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Heavy Metal Pollutants in Fresh Water

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Abstract: Water quality is one of the most important concerns. This study focused on screening of the most dangerous heavy metals(cadmium, chromium, copper, lead and nickel)in fresh water sources (surface and groundwater) of study area, Sohag governorate, Egypt. Ninety samples were collected from 15 sites along the study area extending from Tima to Dar-Elsalam cities; 12 wells and 3 Nile river local sites, 6 samples for each site, three during winter and three during summer. Results indicated that, total dissolved solids (TDS) and electric conductivity(EC) parameters in all samples increased significantly in summer than winter. While pH increased in winter than summer. All tested physical parameters of samples were within the safe limit of drinking water as prescribed by WHO, except pH in samples S_1 and S_3. The concentration of metals in the study area showed that all tested samples were free from Cr during winter or summer season. Also, Cu was not recorded in winter but appeared during summer season within permissible limit. Nickel (Ni) was recorded in all tested samples within permissible limit. On the other hand, Cd and Pb were recorded over than permissible limit in some samples. This study may represent dangerous alarm for the potential threats to the fresh water resources in study area.

Keywords: Drink Water, Surface Water, Ground Water, Heavy Metal Pollutants

1. Introduction

Water is the elixir of life, a precious gift of nature to mankind and millions of other species living on the earth. It is fast becoming a scare commodity in most part of the world. Water resources comprising of surface water (river and lakes), groundwater, and marine and coastal waters support all living things including human beings.

At the beginning of the twenty-one century, the earth with its diverse and abundant life forms, including over six billion humans, is facing a serious water crisis. Freshwater represents 3% of the total water on earth, but only a small percentage (0.01%) of this freshwater is available for human use [1].

Quality of the drinking water is a crucial demand as it is an essential substance upon which all life depends; however the world's finite supply of freshwater has been subjected to increasing pressures over the last 50 years. Surface fresh water sources only constitute 0.0067% of the total world water [2], while the world groundwater is about one hundred times more plentiful than surface water [3].

More than 96% of all the Egyptian fresh water resources are supplied by the river Nile, which originates from outside the country boundaries and supplies ten countries among which Egypt. Egypt's share of Nile water is limited according to the 1959 international agreement between Sudan and Egypt at $55.5x10^9 m^3$ [4].

Freshwater is generally obtained from two principal natural sources: surface water such as lakes, rivers, and streams and groundwater [5]. Main water resources in Sohag Governorate (Study area) are the surface water including the water in River Nile, the irrigation canals and the agriculture drains [6].

The other water resources in study area are represented by the water from the groundwater extraction, which are used in domestic, agriculture, and industry. Groundwater is representing the main source of the water in the low desert lands used for land reclamation. Groundwater provides about

85% of the potable water supply [7].

About 109x10^6 m^3 from the groundwater is pumped from the Quaternary aquifer in Sohag area for drinking purposes during 2002/2003 [8]. So, groundwater preservation and protection measures have been generally overlooked in the majority of the practices [9].

Water pollution is considered to be one of the most dangerous hazards affecting both developingand developed countries. The large-scale industrialization and production of variety of chemicalcompounds has led to global deterioration of the environmental quality [10].

Water resources at Sohag area are currently threatened by contamination from municipal, industrial, and agricultural pesticides. Agricultural pesticides and wastewater exhibit major impact on groundwater quality in the study area [11, 12].

The most common environmental pollutants in the world are heavy metals [13]. The presence of heavy metals at trace level and essential elements at elevated concentration causes toxic effects if exposed to human population [14].

Heavy metals are non-degradable toxic pollutants of natural water sources. Not only they persist within the environment but they also pose serious risks as far as population health is concerned since they can be accumulated by living organisms [15].

2. Material and Methods

2.1. Study Area

The study area, Sohag governorate, represents a part of the Nile valley extending between latitude 26°05′58″ to 27°00′00″ N and longitude 31°10′38″ to 32°15′00″E,"Figure 1" [16].

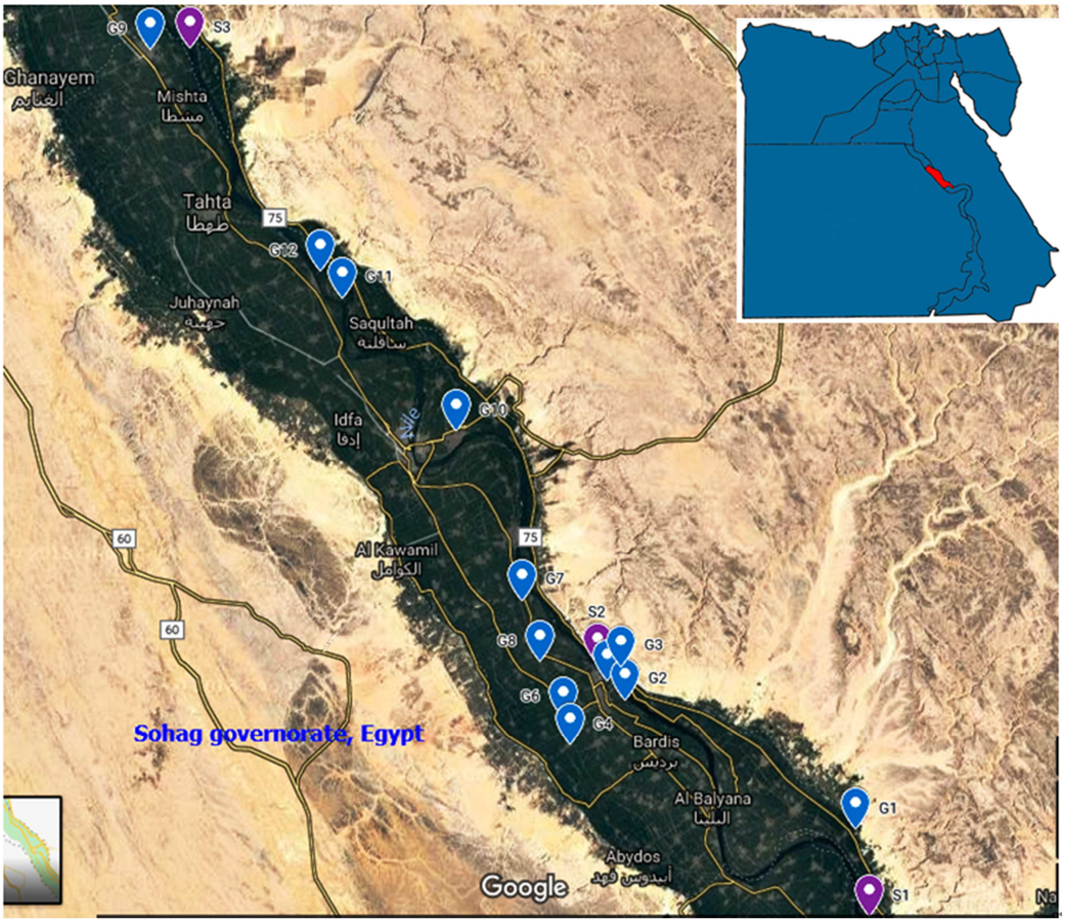

Figure 1. *The map of study area (Sohag Governorate, Egypt).*

2.2. Samples Collection

Total of 90 water samples were collected from 15 sites, in Sohag governorate, Egypt, 6 samples from each site (3 samples during winter season, sample monthly at December, January and February, 2017 and 3 at summer season during May, June and July in the same year).

The samples were distributed as; 18 samples from 3 Nile river local sites and 72 samples from 12 groundwater wells. All samples were collected in 1L polyethylene bottles with tight covers. The bottles were rinsed three times with distilled water then with HNO3 1% and dried all night at 60°C., then rinsed with a portion of the sample just before filling and covered tightly, no air-bubbles were allowed between the water sample-surface and the cover according to American Public Health Association [17].

All sample bottles were labeled; (depth, samples types, sample location latitude and longitude) as stated in "Table 1".

The heavy metal samples were transferred to Mycological laboratory, Botany and Microbiological Department, Sohag Faculty of science, and stored at 4°C in dark refrigerated and analyzed immediately [18].

2.3. Samples Analysis

The hydrogen ions concentration (pH) of each sample was measured using (AD_{11} pH meter-Romania) and total dissolved solids (TDS) and electric conductivity (EC) were investigated using (AD_{31} EC/TDS meter-Romania) in collection sites.

While the samples used to heavy metal investigation were filtered through 42µm filter paper and centrfugated at 4000rpm for 10minutes [17]. One hundred ml of each sample was adjusted to pH 2.0 or less using 1N of HNO3. Heavy metals were detected by the flame atomic absorption (PerkinElmer Atomic Absorption spectrometer AAnalyst 400).

Table 1. *Samples distribution in study area.*

Samples	Source	Sample data			
		Deep (m)	Location	Longitude	latitude
S_1	Nile	Surface	Dar-EL-Saalm	32,16,019 E	26,13,767 N
S_2	Nile	Surface	Gerga	31,88,760 E	26,36,224 N
S_3	Nile	Surface	Tema	31,48,038 E	26,90,937 N
G_1	Well	69.0	Dar-EL-Saalm	32,14,612 E	26,21,553 N
G_2	Well	18.0	Gerga-EL-Gazira	31,91,456 E	26,33,058 N
G_3	Well	34.5	Dar-EL-Saalm	31,91,171 E	26,36,022 N
G_4	Well	17.0	Gerga-EL-Qoraan	31,86,023 E	26,29,058 N
G_5	Well	36.0	Gerga-EL-Gazira	31,89,688 E	26,34,766 N
G_6	Well	15.0	Gerga-EL-Awamer	31,85,340 E	26,31,443 N
G_7	Well	31.0	EL-Aoserat-AwladBahej	31,81,288 E	26,41,940 N
G_8	Well	48.0	EL-Aoserat-AwladBahej	31,83,039 E	26,36,435 N
G_9	Well	32.0	Tema	31,44,004 E	26,90,845 N
G_{10}	Well	57.0	Akhmem	31,74,628 E	26,56,965 N
G_{11}	Well	36.0	Maragha-Gazerat EL-Shorania	31,63,256 E	26,68,842 N
G_{12}	Well	32.0	Maragha-Gazerat EL-Shorania	31,61,067 E	26,71,250 N

3. Result and Discussion

3.1. Physical Properties

Average seasonal of hydrogen ion concentration (pH), Total dissolved solids (TDS) and Electric conductivity (EC) are summarized in "Table 2".

3.1.1. Surface Water

The result in Table (2) revealed that, physical parameters of surface water, pH, TDS and EC were within permissible limit of drinking water [19] except pH of S_1 and S_3 during winter season. Where thepH ranged from 8.3to 8.7, total dissolved solids (TDS)ranged from 146 to 209 ppm andelectric conductivity (EC) ranged from 271 to 348 µS/cm.

These results are in agreement with those obtained by Elnazer*et* [20], who found that all physical parameters of the collected samples were acceptable levels of water major characteristics for drinking purposes.

3.1.2. Groundwater

The pH of groundwater (7.4–8.0) is less than in surface water, while total dissolved solids (TDS) (201-419 ppm) and electric conductivity (EC) (316-842 µS/cm)more than it in surface water, although that, the physical parameters of ground water within permissible limit for standard values of drinking water [19].

These results are in agreement with those obtained by Abdel Azeem [21], who found that all water Wells (19) except Well El-Kharaza from 95 samples in Saint Katherine protectorate, South Sinai Governorate, Egypt, was accepted to pH, TDS and EC according to WHO. Also, El-Senousy [21] reported that the pH, TDS and EC of groundwater samples which collected from different sites at Sohag Governorate, Egypt within permissible limit of [23].

Table 2. *Physical properties of water samples.*

Samples	Source	Average					
		Winter			Summer		
		pH	TDS ppm	EC μS	pH	TDS ppm	EC μS
S_1	Nile	8.7	170	341	8.4	168	312
S_2	Nile	8.4	158	319	8.3	146	279
S_3	Nile	8.6	209	348	8.4	199	271
G_1	Well	7.9	249	497	7.7	219	387
G_2	Well	7.5	274	516	7.6	243	401
G_3	Well	7.6	419	842	7.5	399	711
G_4	Well	8.0	250	499	7.9	201	316
G_5	Well	7.6	299	603	7.6	234	479
G_6	Well	7.8	276	541	7.7	216	413
G_7	Well	7.8	289	566	7.8	218	417

Samples	Source	Average					
		Winter			Summer		
		pH	TDS ppm	EC µS	pH	TDS ppm	EC µS
G_8	Well	7.7	301	589	7.6	269	434
G_9	Well	7.6	267	519	7.6	241	389
G_{10}	Well	7.4	291	569	7.4	252	423
G_{11}	Well	7.6	314	612	7.5	273	489
G_{12}	Well	7.6	291	578	7.5	241	412

3.2. Heavy Metal Analysis

3.2.1. Surface Water

All river Nile samples in study area were free from hazard element chromium. Also Cu was non-detectable during winter while detected in summer season (0.005-0.009 mg/l) within permissible limit. As well as Ni detected in all samples during winter and summer but within permissible limit. On other hand, Cd and Pb detected over permissible limit in some sites; Cd detected in 2/3 sites and Pb in 2/3 sites during winter and 3/3 sites during summer 'Table 3".

3.2.2. Groundwater

The same result of Cr in surface water was recorded in groundwater, also, Cu which non-detectable in winter season and recorded in some wells (8/12) in summer season within permissible limit. Ni detected in all wells during winter and summer season within permissible limit. On other hand, Cd and Pb detected over permissible limit in some sites; Cd detected in 6/12 wells during winter and 10/12 wells during summer and Pb detected in 4/12 wells during winter and 11/12 wells during summer 'Table 3".

Some surface and groundwater samples have Cd over contaminant level of 3 µg/l [23]. This is of concern because Cd has carcinogenic [24]. River Nile water content of Cd was raised from 12.5 µg/l in 2009 to 16 µg/l [25], where recorded in this study 53 µg/l in sample S_2, this increase is dangerous alarm.

The contamination of surface and groundwater by Cd and Pb in study area should be accorded maximum attention, these results agreement with Osman [26], who found that high level occurrence of cadmium and lead in surface and groundwater in Sohag governorate, Egypt. Also, agreement with Ahmed [16] study, that reveals to water resources in Sohag governorate, Egypt are highly contaminated with Cd and Pb.

Table 3. *Heavy metal concentration in water samples (ppm).*

Samples ID	Average heavy metal (ppm)									
	Winter					Summer				
	Cu	Pb	Cd	Ni	Cr	Cu	Pb	Cd	Ni	Cr
WHO	2.0	0.01	0.003	0.07	0.05	2.0	0.01	0.003	0.07	0.05
S_1	0.000	0.016	0.004	0.022	0.000	0.009	0.102	0.053	0.016	0.000
S_2	0.000	0.019	0.004	0.019	0.000	0.007	0.104	0.050	0.023	0.000
S_3	0.000	0.000	0.000	0.014	0.000	0.005	0.011	0.027	0.023	0.000
G_1	0.000	0.000	0.004	0.022	0.000	0.001	0.011	0.006	0.017	0.000
G_2	0.000	0.000	0.004	0.024	0.000	0.001	0.017	0.009	0.013	0.000
G_3	0.000	0.000	0.003	0.021	0.000	0.003	0.014	0.004	0.032	0.000
G_4	0.000	0.000	0.003	0.024	0.000	0.002	0.021	0.005	0.052	0.000
G_5	0.000	0.000	0.003	0.020	0.000	0.002	0.018	0.005	0.021	0.000
G_6	0.000	0.000	0.003	0.023	0.000	0.005	0.016	0.006	0.017	0.000
G_7	0.000	0.022	0.004	0.018	0.000	0.008	0.078	0.047	0.026	0.000
G_8	0.000	0.044	0.005	0.019	0.000	0.000	0.082	0.013	0.027	0.000
G_9	0.000	0.031	0.004	0.023	0.000	0.000	0.059	0.007	0.033	0.000
G_{10}	0.000	0.044	0.005	0.025	0.000	0.009	0.112	0.048	0.015	0.000
G_{11}	0.000	0.000	0.000	0.017	0.000	0.000	0.007	0.003	0.019	0.000
G_{12}	0.000	0.000	0.000	0.016	0.000	0.000	0.011	0.002	0.047	0.000

4. Conclusion

Data revealed that all tested samples were free from Cr, While Ni and Cu were present in within permissible limit. On the other hand, Cd and Pb were recorded over permissible limit in some samples. Where, Cd recorded in (2/3 and 6/12) of surface and groundwater sites respectively during winter and in (3/3 and 10/12) of surface and groundwater sites respectively during summer season. While Pb recorded in (2/3 and 4/12) of surface and groundwater sites respectively during winter and (3/3 and 11/12) of surface and groundwater sites respectively during summer season.

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