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

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ABSTRACT:

In this paper, the heavy metals of the surface drinking water of Damietta governorate were evaluated. Damietta district, Farascore City, EL-Zarka City and Kafr Saad City are the main locations of drinking water pollution. The villages of the Damietta governorate have concentration values less than the permissible limits of World Health Organization (WHO) and Egyptian Ministry Health (EMH). The pollution in the villages water by heavy metals less than that in the cities.

Keywords: Water – pollution – Drinking – Damietta - Toxic

INTRUDUTION:

Environmental problems such as water and air pollution have been occurred due to the agricultural and industrial development, where this pollution affect on the human health (Wang et al. 2010;Patrick 2003). The heavy metals entering the biosphere due to the industrialization and urbanization projects (Nweke 2009;Gazso 2001). About 80% of the illness is accompanied with water pollution in developing countries, where more than 14,000 death cases daily (Pink and Daniel 2006; West 2006).

Uses of water for drinking, agriculture and industry purposes impair due to anthropogenic and natural processes that degrade the water (Sanchez et al. 2007). Chronic diseases (Liver Cirrhosis, Rental Failure, Chronic Anemia and Hair Loss) occur due to the pollution of drinking water by heavy metals such as Cu, Cd, Ni, Cr and Pb (Wang et al, 2010, Salem et al., 2000). Renal failure is occur when the drinking water polluted with Cd and Pb; liver cirrhosis to the pollution with Cu and molybdenum; hair loss to the pollution with Cr and Ni; and chronic anemia to the pollution with Cd and Cu (Johri et al., 2010).

Most of Damietta governorate lands with agricultural activities. Where, use the pesticides and fertilizers increase the pollution in water and plants. Thus the human health in dangerous in Damietta Governorate especially after the construction of the industrial area, Damietta Harbor, reclamation projects and agricultural development.

The drinking water resources in the Damietta governorate comprise both Damietta Nile branch surface and ground waters. Water pollution is the main environmental problem in Damietta Governorate and in whole Arab Republic of Egypt. Pollution sources of Damietta Nile Branches water come from agricultural drains, domestic sewage, industrial effluents and fish farms (Abdel Wahaab and Badawy 2004).

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49 **SAMPLING AND METHODS:**
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51   Drinking water samples were collected from different districts of Damietta
52 governorate; Damietta, New Damietta City, Ras El-Bar, Kfr Saad, Farascore and EL-
53 Zarka (Fig. 1). These samples collected from surface network water in each district,
54 where the samples taken from public site in district. The samples randomly collected
55 from each site in district. Heavy metals concentrations of drinking surface network water
56 were analyzed by atomic absorption spectrophotometer (AAS) (Table 1). These metals
57 are lead (Pb), zinc (Zn), copper (Cu), cobalt (Co), cadmium (Cd), nickel (Ni), chromium
58 (Cr), iron (Fe) and manganese (Mn). The estimated values compared with WHO, 2011
59 and EMH, 2007 values to evaluate the studied drinking water. Where, this instrument
60 available in the National Research Center for such studies.
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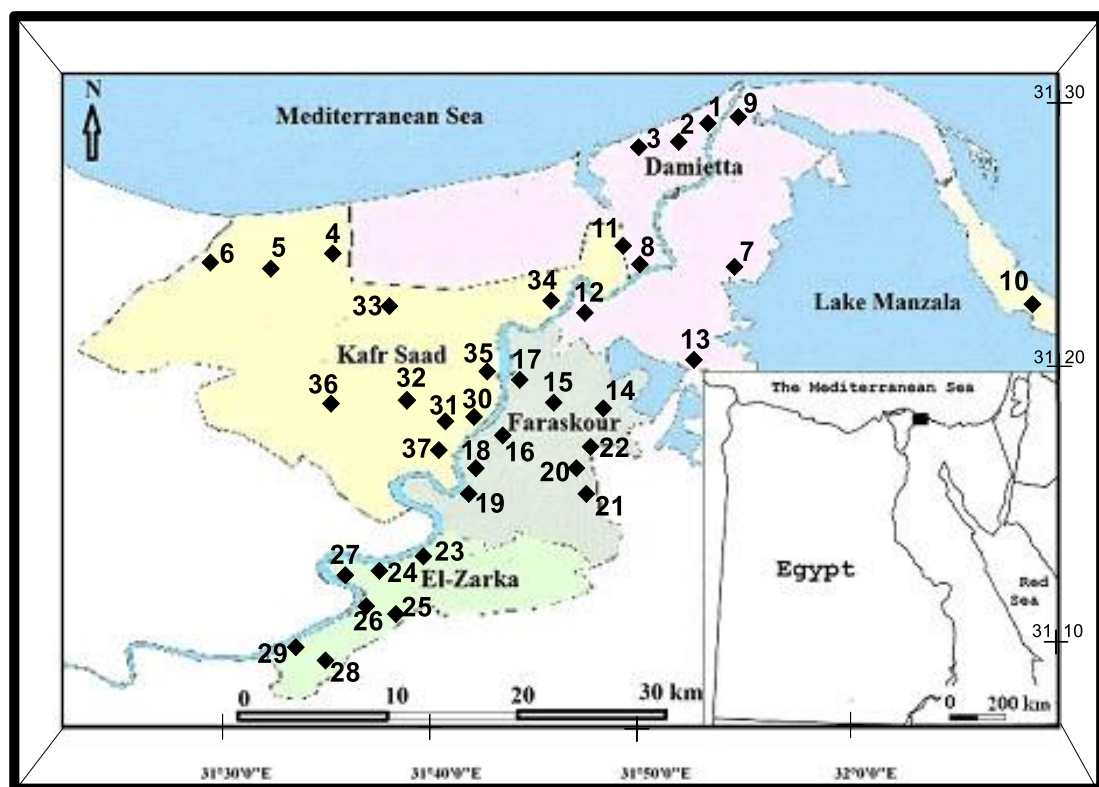
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64   **Fig. (1): Location map for the different surface drinking water samples.**
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66
67 **Calculation of Pollution Index:**
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69   The pollution index (PI) was used in this study to evaluate the degree of heavy
70 metal contamination in water samples (Chon, et al., 1991; Kim et al., 1998; Emoyan et
71 al., 2005; Odukoya and Abimbola 2010). The tolerable level is the element concentration
72 in the water considered safe for human consumption (Lee et al., 1998). Pollution index

73   (PI) is based on individual metal calculations and categorized into 6 classes (Table 2)
74   according the following equation (Caerio et al., 2005).

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

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

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

No.	District/sample name	Cd	Cu	Co	Ni	Cr	Pb	Mn	Fe	Zn
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

Continued: Table (1): Values of some heavy metals analyses in ppm (mg/L) of drinking surface network water in Damietta governorate, northern Egypt.

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

Table. (2): Categories of Water Pollution Index.

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

RESULTS AND DISCUSSION

The results are shown in Table 1 and 3. Where, the concentration of heavy metals in the drinking water and the pollution index of each site recorded in these tables. The values in Table 1 were compared with the permissible limits of Egyptian Ministry Health (EMH) permissible limits, 2007 and the permissible limits of WHO, 2011. As well as the pollution index were determined for each site or sample.

The drinking surface network water in Ras EL-Bar and New Damietta cities is suitable for drinking due to the whole values of heavy metals less than the permissible limits of EMH, 2007 and WHO, 2011 (Table. 1). Pollution index (PI) of these districts or cities in Damietta governorate showed that the degree of heavy metals contamination is no effect (<1) (Table. 2 and 3).

In Damietta district, Cd values of the samples are more than the permissible limits of EMH, 2007 and WHO, 2011. Cu values of the samples less than the permissible limits of EMH, 2007 and WHO, 2011 except in samples 9 and 12. Ni, Cr, Pb values are ≥ the permissible limits of EMH, 2007 and WHO, 2011. Co, Mn and Fe values are less than the permissible limits of EMH, 2007 and WHO, 2011. Pollution index of Damietta district is moderately affected category (2-3) (Table 2 and 3).

In Farascore district, the concentration values of heavy metals in Farascore city more than that in the villages of Farascore. Samples of Farascore city (14,15 and 16) showed that Cd, Ni, Cr and Pb values more than the permissible limits of EMH and WHO. The Cu, Co, Mn, Fe and Zn are less than the permissible limits of EMH and WHO. Samples of the villages of Farascore have values less than the permissible limits of EMH and WHO. Pollution index of the Farascore district showed slightly affected grad in samples 14, 15 and 16, while it is no affected grad in the other samples.

In EL-Zarka district, samples 25, 26 and 27 of Zarka city show that Cd Ni, Cr and Pb values more than the permissible limits of EMH, 2007 and WHO,2011. The Cu, Co, Mn, Fe and Zn are less than the permissible limits cof EMH and WHO. Samples of the villages of EL-Zarka have values less than the permissible limits of EMH and WHO. Pollution index of EL-Zarka district showed slightly affected grad in samples 25, 26 and 27, while it is no affected grad in the other samples.

In Kaf Saad district, the sample 30 and 31 of Kafr Saad city showed that Cd, Ni, Cr and Pb values more than the permissible limits of EMH, 2007 and WHO,2011, while the other metals are less than the permissible limits. Samples of the villages of Kafr Saad have concentration values less than the permissible limits of EMH, 2007 and WHO,2011. Pollution index of Kafr Saad district showed slightly affected grad in samples 30 and 31, while it is no affected grad in the other samples.

Thus the populations of Damietta City, Farascore City, EL-Zarka City and Kafr Saad City may be suffering from many diseases such as Liver Cirrhosis, Rental Failure, Chronic Anemia and Hair Loss.

CONCLUSIONS

140   pollution of surface drinking water of Damietta governorate by heavy metals in
141   most of villages less than that in the cities of the Damietta governorate. Pollution index is
142   ranged between no affected to moderately affected for whole station samples.
143
144   **Table. (3): Pollution Index of drinking surface network water in Damietta**
145   **governorate, northern Egypt.**
146

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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