1 **Toxic Levels of Some Heavy Metals in Drinking Network Surface Water of**
2 **Damietta Governorate, Egypt**

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10 **ABSTRACT:**
11   In this paper, the heavy metals of the surface drinking water of Damietta
12 governorate were evaluated. Damietta district, Farascore City, EL-Zarka City and Kafr
13 Saad City are the main locations of drinking water pollution. The villages of the Damietta
14 governorate have concentration values less than the permissible limits of World Health
15 Organization (WHO) and Egyptian Ministry Health (EMH).
16

17 **Keywords:** Water – pollution – Drinking – Damietta - Toxic

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19 **INTRUDUTION:**
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21   Environmental problems such as water and air pollution have been occurred due
22 to the agricultural and industrial development, where this pollution affect on the human
23 health (Wang et al. 2010;Patrick 2003). The heavy metals entering the biosphere due to
24 the industrialization and urbanization projects (Nweke 2009;Gazso 2001). About 80% of
25 the illness is accompanied with water pollution in developing countries, where more than
26 14,000 death cases daily (Pink and Daniel 2006; West 2006).
27   Uses of water for drinking, agriculture and industry purposes impair due to
28 anthropogenic and natural processes that degrade the water (Sanchez et al. 2007).
29 Chronic diseases (Liver Cirrhosis, Rental Failure, Chronic Anemia and Hair Loss) occur
30 due to the pollution of drinking water by heavy metals such as Cu, Cd, Ni, Cr and Pb
31 (Wang et al, 2010, Salem et al., 2000). Renal failure is occur when the drinking water
32 polluted with Cd and Pb; liver cirrhosis to the pollution with Cu and molybdenum; hair
33 loss to the pollution with Cr and Ni; and chronic anemia to the pollution with Cd and Cu
34 (Johri et al., 2010).
35   Most of Damietta governorate lands with agricultural activities. Where, use the
36 pesticides and fertilizers increase the pollution in water and plants. Thus the human
37 health in dangerous in Damietta Governorate especially after the construction of the
38 industrial area, Damietta Harbor, reclamation projects and agricultural development.
39   The drinking water resources in the Damietta governorate comprise both Damietta
40 Nile branch surface and ground waters. Water pollution is the main environmental
41 problem in Damietta Governorate and in whole Arab Republic of Egypt. Pollution
42 sources of Damietta Nile Branches water come from agricultural drains, domestic
43 sewage, industrial effluents and fish farms (Abdel Wahaab and Badawy 2004).
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45 **SAMPLING AND METHODS:**
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47    Drinking water samples were collected from different districts of Damietta
48 governorate; Damietta, New Damietta City, Ras El-Bar, Kfr Saad, Farascore and EL-
49 Zarka (Fig. 1). These samples collected from surface network water in each district,
50 where the samples taken from public site in district. The samples randomly collected
51 from each site in district. Heavy metals concentrations of drinking surface network water
52 were analyzed by atomic absorption spectrophotometer (AAS) (Table 1). These metals
53 are lead (Pb), zinc (Zn), copper (Cu), cobalt (Co), cadmium (Cd), nickel (Ni), chromium
54 (Cr), iron (Fe) and manganese (Mn). The estimated values compared with WHO, 2011
55 and EMH, 2007 values to evaluate the studied drinking water. Where, this instrument
56 available in the National Research Center for such studies.
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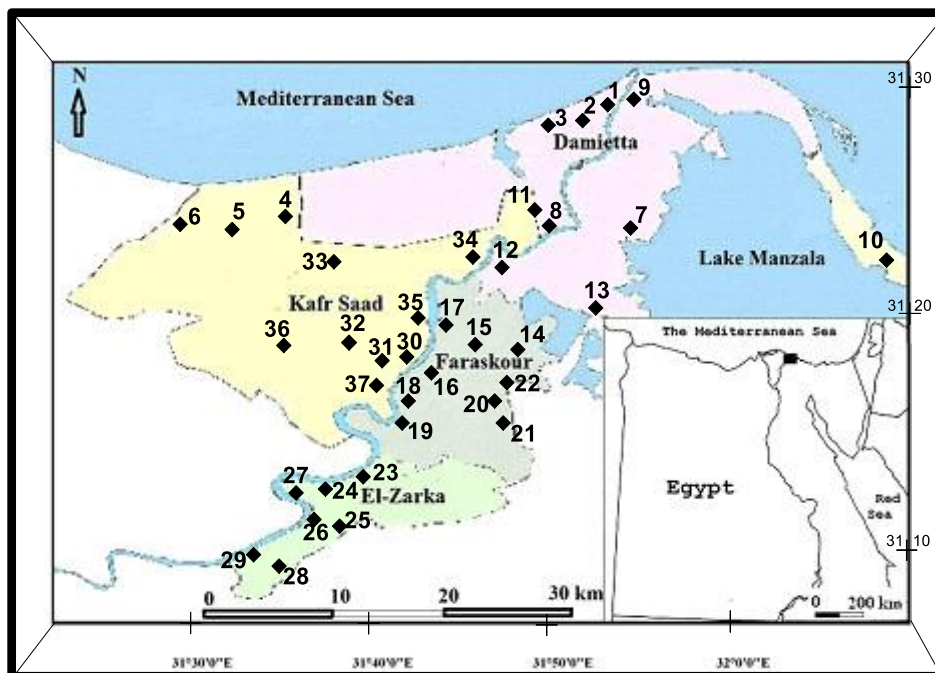
60    **Fig. (1): Location map for the different surface drinking water samples.**

63  **Calculation of Pollution Index:**

65    The pollution index (PI) was used in this study to evaluate the degree of heavy
66 metal contamination in water samples (Chon, et al., 1991; Kim et al., 1998; Emoyan et
67 al., 2005; Odukoya and Abimbola 2010). The tolerable level is the element concentration
68 in the water considered safe for human consumption (Lee et al., 1998). Pollution index
69 (PI) is based on individual metal calculations and categorized into 6 classes (Table 2)
70 according the following equation (Caerio et al., 2005).

$$PI = \sum_{i=1}^{n} \frac{\left(\frac{Ci}{Si}\right)}{Nm}$$

71
72   Where Ci = Heavy metal concentration in water; Si= permissible Level and N$_m$ = Number
73   of Heavy metals.
74   Water sample with Pollution Index (PI) greater than 1 is regarded as being contaminated
75   **Table (1): Values of some heavy metals analyses in ppm (mg/L) of drinking surface**
76   **network water in Damietta governorate, northern Egypt.**
77

No.	District/sample name	Cd	Cu	Co	Ni	Cr	Pb	Mn	Fe	Zn
	Permissible limit of WHO (2011)	0.003	2.0	0.05	0.07	0.05	0.01	0.4	0.3	3.0
	Permissible limit of EMH (2007)	0.003	2.0	0.05	0.02	0.05	0.01	0.4	0.3	3.0
Ras ELBar District Network										
1	East of Ras ELBar	0.003	0.01	0.003	0.008	0.001	0.003	0.0	0.02	0.0
2	Center of Ras ELBar	0.003	0.01	0.002	0.009	0.002	0.003	0.01	0.02	0.01
3	West of Ras ELBar	0.003	0.01	0.002	0.009	0.003	0.003	0.00	0.03	0.00
New Damietta District Network										
4	East of New Damietta City	0.003	0.05	0.002	0.007	0.006	0.003	0.01	0.03	0.01
5	Center of New Damietta City	0.003	0.01	0.002	0.009	0.007	0.004	0.00	0.03	0.00
6	West of New Damietta City	0.003	0.01	0.002	0.008	0.005	0.003	0.01	0.03	0.01
Damietta District Network										
7	East of Damietta City	0.03	0.05	0.002	0.08	0.06	0.03	0.0	0.0	0.0
8	West of Damietta City	0.04	1.01	0.001	0.09	0.07	0.04	0.02	0.02	0.01
9	EzbitELBurg	0.04	2.01	0.003	0.08	0.05	0.03	0.0	0.02	0.01
10	Shata	0.03	0.05	0.002	0.08	0.06	0.03	0.0	0.02	0.0
11	ELSenanea	0.04	1.01	0.001	0.09	0.07	0.04	0.00	0.01	0.01
12	ELBostan	0.04	2.01	0.001	0.08	0.05	0.03	0.02	0.00	0.00
13	ELBasarta	0.03	0.05	0.001	0.08	0.06	0.03	0.01	0.00	0.01
Farascor District Network										
14	East of Farascor City	0.03	0.01	0.002	0.07	0.02	0.011	0.01	0.01	0.01
15	Center of Farascor City	0.03	0.02	0.003	0.09	0.04	0.022	0.0	0.01	0.01
16	West of Farascor City	0.02	0.01	0.003	0.08	0.03	0.011	0.0	0.01	0.0
17	ELHorany	0.003	0.01	0.003	0.009	0.002	0.022	0.0	0.0	0.01
18	KafrELArab	0.003	0.01	0.002	0.008	0.003	0.023	0.01	0.01	0.01
19	ELBarashea	0.002	0.0	0.002	0.007	0.003	0.022	0.01	0.00	0.01
20	ELRoda	0.003	0.01	0.002	0.006	0.003	0.021	0.01	0.01	0.00
21	TafteshELSerw	0.003	0.0	0.002	0.006	0.002	0.011	0.001	0.01	0.0

| 22 | ELAtawy | 0.002 | 0.01 | 0.001 | 0.007 | 0.001 | 0.023 | 0.00 | 0.00 | 0.01 |

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84 **Continued: Table (1): Values of some heavy metals analyses in ppm (mg/L) of**
85 **drinking surface network water in Damietta governorate, northern Egypt.**
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No.	District/sample name	Cd	Cu	Co	Ni	Cr	Pb	Mn	Fe	Zn
	Permissible limit of WHO (2011)	0.003	2.0	0.05	0.07	0.05	0.01	0.4	0.3	3.0
	Permissible limit of EMH (2007)	0.003	2.0	0.05	0.02	0.05	0.01	0.4	0.3	3.0
EL-Zarka District Network										
23	Dakahla	0.003	0.01	0.001	0.007	0.01	0.01	0.01	0.00	0.01
24	ELSerw	0.003	0.01	0.002	0.08	0.01	0.01	0.5	0.01	0.01
25	East of ELZarka City	0.03	0.00	0.002	0.06	0.02	0.01	0.00	0.00	0.01
26	Center of ELZarka City	0.03	0.01	0.002	0.07	0.003	0.01	0.01	0.00	0.00
27	West of ELZarka City	0.03	0.01	0.001	0.007	0.002	0.01	0.01	0.00	0.01
28	EzbitFarag	0.001	0.0	0.001	0.005	0.0	0.0	0.0	0.0	0.002
29	Sheremsah	0.003	0.01	0.001	0.006	0.01[	0.0	0.0	0.0	0.001
Kafr-Sad District Network										
30	East of Kafr Sad City	0.01	0.0	0.001	0.08	0.06	0.02	0.0	0.0	0.0
31	Center of Kafr Sad City	0.02	0.01	0.001	0.04	0.07	0.02	0.01	0.0	0.0
32	West of Kafr Sad City	0.001	0.01	0.002	0.07	0.006	0.003	0.02	0.02	0.01
33	Om ELReda	0.002	0.00	0.002	0.008	0.002	0.002	0.01	0.00	0.01
34	KafrELBatekh	0.003	0.01	0.003	0.009	0.001	0.002	0.0	0.00	0.01
35	KafrEsleman	0.001	0.01	0.002	0.007	0.002	0.001	0.01	0.02	0.01
36	ELMohamadea	0.001	0.00	0.001	0.008	0.001	0.002	0.01	0.02	0.00
37	Mit Abu Ghaleb	0.003	0.01	0.002	0.006	0.002	0.001	0.0	0.00	0.00

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90 **Table. (2): Categories of Water Pollution Index.**
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Class	PI value	Class
1	<1	No effect
2	1–2	Slightly affected
3	2–3	Moderately affected
4	3–5	Strongly affected
5	>5	Seriously affected

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94   **RESULTS AND DISCUSSION**
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96   The results are shown in Tables 1 and 3. Where, the concentration of heavy
97   metals in the drinking water and the pollution index of each site recorded in these tables.
98   The values in table 1 were compared with the permissible limits of Egyptian Ministry
99   Health (EMH) permissible limits, 2007 and the permissible limits of WHO, 2011. As
100 well as the pollution index were determined for each site or sample.
101   The drinking surface network water in Ras EL-Bar and New Damietta cities is
102 suitable for drinking due to the whole values of heavy metals less than the permissible
103 limits of EMH, 2007 and WHO, 2011 (Table. 1). Pollution index (PI) of these districts or
104 cities in Damietta governorate showed that the degree of heavy metals contamination is
105 no effect (<1) (Tables. 2 and 3).
106   In Damietta district, Cd values of the samples are more than the permissible limits
107 of EMH, 2007 and WHO, 2011. Cu values of the samples less than the permissible limits
108 of EMH, 2007 and WHO, 2011 except in samples 9 and 12. Ni, Cr, Pb values are ≥ the
109 permissible limits of EMH, 2007 and WHO, 2011. Co, Mn and Fe values are less than the
110 permissible limits of EMH, 2007 and WHO, 2011. Pollution index of Damietta district is
111 moderately affected category (2-3) (Tables 2 and 3).
112   In Farascore district, the concentration values of heavy metals in Farascore city
113 more than that in the villages of Farascore. Samples of Farascore city (14,15 and 16)
114 showed that Cd, Ni, Cr and Pb values more than the permissible limits of EMH and
115 WHO. The Cu, Co, Mn, Fe and Zn are less than the permissible limits of EMH and
116 WHO. Samples of the villages of Farascore have values less than the permissible limits
117 of EMH and WHO. Pollution index of the Farascore district showed slightly affected
118 grad in samples 14, 15 and 16, while it is no affected grad in the other samples.
119   In EL-Zarka district, samples 25, 26 and 27 of Zarka city show that Cd Ni, Cr and
120 Pb values more than the permissible limits of EMH, 2007 and WHO,2011. The Cu, Co,
121 Mn, Fe and Zn are less than the permissible limits cof EMH and WHO. Samples of the
122 villages of EL-Zarka have values less than the permissible limits of EMH and WHO.
123 Pollution index of EL-Zarka district showed slightly affected grad in samples 25, 26 and
124 27, while it is no affected grad in the other samples.
125   In Kaf Saad district, the sample 30 and 31 of Kafr Saad city showed that Cd, Ni,
126 Cr and Pb values more than the permissible limits of EMH, 2007 and WHO,2011, while
127 the other metals are less than the permissible limits. Samples of the villages of Kafr Saad
128 have concentration values less than the permissible limits of EMH, 2007 and WHO,2011.
129 Pollution index of Kafr Saad district showed slightly affected grad in samples 30 and 31,
130 while it is no affected grad in the other samples.
131   Thus the populations of Damietta City, Farascore City, EL-Zarka City and Kafr
132 Saad City may be suffering from many diseases such as Liver Cirrhosis, Rental Failure,
133 Chronic Anemia and Hair Loss.
134
135   **CONCLUSIONS**
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137   pollution of surface drinking water of Damietta governorate by heavy metals in
138 most of villages less than that in the cities of the Damietta governorate. Pollution index is
139 ranged between no affected to moderately affected for whole station samples.

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145 **Table. (3): Pollution Index of drinking surface network water in Damietta**
146 **governorate, northern Egypt.**
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No.	Cd	Cu	Co	Ni	Cr	Pb	Mn	Fe	Zn	PI
**Ras ELBar District Network**
1	0.111	0	0.006	0.044	0.002	0.033	0	0.007	0	0.205
2	0.111	0	0.004	0.05	0.004	0.033	0.002	0.007	0	0.214
3	0.111	0	0.004	0.05	0.006	0.033	0	0.011	0	0.217
**New Damietta District Network**
4	0.111	0	0.004	0.038	0.004	0.033	0.002	0.011	0	0.206
5	0.111	0	0.004	0.05	0.006	0.033	0	0.011	0	0.217
6	0.111	0	0.004	0.044	0.004	0.033	0.002	0.011	0	0.212
**Damietta District Network**
7	1.11	0.002	0.004	0.44	0.133	0.333	0	0	0	2.02
8	1.48	0.056	0.002	0.5	0.155	0.444	0.005	0.007	0.	2.65
9	1.48	0.111	0.006	0.444	0.111	0.333	0	0.007	0	2.49
10	1.11	0.002	0.004	0.444	0.133	0.333	0	0.007	0	2.03
11	1.48	0.056	0.002	0.5	0.155	0.444	0	0.003	0	2.64
12	1.48	0.111	0.002	0.444	0.111	0.333	0.005	0	0	2.48
13	1.11	0.002	0.002	0.444	0.133	0.333	0.002	0	0	2.03
**Farascor District Network**
14	1.11	0	0.004	0.388	0.044	0.122	0.002	0.003	0	1.67
15	1.11	0.001	0.006	0.5	0.088	0.244	0	0.003	0	1.95
16	0.740	0	0.006	0.444	0.066	0.122	0	0.003	0	1.38
17	0.111	0	0.006	0.05	0.004	0.244	0	0	0	0.417
18	0.111	0	0.004	0.044	0.006	0.255	0.002	0.003	0	0.429
19	0.074	0	0.004	0.038	0.006	0.244	0.002	0	0	0.371
20	0.111	0	0.004	0.033	0.006	0.233	0.002	0.003	0	0.395
21	0.111	0	0.004	0.033	0.004	0.122	0	0.003	0	0.279
22	0.074	0	0.002	0.038	0.002	0.255	0	0	0	0.373
**EL-Zarka District Network**
23	0.111	0	0.002	0.038	0.002	0.111	0.002	0	0	0.269
24	0.111									0.111
25	1.11	0	0.004	0.333	0.044	0.111	0	0	0	1.60
26	1.11	0	0.004	0.388	0.007	0.111	0.002	0	0	1.62
27	1.11	0	0.002	0.038	0.004	0.111	0.002	0	0	1.27
28	0.037	0	0.002	0.027	0	0	0	0	0	0.067
29	0.111	0	0.002	0.033	0.022	0	0	0	0	0.169
**Kafr-Sad District Network**
30	0.37	0	0.002	0.444	0.133	0.222	0	0	0	1.17
31	0.74	0	0.002	0.222	0.155	0.222	0.002	0	0	1.34
32	0.037	0	0.004	0.388	0.013	0.033	0.005	0.007	0	0.490
33	0.074	0	0.004	0.044	0.004	0.022	0.002	0	0	0.152
34	0.111	0	0.006	0.05	0.002	0.022	0	0	0	0.193

35	0.037	0	0.004	0.038	0.004	0.011	0.002	0.007	0	0.107
36	0.037	0	0.002	0.044	0.002	0.022	0.002	0.007	0	0.118
37	0.111	0	0.004	0.033	0.004	0.011	0	0	0	0.165

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