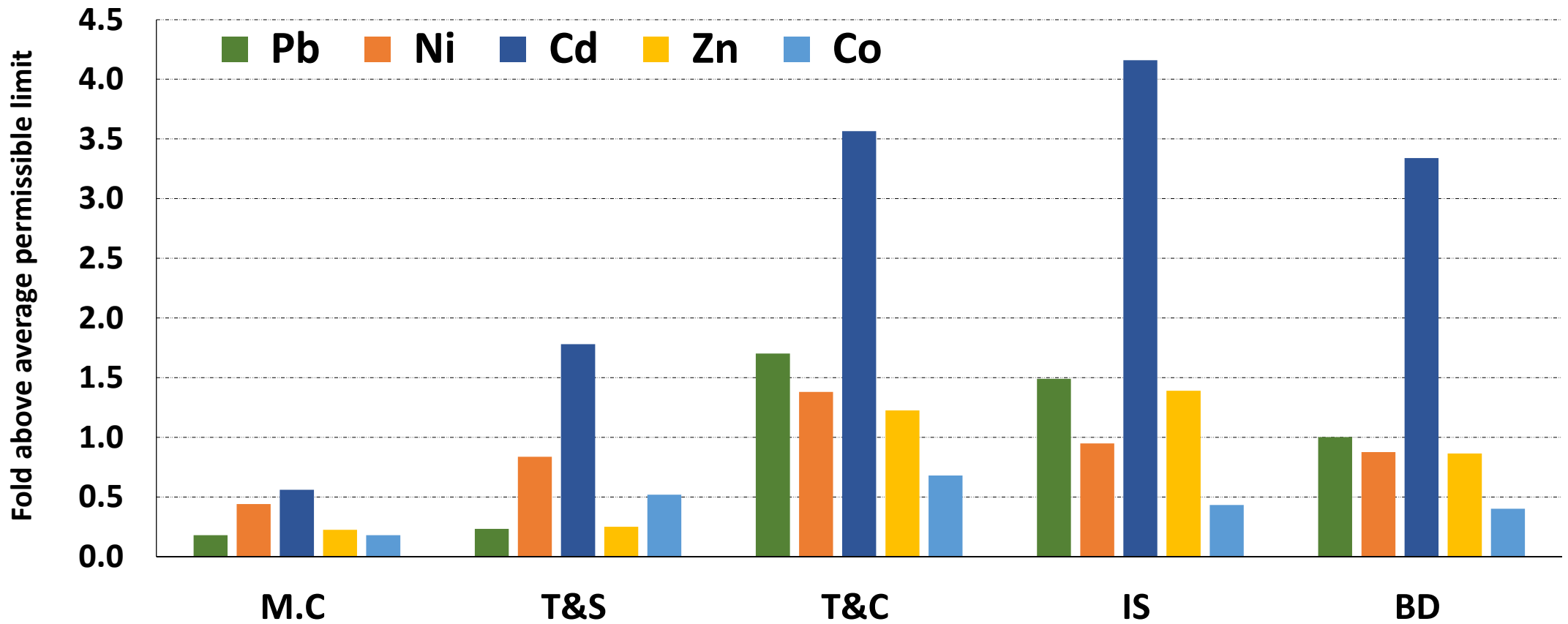


# **Impact of industrial wastewater on the heavy metal contents of soils**

**Table 3: Total heavy metals contents (mg.kg<sup>-1</sup>) of the studied soil samples.**

Analyte	M.C Soil <sup>a</sup>	T&S Soil	T&C Soil	IS Soil	BD Soil
<b>Pb</b>	<b>25.50 c</b>	<b>33.15 c</b>	<b>241.60 a</b>	<b>211.70 a</b>	<b>142.30 b</b>
<b>Ni</b>	<b>28.18 c</b>	<b>53.61 b</b>	<b>88.30 a</b>	<b>60.72 b</b>	<b>56.10 b</b>
<b>Cd</b>	<b>1.12 c</b>	<b>3.56 b</b>	<b>7.13 a</b>	<b>8.32 a</b>	<b>6.68 a</b>
<b>Zn</b>	<b>56.2 c</b>	<b>62.35 c</b>	<b>305.2 a</b>	<b>346.3 a</b>	<b>215.5 b</b>
<b>Co</b>	<b>5.40 c</b>	<b>15.60 b</b>	<b>20.40 a</b>	<b>13.02 b</b>	<b>12.06 b</b>

<sup>a</sup> M.C soil: irrigated from Mahmoudia canal, T&S Soil: adjacent to Textile and Spinning Egyptian Company, T&C soil: adjacent to Tinting and Chemicals Company, IS soil: adjacent to Industrial Silk Egyptian Company, BD soil: adjacent to Al-Bayda Dyers Company.



**Fig. 4: Relative toxic effects of total heavy metals at different sampling sites, expressed as fold above average permissible limit of different heavy metals in agricultural soil.**

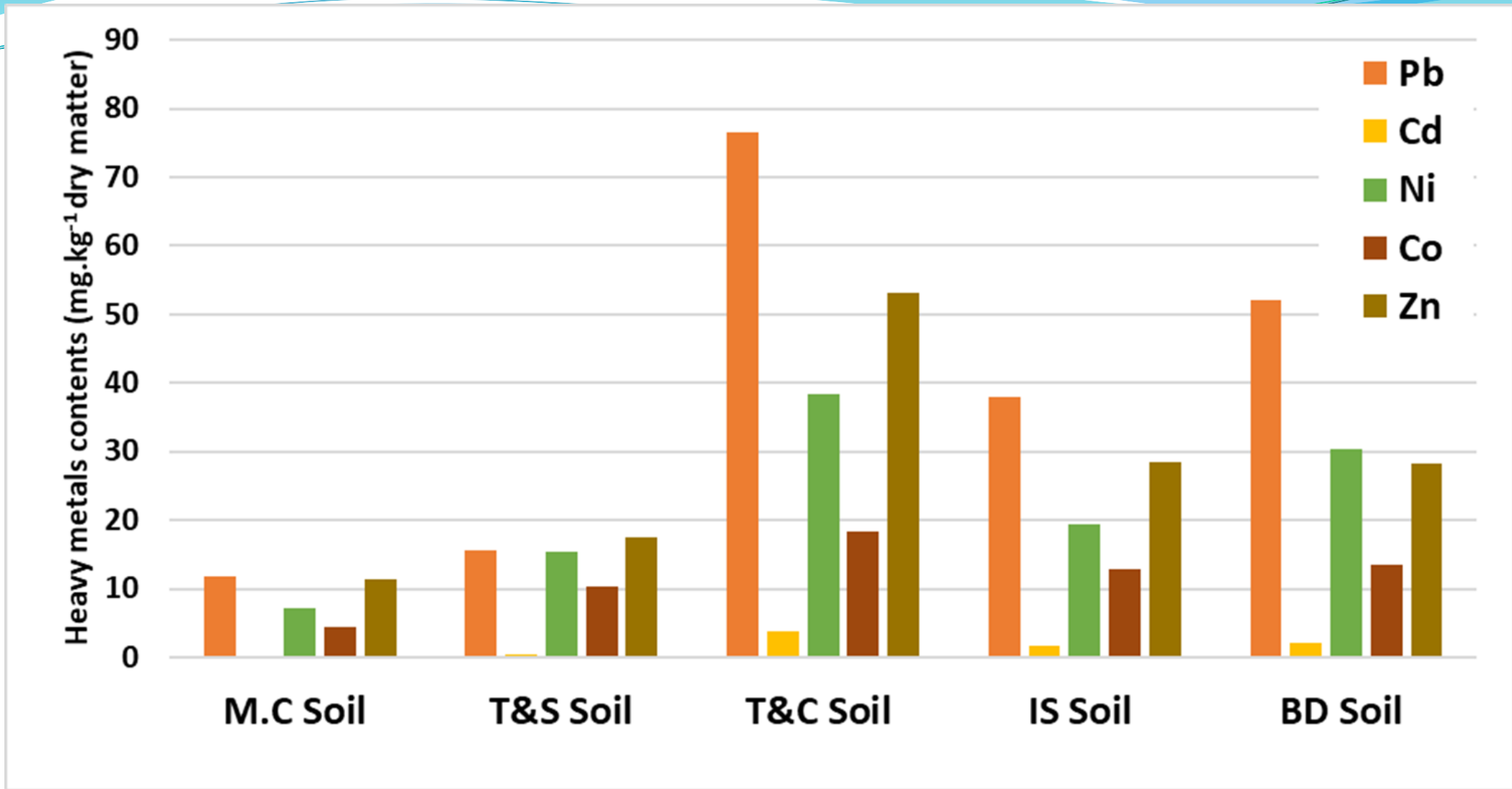


# **Heavy metals contents in some plants grown in the tested polluted soils**

**Table 4. Heavy metals contents (mg.kg<sup>-1</sup> dry matter) in some plants grown in the tested polluted soils.**

<b>Crop<sup>a</sup></b>	<b>Heavy metals mg.kg<sup>-1</sup></b>	<b>M.C Soil</b>	<b>T&amp;S Soil</b>	<b>T&amp;C Soil</b>	<b>IS Soil</b>	<b>BD Soil</b>
<b>Wheat</b>	Pb	13.7 c	-	68.6 a	-	42.4 b
	Cd	ND <sup>b</sup>	-	3.1 a	-	2.8 a
	Ni	9.3 c	-	26.4 a	-	21.3 b
	Co	3.7 b	-	14.1 a	-	15.6 a
	Zn	9.8 b	-	28.3 a	-	28.6 a
<b>Clover</b>	Pb	11.7 d	15.6 d	76.6 a	38.0 c	52.0 b
	Cd	ND e	0.5 d	3.7 a	1.7 c	2.2 b
	Ni	7.2 d	15.3 c	38.3 a	19.3 c	30.4 b
	Co	4.4 c	10.3 b	18.4 a	12.8 b	13.5 b
	Zn	11.3 c	17.5 c	53.2 a	28.4 b	28.2 b
<b>Faba bean</b>	Pb	19.3 b	21.3 b	-	56.4 a	-
	Cd	0.2 c	0.6 b	-	1.3 a	-
	Ni	8.1 b	12.8 a	-	12.4 a	-
	Co	3.9 b	9.8 a	-	10.5 a	-
	Zn	14.5 b	21.6 a	-	25.4 a	-

<sup>a</sup> Clover (*Trifolium sativum*), Faba bean (*Vicia faba*), and Wheat (*Triticum aestivum*). <sup>b</sup> ND: Not detected.



**Fig. 5: Heavy metals contents (mg.kg<sup>-1</sup> dry matter) in some plants grown in the tested polluted soils.**



# Conclusion and Recommendations

- Results showed that a clear risk associated with the irrigation of soils and crops with agricultural drainage water mixed with industrial waste effluents in relation with the heavy metal contents.
- The long term of soil irrigated by this water, will cause deterioration to agricultural land, harmful effect on crop quality and quantity, and cause environmental problems.
- Therefore, it is important to issue laws and limitations for these companies to prevent them from polluting agricultural soils.
- Industrial establishments should treat their wastes before disposal and dump them under strict measures.
- Aqueous wastes, under all circumstances, should not be discharged into irrigation water canals.
- Newly planned industrial activities should take place away from population masses, as well as from the agricultural land.

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