



Journal of Environmental Science and Technology

ISSN 1994-7887

science
alert

ANSI*net*
an open access publisher
<http://ansinet.com>



Research Article

Quality Assessment of River Nile Sediment Between Qena and Sohag Cities, Egypt

¹Alaa Mostafa, ²Salman A. Salman, ¹Elmontser M. Seleem, ²Ahmed A. Elnazer, ³Ahmed Gab-Allah Al-Gamal, ⁴Atef El-Taher and ^{5,6}Howaida Mansour

¹Department of Geology, Faculty of Science, Al Azhar University, Assiut Branch, Egypt

²Department of Geological Sciences, National Research Centre, Dokki, Giza, Egypt

³Quarries Administration, Sohag Governorate, Egypt

⁴Department of Physics, Faculty of Science, Al Azhar University, Assiut Branch, Egypt

⁵Department of Physics, Faculty of Women for Arts, Science and Education, Ain Shams University, Egypt

⁶Department of Physics, College of Science and Art, Ar Rass, Qassim University, Kingdom of Saudi Arabia

Abstract

Background and Objective: River bottom sediment quality is a good indicator for river health, directly impact water chemistry and aquatic life. The aim of the current work was the assessment of the River Nile sediment quality between Qena and Sohag cities, Egypt. **Materials and Methods:** The pH, particle size distributions (PSDs), organic matter (%) (OM %) as well as As, Cd, Cr, Cu and Pb ($\mu\text{g g}^{-1}$) concentrations were determined according to standard methods in the collected 28 samples. Index of geoaccumulation (I_{geo}) and sediment quality index (SQI) were applied to evaluate the sediment quality degree. **Results:** The pH of sediments are alkaline ($\text{pH} \approx 7.5$) and sandy (sand $\approx 79.3\%$) with low OM ($\approx 4.48\%$). Most of the studied sediment samples contain alert concentrations of As ($62.6 \mu\text{g g}^{-1}$), Cd ($4.17 \mu\text{g g}^{-1}$) and Cr ($98.2 \mu\text{g g}^{-1}$) that can cause adverse biological impacts. However, the sediments are biologically safe with respect to their contents of Pb ($16.43 \mu\text{g g}^{-1}$) and to great extent with Cu ($77.22 \mu\text{g g}^{-1}$). **Conclusion:** The pH of the sediments was slightly alkaline. The I_{geo} indicated the severe pollution of sediment with Cd followed by As, Cu and Cr.

Key words: Sediment quality index, index of geoaccumulation, river Nile, heavy metals, geogenic, anthropogenic, bottom sediment, water chemistry

Citation: Alaa Mostafa, Salman A. Salman, Elmontser M. Seleem, Ahmed A. Elnazer, Ahmed Gab-Allah Al-Gamal, Atef El-Taher and Howaida Mansour, 2019. Quality assessment of river Nile sediment between Qena and Sohag cities, Egypt. J. Environ. Sci. Technol., 12: 117-124.

Corresponding Author: Howaida Mansour, Department of Physics, College of Science and Art, Ar Rass, Qassim University, Kingdom of Saudi Arabia
Tel: 00966569098742, 00966546598215

Copyright: © 2019 Alaa Mostafa *et al.* This is an open access article distributed under the terms of the creative commons attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The River Nile played a big role in the rise and evolution of the Egyptian societies. Egyptian old civilization had flourished and the most development activities are still depending upon it. It is the main source of fresh water for drinking, agricultural and industrial activities. Unfortunately, industrial, agricultural and urban activities discharge polluted wastewater into the River Nile, so it affects on its water quality¹⁻³. The main source of sediments into the Nile trunk in Egypt is the Blue Nile ($60 \pm 4\%$) followed by Atbara ($36 \pm 4\%$) and the White Nile ($3 \pm 2\%$). The Blue Nile and Atbara drain the Ethiopian highlands, while the White Nile drains the Archean basement of the Congo Craton⁴.

The sediments of rivers are a natural sponge that adsorbs all kinds of pollutants occurring in water⁵. However sediments aren't only an accumulator of water body pollutants, but also it is a secondary pollution source which has a potential impact on water quality⁶. Therefore, sediment quality gives a good indication on water quality because sediments absorb organic and inorganic pollutants⁷. Sediment pollution, especially with heavy metals has an important impact on the aquatic environment and a director potential threat to the human⁶. Generally, the metals present in unpolluted rivers with very low concentration safe to aquatic environment and is derived from rock and soil⁸. However, these metals concentrations raised in rivers into alert levels as a result of anthropogenic activities owing to the disposal of untreated and/or partially treated wastewaters^{1,3}.

The sediment quality index (SQI) is a useful and a simple tool for determination of the quality of sediment through integrating many results digits into a single number. There are two types of SQI calculation produces, one to give an indication about specific site quality and the other for an entire area quality^{9,10}. The SQI works through the calculation of sediment quality with reference to sediment quality guidelines. CCME¹¹ proposed two limits of individual chemicals to distinguish the adverse impact of these chemicals on the biological environment.

Since it was proposed by Muller¹² the index of geoaccumulation (I_{geo}) is widely used in sediment contamination studies by many authors like Mohiuddin *et al.*¹³ and Rzetala¹⁴. The advantage of I_{geo} is its ability on the assessment of sediment contamination in various sedimentary environments¹⁴.

In recent years, it is clear that the River Nile suffers from a big increasing of pollution that may cause a big danger on human health. This issue pushed the authors to think of a solution of this problem via the study of sediment of River Nile and determining the pollution ratio. The aim of this study was to evaluate the River Nile sediment quality in the sector between Qena and Sohag cities, Egypt, through physic-chemical characterization of this sediment as well as application of SQI and I_{geo} .

MATERIALS AND METHODS

Study area: The area of study extended about 153 km in the main river trunk, starting from Qena city (upstream) to Sohag city¹⁵ (downstream) as shown in Fig. 1. It lies between longitudes $31^{\circ}42'12''$ and $32^{\circ}42'36''$ and latitudes $26^{\circ}8'48''$ and $26^{\circ}32'48''$. The area contains many pollution point sources as agricultural drains, agro-industries, metallurgical (Aluminum) industries, navigation and drinking water network washing station¹⁶ were pointed out the role of sugar factories in Sohag governorate in increasing pollution of the River Nile by Pb and Cd. In the study area coal used in smelters that represent a great source of environmental pollution with heavy metals. Also, the study area contains many canals and drains that can transport the pollutants from inner cities and villages into the River Nile.

Sampling and analyses: Twentyeight samples were collected from the River Nile trunk bottom sediments between Qena and Sohag cities during January, 2016. In this period, the level of the Nile water is dwindled as a result of winter drought and accordingly the sampling of sediment is accessible. All sediment samples were placed in polyethylene bags and then brought to the laboratory. In the lab, all sediment samples were air-dried at room temperature for 3 weeks, slightly crushed, passed through 2 mm nylon sieve to remove coarse debris and stones, quartered and stored in plastic containers. A sub-sample was used for particle size distribution and pH values determined based on Soil Survey¹⁷. Another sub-sample was crushed to 0.15 mm and then organic matter (%) was determined based on Soil Survey¹⁸. Then sub-sample was dried at 105°C , pulverized to $63\text{ }\mu\text{m}$ and 1 g was weighed and digested with aqua regia (1 HNO_3 : 3 HCL). Concentrations of As, Cd, Cr, Cu and Pb were measured in triplicate in both sub-samples by flame atomic absorption spectrometry and Spearman correlation was studied between the parameters of the sediments.

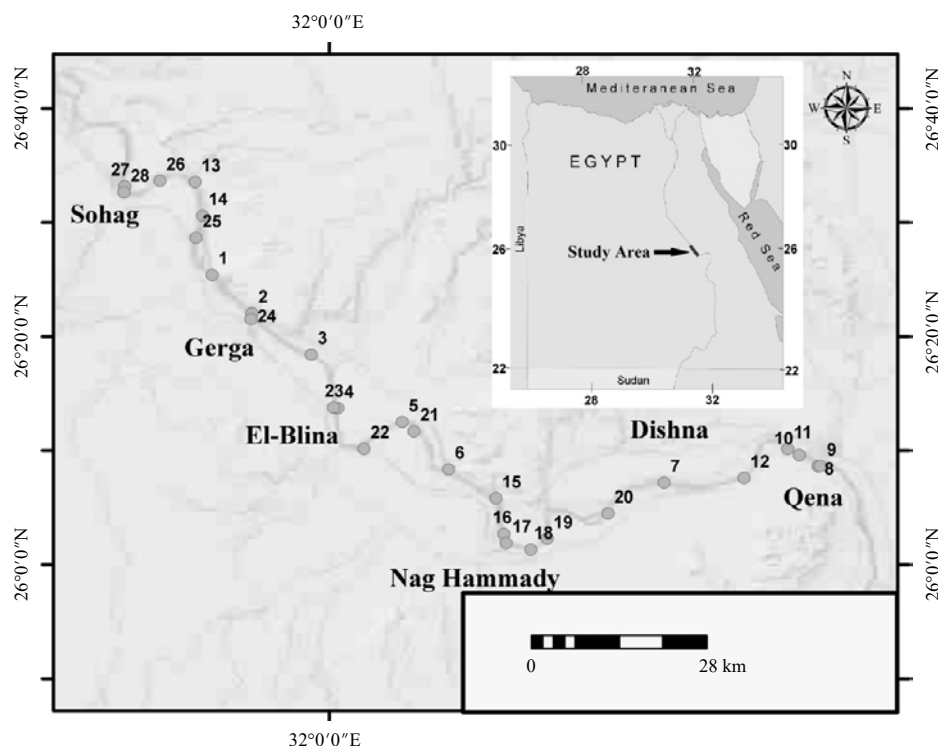


Fig. 1: Location map of the study area and sampling sites

Source: Elnazer¹⁵

Calculation of the sediment quality index: The Sediment Quality Index (SQI) was calculated according to the following equation^{9,10}:

$$SQI_a = 100 - \left(\frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732} \right)$$

$$SQI_s = 100 - \left(\frac{\sqrt{F_1^2 + F_3^2}}{1.414} \right)$$

Two versions of the index were explored, the site-specific SQI (SQI_s) and an area-average SQI (SQI_a). The divisors 1.732 and 1.414 normalizes the resultant values to a range between 0 and 100, where 0 represents the "worst" sediment quality and 100 represents the "best" sediment quality¹⁰.

Where, F_1 (Scope): Failed variables (the percentage of variables that do not meet their objectives at least once during the time period under consideration), relative to the total number of measured variables:

$$F_1 = \left(\frac{\text{Number of failed variables}}{\text{Total number of variables}} \right) \times 100$$

F_2 (Frequency) : Failed test (Percentage of individual tests that don't meet objectives):

$$F_2 = \left(\frac{\text{Number of failed testes}}{\text{Total number of testes}} \right) \times 100$$

F_3 (Amplitude) : The amount by which failed test values don't meet their objectives:

$$F_3 = \frac{\text{mdnc}}{0.01\text{mdnc} + 0.01}$$

$$\text{mdnc} = \frac{\sum_{i=1}^n \text{non-compliance}(i)}{\text{Total number of testes}}$$

$$\text{Non-compliance}(i) = \left(\frac{\text{Failed test value}(i)}{\text{guideline}(i)} \right) - 1$$

Where:

- mdnc = Mean degree of non-compliance
- i = Individual guideline
- n = Total number of guidelines used
- Non-compliance = Amount by which the concentration of a variable exceeds its guideline value

Once the SQI value has been determined, sediment quality is ranked into five categories: Poor quality ($SQI < 45$), Marginal ($45 \leq SQI < 60$), Fair ($60 \leq SQI < 80$), Good ($80 \leq SQI < 95$) and Excellent quality ($SQI \geq 95$).

Calculation of the index of geoaccumulation: To assess the pollution degree of sediment, the index of geoaccumulation equation of Muller¹² was applied:

$$I_{geo} = \log_2 \left(\frac{C_m}{1.5 \times B_m} \right)$$

where, C_m is the metal concentration in the studied sediment samples and B_m is its background value. The concentrations of studied metal in Nasser Lake¹⁹ were used as background in the current study but the toxicity reference value (TRV) was used as background. The use of regional geochemical background of metals gives a good indication about the sediment pollution than the use of Earth's crust metal background¹⁴. The constant 1.5 is used for the possible variations of the background data due to the lithogenic effects. Muller¹² has distinguished the following 7 classes based on the I_{geo} values; (a) Class 0 uncontaminated with $I_{geo} \leq 0$, (b) Class 1

uncontaminated to moderately contaminated with $0 < I_{geo} \leq 1$, (c) Class 2 moderately contaminated with $1 < I_{geo} \leq 2$, (d) Class 3 moderately to strongly contaminated with $2 < I_{geo} < 3$, (e) Class 4 strongly contaminated with $3 < I_{geo} \leq 4$, (f) Class 5 strongly to extremely contaminated with $4 < I_{geo} \leq 5$ and (g) Class 6 extremely contaminated with $I_{geo} > 5$.

RESULTS AND DISCUSSION

The descriptive statistics of the studied physicochemical parameters results of sediments during the current study are illustrated in Table 1. The pH of the sediments was slightly alkaline and ranged from 7.1-8.00. The organic matter content in analyzed samples of bottom sediments ranged from 0.46-9.78%. The studied elements concentrations were illustrated also in Table 1. The average concentration of As, Cd, Cr, Cu and Pb was 62.63, 4.17, 98.2, 77.22 and 16.43 $\mu\text{g g}^{-1}$.

It is shown in Table 2 that the negative correlation between sand (%) and OM (%) and positive correlation of OM (%) with both of silt and clay.

The comparison between the current results and other parts of the River Nile trunk is indicated the elevated concentrations in the current study (Table 3).

Table 1: Descriptive statistics of physicochemical parameters of sediments

Parameters	pH	OM (%)	Sand (%)	Silt (%)	Clay (%)	As ($\mu\text{g g}^{-1}$)	Cd ($\mu\text{g g}^{-1}$)	Pb ($\mu\text{g g}^{-1}$)	Cr ($\mu\text{g g}^{-1}$)	Cu ($\mu\text{g g}^{-1}$)
Mean	7.5	4.48	79.3	12.2	8.5	62.63	4.17	16.43	98.20	77.22
Median	7.5	3.90	85.0	6.3	7.5	9.15	4.20	16.95	102.50	62.70
S.D.	0.2	2.75	20.8	15.3	6.3	109.36	1.75	29.17	41.95	40.26
Minimum	7.1	0.46	8.0	0.0	2.5	0.00	0.42	7.90	21.00	20.00
Maximum	8.0	9.78	98.0	56.8	35.0	442.30	7.20	37.40	180.40	177.60
Q1	7.3	2.17	74.7	1.9	5.0	0.00	3.45	9.15	66.45	50.63
Q3	7.7	6.92	93.2	14.1	10.0	71.50	5.40	20.23	116.80	96.30

SD: Standard deviation

Table 2: Spearman correlation coefficient between the studied parameters of sediments

Parameters	Sand	Silt	Clay	pH	OM	CaCO ₃	As	Cd	Pb	Cr	Cu
Sand	1										
Silt	-0.98	1									
Clay	-0.92	0.84**	1								
pH	0.40*	-0.44**	-0.31	1							
OM	-0.76	0.77**	0.68**	-0.54**	1						
CaCO ₃	-0.61	0.58**	0.59**	-0.21	0.69**	1.0					
As	-0.16	0.25	0.00	-0.02	0.07	-0.15	1.0				
Cd	-0.49	0.54**	0.37*	-0.36*	0.62**	0.57**	0.0	1.0			
Pb	-0.57	0.66**	0.35*	-0.39*	0.77**	0.46**	0.14	0.69**	1.0		
Cr	-0.13	0.19	0.06	-0.10	0.0	-0.13	0.24	0.22	0.23	1.00	
Cu	-0.49	0.51**	0.37*	-0.31	0.72**	0.54**	0.21	0.57**	0.66**	0.25	1

**Correlation is significant at 0.01 level. *Correlation is significant at 0.05 level

Table 3: Comparison between the current results and other parts of the River Nile as well as USEPA²⁴ TRV

Locations	As	Cd	Pb	Cr	Cu	References
Current	62.63	4.17	21.04	98.20	77.22	This study
Lake Nasser (Egypt)	-	0.175	10.91	30.79	21.78	18
River Nile (Aswan-Isna)	-	3	10	-	42	26
River Nile (Greater Cairo)	-	1.7-3	2.33-685	36.6-46	27-90	27
TRV (Toxicity reference value)	6	0.6	31	26	16	23

Table 4: SQI values and ranks based on ISQG and PEL backgrounds

SQI (ISQG)	Rank	SQI (PEL)	Rank
57	Marginal	100	Excellent
44	Poor	82	Good
14	Poor	39	Poor
36	Poor	51	Marginal
68	Fair	100	Excellent
34	Poor	67	Fair
19	Poor	45	Marginal
18	Poor	43	Poor
14	Poor	32	Poor
12	Poor	27	Poor
21	Poor	50	Marginal
53	Marginal	86	Good
20	Poor	61	Fair
38	Poor	71	Fair
31	Poor	67	Fair
12	Poor	67	Fair
44	Poor	86	Good
24	Poor	69	Fair
15	Poor	35	Poor
42	Poor	83	Good
38	Poor	85	Good
24	Poor	70	Fair
35	Poor	70	Fair
26	Poor	81	Good
54	Marginal	86	Good
34	Poor	70	Fair
43	Poor	86	Good
28	Poor	82	Good

Table 5: Calculated I_{geo} and rank of different sites

Pb	Cd	Cr	As	Cu
-0.9*	3.5 [†]	0.0*	-1.5*	0.0*
-0.8*	1.2 [‡]	1.9 [‡]	0.5**	0.8**
0.9**	4.0 [†]	0.2**	5.0 [§]	1.9 [‡]
-1.0*	0.7**	1.1	3.8 [†]	-0.7*
-1.1*	1.0**	0.6**	-	0.8**
0.7**	4.4 [§]	1.9 [‡]	-	0.6**
0.2**	4.2 [§]	1.3 [‡]	3.3 [†]	0.9**
0.3**	4.4 [§]	1.3 [‡]	3.4 [†]	1.5 [‡]
-0.5*	4.0 [†]	1.2 [‡]	4.9 [§]	1.8 [‡]
0.0*	4.5 [§]	1.3 [‡]	5.6***	0.9**
-0.1*	3.8 [†]	1.1 [‡]	2.9 [‡]	0.7**
-0.8*	3.5 [†]	1.0**	-	0.1**
0.4**	4.7 [§]	0.8**	2.6 [‡]	0.8**
0.2**	4.0 [†]	1.2 [‡]	-	1.0**
0.4**	4.8 [§]	1.6 [‡]	-	2.0 [‡]
1.2	3.8 [†]	0.4**	2.2 [‡]	2.2 [‡]
-1.0*	3.8 [†]	0.1**	-	0.2**
0.1**	4.4 [§]	1.5 [‡]	0.7**	1.2 [‡]
0.4**	4.2 [§]	1.6 [‡]	4.5 [§]	2.2 [‡]
0.2**	4.5 [§]	-1.0*	-	2.4 [‡]
0.1**	4.2 [§]	0.9**	-	0.9**
0.0*	4.5 [§]	1.2 [‡]	-0.5*	1.4 [‡]
0.4**	4.4 [§]	1.2 [‡]	-	1.3 [‡]
-0.9*	3.5 [†]	0.9**	2.0 [‡]	0.6**
-0.9*	3.8 [†]	-1.1*	-	0.7**
0.2**	4.4 [§]	1.3 [‡]	-	1.9 [‡]
-0.7*	3.8 [†]	0.2**	-	0.5**
-0.9*	3.2 [†]	2.0 [‡]	0.4**	1.1 [‡]

*Practically uncontaminated, **Uncontaminated to moderately contaminated,

†Moderately contaminated, ‡Moderately to heavily contaminated, §Heavily contaminated, §Heavily to extremely contaminated, ***Extremely contaminated

The calculated SQI_s with reference to ISQG for River Nile individual sites showed that 24 samples are of poor quality with SQI_s ≤ 44, 3 samples are of marginal quality and only 1 sample is of fair quality as it is shown in Table 4. However, the calculated SQI_s with based on PEL guidelines indicated that only 5 samples were of poor quality and more than 50% of samples were of good (9 samples) and fair (9 samples) quality (Table 4), but only 2 samples are of excellent quality 3 samples are of marginal quality (Table 4). Generally, the calculated SQI_a values for the area were 17 (poor quality) and 53 (marginal quality) based on ISQG and PEL, respectively.

The calculated I_{geo} for heavy metals of sediments of the study area and their corresponding contamination intensity are illustrated in Table 5. The I_{geo} values of the studied samples ranged from class 0 (practically uncontaminated) to 6 (extremely contaminated). The I_{geo} values for Pb less than zero indicating practically uncontaminated (Class 0) and from 0.1-1.2 indicating uncontaminated to moderately contaminated sediment quality (Class 2). The trend of I_{geo} index values for Cr is ranged from practically uncontaminated to moderately contaminated, for Cd ranged from moderately contaminated (Class 2) to heavily-extremely contaminated (Class 5), for Cu ranged from practically uncontaminated (Class 1) to moderately to heavily contaminated (Class 3). For As, it was not detected in 50% of the studied samples. The I_{geo} values for As were distributed in all classes, but only one sample shows extremely contaminated sediment (Class 6).

The PEL values were 17, 3.5, 90, 197 and 91.3 µg g⁻¹ for As, Cd, Cr, Cu and Pb, respectively. While The ISQG values were 5.9, 0.6, 37.3, 35.7 and 35 µg g⁻¹ for As, Cd, Cr, Cu and Pb, respectively as shown Fig. 2a-e. These results indicated that there are expected biological effects from Cd, Cr and As. However, the samples contain Pb and Cu concentrations below the ISQG guideline as shown in Fig. 2d and e nearly 68% of the samples. These results indicated that there are no any expected adverse biological effects from Pb and Cu. The guidelines of CCME¹¹ have identified two numerical guideline levels for sediment pollutants; the Probable Effect Level (PEL) and the Interim Sediment Quality Guideline (ISQG). Sediment pollutants below the ISQG guidelines are safe and above PEL guidelines are harmful. While, sediment pollutants levels between the ISQGs and PELs may have occasional adverse effects.

The current study showed that the small variation of pH among samples may due to the different activities at each sampling point. Sediment pH controls the mobility and concentration of soluble metals, which generally increase with decreasing pH and vice versa²⁰ as supported by the negative correlation between pH and the studied metals (Table 2). The high OM% in some samples may be due to the higher supply

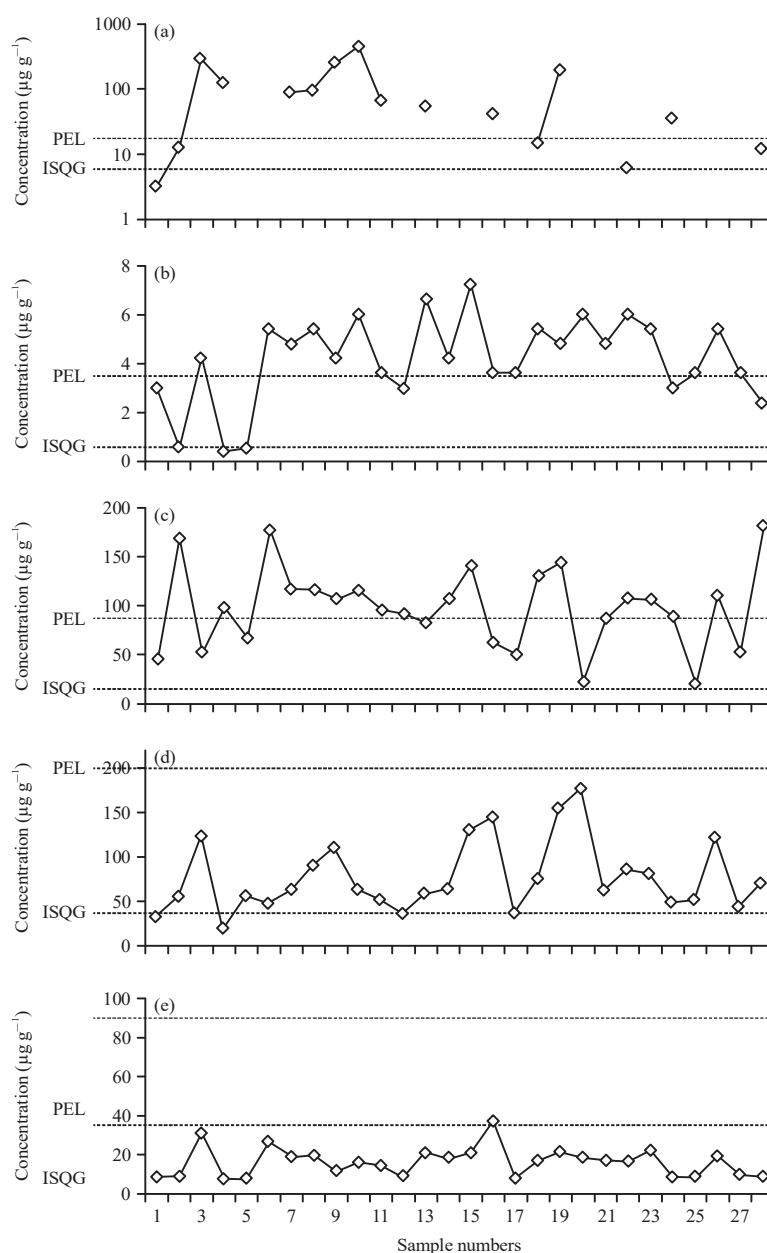


Fig. 2(a-e): Comparison of studied samples content of elements and ISQG and PEL, (a) As, (b) Cd, (c) Cr, (d) Cu and (e) Pb

of OM from the abundant vegetation on river banks, traffic exhaust and water washout station. It is also evident from the results that low OM% may due to the sandy nature of the studied sediments, as the organic carbon variation is largely controlled by the fine fraction of the sediment²¹.

The increase in OM% will lead to the pollution increase¹³; this is evident the positive correlation between OM% and heavy metals as it is shown in Table 2.

It was observed that the river channel sand dominated (Table 1), which may due to clay washing out during transport

and therefore; the dominance of sand²². In addition, the storms in the last decades transport a considerable amount of sand into the River Nile trunk. The USDA's triangle²³ indicated that the samples are mainly sand loamy sand and sandy loam. Fine sediments are typically those that are most heavily contaminated as indicated from the positive correlations between metals and both of silt and clay (Table 2). However, sandy sediment will be more toxic than silty sediments because the partitioning to the pore water will be greater²².

Also, the studied samples contained higher concentrations of As, Cd, Cr and Cu than the toxicity reference values of USEPA²⁴. These noticed elevated concentrations may refer to many sources especially the accident of phosphate ship sinking in the study area on April, 2015. Many authors pointed out the presence of these metals in the source rock of Nile sediments in the Ethiopian plateau. Alemayehu²⁵ pointed out the presence of Cd, Cr, Cu and Pb in some volcanic rocks in Ethiopia with concentrations of about 0.154, 28.29, 20.29 and 223.14 $\mu\text{g g}^{-1}$, respectively. Also, Rango *et al.*²⁶ recorded 0.59 and 2.46 $\mu\text{g g}^{-1}$ As in basalt and rhyolites rocks of Ethiopia, respectively. In addition to, they recorded considerable concentrations of Cu, Cr and Pb in these rocks. Furthermore, Lake Nasser sediments south Egypt contains considerable concentrations of these metals¹⁹. In addition, the occasional seasonal flash floods drain the eastern Desert represents another natural source of River Nile pollution²⁷. Accordingly, these metals have a geogenic source in addition to the anthropogenic sources.

It is observed that the highest concentrations were recorded at navigation sites, bridges and residential areas. The pollution of the Nile bottom sediments with Cd in Upper Egypt is mostly related to phosphate shipping and production²⁷. The increasing of heavy metals contamination of aquatic ecosystems localized in areas with intense traffic is very a disturbing trend. Also, it is well known that 89% of Cd comes from the anthropogenic sources and only 11% occurs naturally from volcanic emissions²⁸. The highest Cu concentrations were observed near agricultural land use, navigation sites and bridges of railway and automobiles. In the studied samples, Cu is mainly incorporated in the OM as indicated from the significant positive correlation between Cu and OM% (Table 2). The highest lead (Pb) concentrations were recorded at the measuring point Nag Hamadi Bridge (Qena); this may due to heavy traffic emissions and trains. However, the River Nile bottom sediments are not contaminated with Pb based on USEPA²⁴ TRV. The pattern of lead concentration variability in bottom sediments coincides substantially with the geochemical pattern of this element in the source rocks because of the sediments of Lake Nasser, Egypt, contain¹⁹ Pb from 2-36.14 ppm. It has appeared that OM, silt and clay enhanced the Pb in the studied samples while alkaline pH led to decrease of Pb.

CONCLUSION

The pH of the sediments was slightly alkaline, some of the samples were highly in OM (%) may be related to the abundant vegetation, agricultural run-off, bridges and water

washout station and finally sand dominates the river channel. The average concentration of As, Cd, Cr, Cu and Pb was 62.63, 4.17, 98.2, 77.22 and 16.43 $\mu\text{g g}^{-1}$. The I_{geo} indicated the severe pollution of sediment with Cd followed by As, Cu and Cr. The results support the mixed source of the studied metals; geogenic and anthropogenic. The calculated SQI with reference to ISQG showed the poor quality sediments, while SQI with reference to PEL showed that most of the samples of good to fair quality.

SIGNIFICANCE STATEMENT

The current study discovered the sediment of River Nile are no any expected adverse biological effects from Pb and Cu that can be beneficial for the abundant vegetation, agricultural and drinking water. So this study will help the researchers to uncover the critical areas of River Nile of sediment between Qena and Sohag that many researchers were not able to explore. Thus a new theory on sediment of River Nile may be arrived at beneficial data to predict any pollution in the River Nile sediment.

REFERENCES

1. Ali, S.M., S.Z. Sabae, M. Fayez, M. Monib and N.A. Hegazi, 2011. The influence of agro-industrial effluents on River Nile pollution. *J. Adv. Res.*, 2: 85-95.
2. Zaki, R., E.A. Ismail, W.S. Mohamed and A.K. Ali, 2015. Impact of surface water and groundwater pollutions on irrigated soil, El Minia province, Northern upper Egypt. *J. Water Resour. Prot.*, 7: 1467-1472.
3. Abu El Ella, E.M., M. Elsayed, A.A. Elnazer and S.A. Salman, 2017. The effect of human activities on the pollution of water in Southwest Giza area, Egypt. *Water Sci. Technol.: Water Supply*, 17: 1368-1376.
4. Garzanti, E., S. Ando, M. Padoan, G. Vezzoli and A. El Kammar, 2015. The modern Nile sediment system: Processes and products. *Q. Sci. Rev.*, 130: 9-56.
5. Yahaya, M.I., A.G. Jacob, Z.M. Agbendeh, G.P. Akpan and A.A. Kwasara, 2012. Seasonal potential toxic metals contents of Yauri river bottom sediments: North Western Nigeria. *J. Environ. Chem. Ecotoxicol.*, 4: 212-221.
6. Wang, C.C., Z.G. Niu, Y. Li, J. Sun and F. Wang, 2011. Study on heavy metal concentrations in river sediments through the total amount evaluation method. *J. Zhejiang University-Science A*, 12: 399-404.
7. Saeed, S.M. and S.F. Sakr, 2008. Impact of cage-fish culture in the river Nile on physico-chemical characteristics of water, metals accumulation, histological and some biochemical parameters in fish. *Abbassa Int. J. Aquatic*, 1: 179-202.

8. Reza, R. and G. Singh, 2010. Heavy metal contamination and its indexing approach for river water. *Int. J. Environ. Sci. Technol.*, 7: 785-792.
9. Grapentine, L., C. Marvin and S. Painter, 2002. Initial development and evaluation of a sediment quality index for the Great lakes region. *Hum. Ecol. Risk Assess.*, 8: 1549-1567.
10. Marvin, C., L. Grapentine and S. Painter, 2004. Application of a sediment quality index to the lower Laurentian great lakes. *Environ. Monitor. Assess.*, 91: 1-16.
11. CCME., 1999. Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg, pp: 61.
12. Muller, G., 1979. Schwermetalle in den sedimenten des Rheins Veranderungen seitt. *Umschan*, 79: 778-783.
13. Mohiuddin, K.M., M.M. Alam, I. Ahmed and A.K. Chowdhury, 2015. Heavy metal pollution load in sediment samples of the Buriganga river in Bangladesh. *J. Bangladesh Agric. Univ.*, 13: 229-238.
14. Rzetala, M.A., 2016. Cadmium contamination of sediments in the water reservoirs in Silesian upland (Southern Poland). *J. Soils Sediments*, 16: 2458-2470.
15. Elnazer, A.A., A. Mostafa, S.A. Salman, E.M. Seleem and A.G.A. Al-Gamal, 2018. Temporal and spatial evaluation of the River Nile water quality between Qena and Sohag Cities, Egypt. *Bull. Nat. Res. Centre*, Vol. 42. 10.1186/s42269-018-0005-6.
16. Melegy, A.A., A.M. Shaban, M.M. Hassaan and S.A. Salman, 2014. Geochemical Mobilization of some heavy metals in water resources and their impact on human health in sohag Governate, Egypt. *Arabian J. Geosci.*, 7: 4541-4552.
17. Burt, R., 2009. Soil survey staff, soil survey field and laboratory methods manual 2009. Soil survey investigations report No. 51, Version 1.0. U.S. Department of Agriculture, Natural Resources Conservation Service.
18. USDA. NRCS. and RSSC., 1996. Soil survey staff, soil survey laboratory methods manual 1996. Soil survey investigations report, No. 42. The United States Department of Agriculture (USDA), Natural Resources Conservation Service and National Soil Survey Center, USA.
19. Goher, M.E., H.I. Farahat, M.H. Abdo and G.S. Saliem, 2014. Metal pollution assessment in the surface sediment of Lake Nasser, Egypt. *J. Aquat. Res.*, 40: 213-224.
20. Wang, X.S. and Y. Qin, 2006. Spatial distribution of metals in urban topsoils of Xuzhou (China): Controlling factors and environmental implications. *Environ. Geol.*, 49: 905-914.
21. Marathe, R.B., Y.V. Marathe and C.P. Sawant, 2011. Sediment characteristics of Tapti river, Maharashtra, India. *Int. J. ChemTech Res.*, 33: 1179-1183.
22. Simpson, S.L., G.E. Batley, A.A. Chariton, J.L. Stauber and C.K. King *et al*, 2005. Handbook for Sediment Quality Assessment. CSIRO Energy Technology, Bangor, Page: 117.
23. USDA., 1993. Soil Survey Division Staff, Soil Survey Manual. 1993. UDSA Handbook No. 18. United States Department of Agriculture, Washington, DC., USA.
24. USEPA., 1999. Screening level ecological risks assessment protocol for haz-ardous waste combustion facilities. Appendix E: Toxicity reference values. EPA 530-D99-001C, 3. United States Environmental Protection Agency, USA.
25. Alemayehu, T., 2006. Heavy metal concentration in the urban environment of Addis Ababa, Ethiopia. *Soil Sediment. Contam.*, 15: 591-602.
26. Rango, T., A. Vengosh, G. Dwyer and G. Bianchini, 2013. Mobilization of arsenic and other naturally occurring contaminants in groundwater of the main Ethiopian rift aquifers. *Water Res.*, 47: 5801-5818.
27. El-Kammar, A.M., B.H. Ali and A.M.M. El-Badry, 2009. Environmental geochemistry of river Nile bottom sediments between Aswan and Isna, Upper Egypt. *J. Applied Sci. Res.*, 5: 585-594.
28. Lasheen, M.R. and N.S. Ammar, 2009. Speciation of some heavy metals in River Nile sediments, Cairo, Egypt. *Environmentalist*, 29: 8-16.