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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 KafrSaad 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).
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 etl [1], Patrick [2]). The heavy metals entering the biosphere due to the industrialization and urbanization projects (Nweke and Sanders [3], Gazso [4]). About 80% of the illness is accompanied with water pollution in developing countries, where more than 14,000 death cases daily (Pink [5], West [6]).

Uses of water for drinking, agriculture and industry purposes impair due to anthropogenic and natural processes that degrade the water (Sanchez etl [7]).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 etl [1], Salem etl [8]). 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 etl [9]).

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 [10]).

Sampling and Methods:

Drinking water samples were collected from different districts of Damietta governorate; Damietta, New Damietta City, Ras El-Bar, KfrSaad, Farascore and EL-Zarka (Fig. 1). Heavy metals concentrations of drinking surface network water were analyzed by atomic absorption spectrophotometer (AAS), Buck Scientific Company, USA (Table 1). These metals are lead (Pb), zinc (Zn), copper (Cu), cobalt (Co), cadmium (Cd), nickel (Ni), chromium (Cr), iron (Fe) and manganese (Mn). The estimated values compared with (WHO [11], Egyptian Ministry of Health [12]) values to evaluate the studied drinking water.

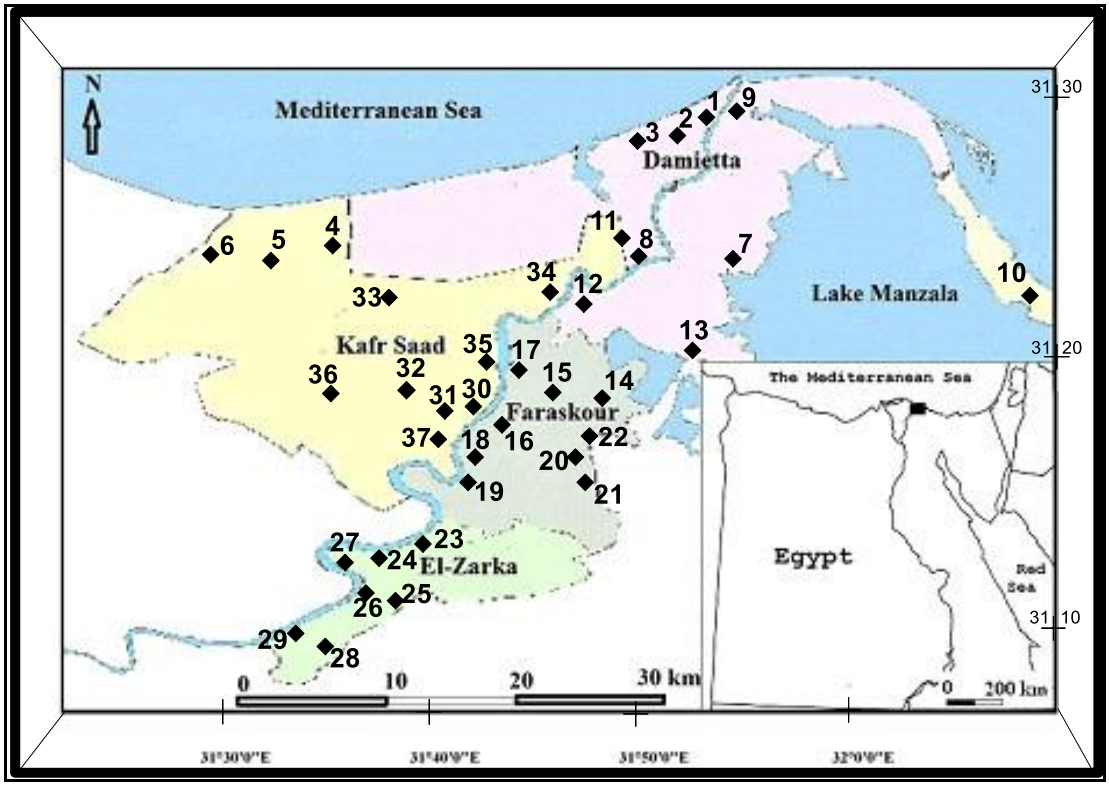

Fig. (1): Location map for the different surface drinking water samples.

Calculation of Pollution Index:

The pollution index (PI) was used in this study to evaluate the degree of heavy metal contamination in water samples (Chon etl [13], Kim etl [14], Emoyan [15], Odukoya and Abimbola [16]). The tolerable level is the element concentration in the water considered safe for human consumption (Lee etl [17]). Pollution index (PI) is based on individual metal calculations and categorized into 6 classes (Table 2) according the following equation (Caerio etl [18]).

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

Where Ci = Heavy metal concentration in water; Si= permissible Level and Nm = Number of Heavy metals.

Water sample with Pollution Index (PI) greater than 1 is regarded as being contaminated

Results and Discussion

The results are shown in Tables 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) [12] permissible limits, and the permissible limits of World Health Organization [11]. 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 Egyptian Ministry Health (EMH) [12] and World Health Organization [11] (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) (Tables. 2 and 3).

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 [11]	0.003	2.0	0.05	0.07	0.05	0.01	0.4	0.3	3.0
	Permissible limit of [12]	0.003	2.0	0.05	0.02	0.05	0.01	0.4	0.3	3.0
RasELBar District Network										
1	East of RasELBar	0.003	0.01	0.003	0.008	0.001	0.003	0.0	0.02	0.0
2	Center of RasELBar	0.003	0.01	0.002	0.009	0.002	0.003	0.01	0.02	0.01
3	West of RasELBar	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

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 [11]	0.003	2.0	0.05	0.07	0.05	0.01	0.4	0.3	3.0
	Permissible limit of [12]	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

Table. (3): Pollution Index of drinking surface network water in Damietta governorate, northern Egypt.

No.	Cd	Cu	Co	Ni	Cr	Pb	Mn	Fe	Zn	PI
RasELBar 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

In Damietta district, Cd values of the samples are more than the permissible limits of Egyptian Ministry Health (EMH) [12] and World Health Organization [11]. Cu values of the samples less than the permissible limits of Egyptian Ministry Health (EMH) [12] and World Health Organization [11] except in samples 9 and 12. Ni, Cr, Pb values are $\geq$ the permissible limits of Egyptian Ministry Health (EMH) [12] and World Health Organization [11]. Co, Mn and Fe values are less than the permissible limits of Egyptian Ministry Health (EMH) [12] and World Health Organization [11]. Pollution index of Damietta district is moderately affected category (2-3) (Tables 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 Egyptian Ministry Health (EMH) [12] and World Health Organization [11]. 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 KafSaad district, the sample 30 and 31 of KafrSaad city showed that Cd, Ni, Cr and Pb values more than the permissible limits of Egyptian Ministry Health (EMH) [12] and World Health Organization [11], while the other metals are less than the permissible limits. Samples of the villages of KafrSaad have concentration values less than the permissible limits of Egyptian Ministry Health (EMH) [12] and World Health Organization [11].

Pollution index of KafrSaad 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 KafrSaad City may be suffering from many diseases such as Liver Cirrhosis, Rental Failure, Chronic Anemia and Hair Loss.

Conclusions

Pollution of surface drinking water of Damietta governorate by heavy metals in most of villages less than that in the cities of the Damietta governorate. Pollution index is ranged between no affected to moderately affected for whole station samples.

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