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Impact of Surface Water and Groundwater Pollutions on Irrigated Soil, El Minia Province, Northern Upper Egypt

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Abstract

Current research has been focused on heavy metals pollution in surface water and groundwater and effect on irrigated soil from El Minia Province, north Upper Egypt. Concentration of heavy metals (e.g., As, Co, Hg, Ni, Se, Cd and Cr) in surface water, groundwater and irrigated soil samples is most significantly affected by leachate of many pollutants as the factories, agricultural activities, urban and natural processes. Microbiological parameters and microscopic investigations are revealed that some localities are common by micro-organisms, which are unsuitable for drinking waters.

Keywords

Heavy Metals Pollution, Surface Water, Groundwater, Soils, El Minia Province, North Upper Egypt

1. Introduction

The area under investigation lies between latitudes 27˚35'N and 28˚45'N and longitudes 30˚35'E and 30˚55'E, within El Minia Province, northern Upper Egypt (**Figure 1**). The pollution of water affects on human, animal life and agriculture. The water borne pathogens cause some diseases (e.g. renal failure, liver cirrhosis, hair loss, chronic anemia…etc.). Heavy metal pollutants are very harmful and toxic.

These elements are encountered in various emission sources related to industrial, transportation, urban activities and agricultural practices [1] [2]. The anthropogenic developments and the most contaminants penetrate into soils or aquifer and eventually groundwater have caused increase of pollution [3] [4]. There is no studied work

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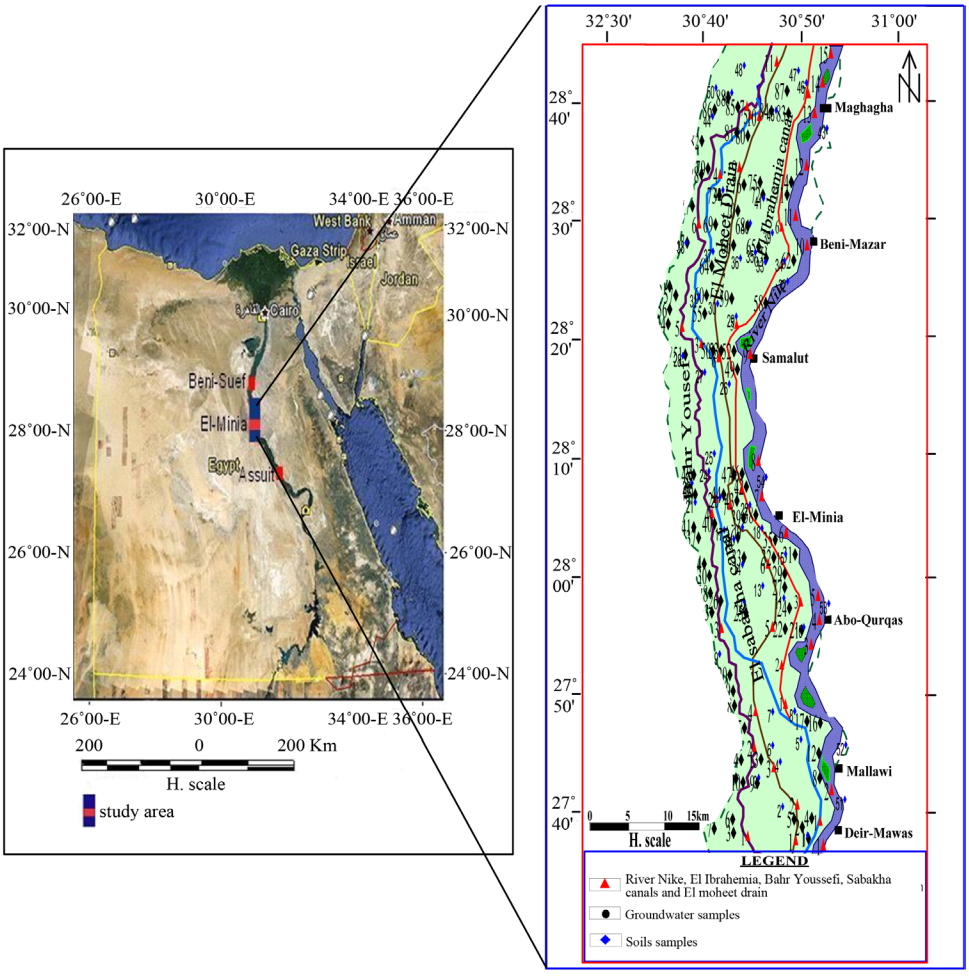

Figure 1. Location map of the studied surface, groundwater and soils samples in the study area.

in the study area discussed the heavy metals pollution in surface water with groundwater and its effect on soils. Therefore, the aim of this study is to assess the heavy metals contamination in waters and its effect on irrigated soils of El Minia Province, northern Upper Egypt.

2. Materials and Methods

A total of 169 water samples were collected during 2013 from El Minia Province. They are distributed as; eighty one surface water samples are represented by fifteen samples from River Nile, fourteen samples from El Ibrahimia canal and Bahr Youssef, five samples from El Sabakha canal, forty seven from surface drains, and eighty-eight groundwater samples. Microbiological procedure and microscopic study of the collected waters were carried out to determine the micro-organisms to confirm the safety for human consumption.

Fifty-four soil samples distributed through eight sites were collected from the surface layers (10 - 30 cm) of the concerned land uses. The depth to water and total depth of drilling were collected from the owner of the wells. The collected soil samples were air-dried, crushed, sieved with a 2 mm size and subjected to physical and chemical analyses. The collected waters and soils were carried out at the Central Health Laboratories, Abdein, Cairo, Egypt and analyzed by using atomic absorption spectrometer (GBC, GF 3000, USA).

3. Geology and Hydrogeologic Setting

Locally, the stratigraphic sequence of the study area is built up from base to top [5] as; Middle Eocene limestone intercalated with shale; Pliocene undifferentiated sands, clays, and conglomerates; Plio-Pleistocene sand and

gravel with clay and shale intercalations; Pleistocene sand and gravel with clay intercalations; and Holocene silt and clay.

The Quaternary aquifer represents the main aquifer in the study area and composed of massive cross-bedded fluvial sand with gravel and clay sediments and rests directly on the Pliocene clay and the fissured Eocene limestone. Generally, the thickness of this aquifer decreases gradually towards the Eocene plateau and hydraulically connected with the underlined Eocene aquifer through many faults [6]. This aquifer is recharge mainly from the surface water, particularly through the irrigations canals, which play a main role in the configuration of the water table. The discharge of this aquifer takes place during the evaporation process. The connection to the underlying aquifer and River Nile acts as an effluent stream in most parts of the study area.

The groundwater flow in the study area is directed generally towards the northeast, *i.e*. towards the River Nile due to the influence of recharging canals. The flow regime has a general trend parallel to the flow of water in the Nile and other trends are parallel to the water of irrigation canals.

4. Results and Discussion

4.1. Water Pollution

In the study area, the heavy metals distribution in surface water and groundwater are given in **Table 1**. Hydrochemically ,the high values of As, Co, Hg, Ni, Se, Cd and Cr in some localities of surface water as, River Nile, El Ibrahemia, El Sabakha and Bahr Youssef. These elements are attributed to anthropogenic activities (in El Moheet drain and its branches), where its septic tanks are affected by the factories (Sugar factory of Abo Qurqas city and Onion factory of Maghagha city), agricultural activities and urban between Abo-Qurqas and Maghagha cities (El Sheikh Ziad village) as well as natural processes (such as changes in precipitation inputs, erosion, weathering of Pliocene and Eocene rocks).

An estimated 44% of surface water (*i.e*., Bahr Youssefi, El Ibrahemia canal and El Sabakha canals) is acceptable for human drinking based on [7] and the rest 56% are unsuitable for drinking due to its higher constituent of these elements (*i.e*., El Moheet drain and its branches having perversions values of toxic heavy metals).

About 49% of the groundwater collected samples exhibit high values of B, Mn, As, Hg, Cr, Ni, Co, Cd, and Se, may be caused by leaching from the industrial wastes coming to El Moheet drain, drainages water of splendiferous irrigated soil and Eocene rocks and corrosion of well casing and other pipes.

Also, the geographic position of the River Nile, El Ibrahemia canal, and El Moheet drain are impact on the groundwater quality. While, 51% of the groundwater samples is suitable for drinking water because these elements have values below the permissible limits of Egyptian standards guidelines for drinking water [7] [8]; Decree of Health Minister (No. 458) (2007) (**Figure 2**).

Microbial Contamination

Microbiological analysis of surface water and groundwater indicate that about 29% and 25% respectively, of the total collected samples are positive for bacteria (positive gram of fecal and total coliform bacteria), *i.e*., surface water samples (sample No. 4 of River Nile, No. 2 of Bahr Youssefi, No. 3 of El Ibrahemia canal, No. 2 of El Sabakha and all samples of El Moheet drain), as well as groundwater samples (samples Nos. 10, 18, 22, 23, 25, 29, 32, 33, 40, 44, 48, 53, 63, 66, 80, 81, 83, and 84). Remaining samples are suitable for drinking and domestic properties. The icroscopic investigation show that about 15% of the total surface water samples are positive for micro-organisms, such as protozoa, A. Minthes (Scistoosom), and algae (Cyamophyte), due to infiltration from septic tanks, while 85% rest is suitable for drinking. The groundwater samples indicate that 75% are free from of the protozoa, Scistoosoma Minthes and Cyamophyte (algae) and the rest (25%) are positive due to infiltration from septic tanks.

4.2. Soil Pollution

71% of soils which irrigated by surface water are polluted with most of heavy metals (Fe, Mn, Zn, Cu and B) and the rest were in the permissible level. The data revealed large different between trace elements content in different soils. The highest content of trace elements (Fe, Mn, Zn, Cu and B) in soils sites which irrigated by surface water, the mean of these element are (4.73, 4.92, 1.4, 1.22 and 1.72 mg/l) compared to that of soils sites which irrigated with groundwater, the mean of these element were (6.39, 3.94, 1.30, 1.61 and 1.28 mg/l) and

Table 1. Range, means and limits of some trace and toxic heavy elements of the collected surface and groundwaters samples in the study area.

	S. Resource	Range of essential trace elements in mg/l					Range of toxic heavy elements in mg/l						
		Zn^{2+}	Cu^{2+}	Mn^{2+}	Fe^{3+}	Co^{2+}	Pb^{2+}	Cd^{2+}	Cr^{4+}	As^{3+}	Hg^{3+}	Ni^{2+}	Se^{2+}
	A* Limits (Emh)	**3.0**	**2.0**	**0.4**	**0.3**	**0.01**	**0.01**	**0.003**	**0.05**	**0.01**	**0.001**	**0.02**	**0.01**
Surface Water Samples	River Nile, El Ibrahimia, Bahr Youssefi and El Sabakha Canals	0.001 - 0.08	0.01 - 0.08	Nil-1.5	Nil-4.5	0.001 - 0.08	0.001 - 1.2	0.0001 - 0.0643	0.001 - 0.963	0.0001 - 0.003	0.001 - 0.003	0.01 - 0.06	0.0001 - 0.357
	Mean	0.041	0.045	0.65	2.25	0.041	0.601	0.0322	0.482	0.0016	0.002	0.025	0.1786
	Standard Deviation	0.02	0.03	0.42	1.44	0	0.42	0.05	0.18	1.71	0	0.02	0.07
	El Moheet drain and its Branches	1.05 - 14.6	1.9 - 7.6	1.22 - 14.5	0.4 - 18.5	1.35 - 6.8	0.234 - 14.6	0.0034 - 2.0863	0.023 - 1.652	0.01 - 1.365	0.4 - 2.67	0.063 - 4.6	0.002 - 0.328
	Mean	7.825	4.75	7.86	9.45	4.08	7.417	1.045	0.838	0.688	1.535	2.335	0.164
	Standard deviation	1.23	4.42	3.66	4.37	9.26	0.3.86	0.5	0.4	0.4	0.54	1.02	0.13
	Groundwater samples	Nil-1.435	0.001 - 2.85	Nil-1.5	Nil-0.6	0.001 - 1.4	0.0001 - 0.365	0.0001 - 0.1836	0.0012 - 0.3212	0.001 - 0.234	0.0001 - 0.0085	0.001 - 0.245	0.001 - 0.294
	Mean	0.718	1.426	0.75	0.3	0.701	0.1826	0.0919	0.1606	0.118	0.0043	0.123	0.148
	Standard deviation	0.42	0.75	0.41	0.21	0	0.07	0.03	0.08	0.05	2.28	0.03	0.04

Shaded area is the high values according to EMH (Egyptian Ministry Health); decree of Health Minister (N0.458/ 2007).

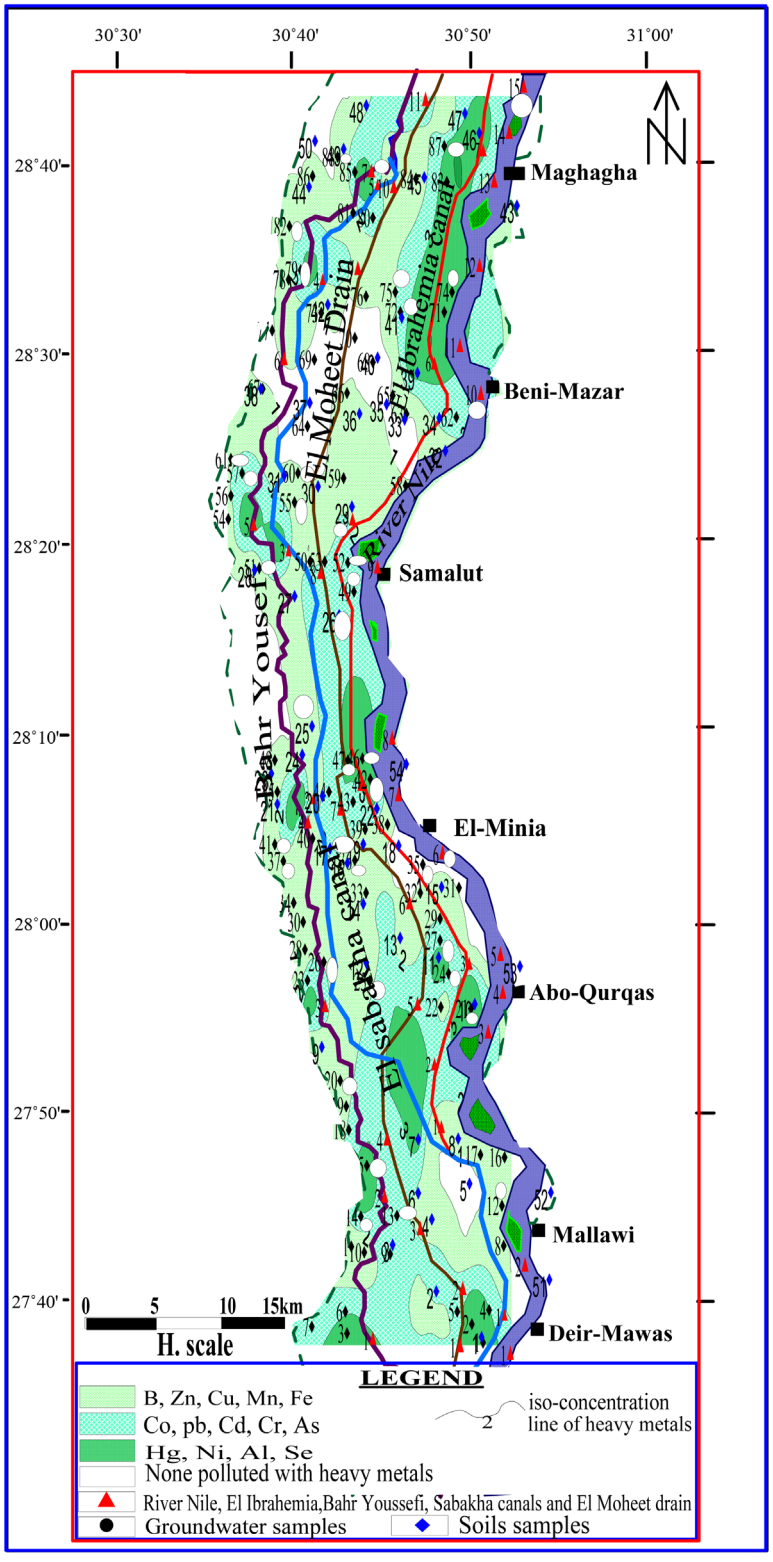

Figure 2. Heavy metals of the studied surface, groundwater and soils samples.

soils sites which irrigated with drains, the mean of these element are (9.8, 11.15, 8.25, 6.30 and 7.05 mg/l) (**Table 1**).

Soils samples which irrigated with groundwater are polluted by some heavy metals (B, Fe and Cu) are represented about 75%, and all soils samples which irrigated with drainage water are exceeds the permissible level that are polluted with high heavy metals (B, Fe and Cu) with mean value of (7.05, 9.8 and 6.30 mg/l) due to recharged of domestic and industrial effluents.

The Sites of Contaminated Soil

The soil which irrigated by River Nile water contaminated with Mn at El Biadia village (Malawi city) refers to domestic activities. The soil which irrigated by El Moheet water contaminated with B, Fe, Cu, Zn, Mn, Pb, Cd, Cr and Se, *i.e.*, Nawai and Ebshadat villages (Malawi city) at east and west of El Moheet drain; Nazlt Grais; Nazlt Roman; Gowaid and Reda villages (Abo Qorkas city) at south of El Moheet drain; Tala and Damsher villages (El Minia city) at east of El Moheet drain; Etsa and Dafsh villages (Samalut city); and Ezbt Ahmed Yones village (Maghagha city).

5. Conclusion

Hydrochemically, surface water shows that about 44% of the collected samples (*i.e.*, Bahr Youssefi, El Ibrahemia canal and El Sabakha canals) are acceptable for human drinking and the rest 56% are unsuitable for drinking due to higher constituent of heavy metals. However, 49% of the groundwater samples exhibit high values of some heavy metals as well as soils samples which irrigated by surface and groundwater are polluted by some heavy metals. These heavy metals may be caused by leaching from the anthropogenic activities (*i.e.*, El Moheet drain and its branches, where they receive wastewater from the factories of Abo-Qurqas Sugar and Maghagha Onion, as well as agricultural wastewater and urban).

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