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Municipal solid waste landfill impact on sediments and surface water quality of Amsal River: A case study of Ziama Mansouriah landfill (Northeastern Algeria)

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ABSTRACT
Landfills represent possible sources of diverse contaminants that can cause human health and ecological problems. The purpose of this study is to assess the pollution caused by a leachate from Ziama Mensouriah municipal landfill (north-eastern Algeria) affecting sediments and surface water. The water quality has been evaluated using River Pollution Index (RPI). Sediment contamination assessment was carried out using the pollution indicators including: contamination factor (CF), pollution load index (PLI) and geo-accumulation index (Igeo). According to the results, the RPI of Amsal River indicates an unpolluted water at site 1 (S1) (RPI = 2.5), severely polluted water at landfill effluent discharge (S2) (RPI = 8.25) and moderately polluted once at site (S3) (RPI = 5.5). In sediments, the order of mean concentration (µg g^{-1}) of metals was Pb (156.2) > Cd (1.76). Furthermore, spatial distribution of both metals in sediments showed a significantly higher concentration at S2 indicating that metal pollution is caused by leachate from the studied municipal landfill. The Igeo values reveal that Pb was significantly accumulated compared to Cd. The highest CF values (>6) of Pb and Cd determined at S2 promote a high Pb and Cd contamination in that specific station. The PLI results showed that all sites, except for S1, were moderately to extremely heavy contaminated.

Key words: Landfill, Water, Sediments, Heavy metals, Algeria.

INTRODUCTION
Landfills constitute potential sources of different pollutants that could generate human health and environmental problems (Vural *et al.* 2017). Areas near landfills have a greater possibility of water contamination because of the potential pollution source of leachate originating from the nearby site. Leachates are produced as a result of rainwater percolation through the waste layers; physical, chemical, biochemical and microbiological reactions of the organics within the waste mass and due to the inherent or interstitial water content of the waste (Li *et al.* 2010; Schiopu & Gavrilescu 2010). The migration of landfill leachates into surface or groundwater is considered to be a serious environmental problem at both uncontrolled and engineered municipal landfill sites (Mor *et al*. 2006; Durmusoglu & Yilmaz 2006). The impact of landfill leachate on the surface and groundwater has given rise to a number of studies in recent years (Abu-Rukah and Kofahi 2001; Mor *et al.* 2006; Han *et al.* 2014; Talalaj 2014; Alam *et al.* 2020). Otherwise, assessing the actual impact of municipal solid waste landfills on the quality of surface waters is not an easy task. A variety of waste deposited in landfills cause the penetration of various substances, that are not subject of the periodic analytical studies or are not covered by continuous monitoring, into surface and ground waters (Melnyk *et al.* 2014).

Caspian J. Environ. Sci. Vol. 19 No. 1 pp. 115~125
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In Algeria, most of the landfills are situated beside the rivers. This situation has caused wide concern over the water safety. The Amsal River, located close to Ziama Mansouriah, is one of the most important ecosystems playing a very important role in minimizing rural poverty of the local people community (Henniche 2014).

The main objective of this study is (i) to investigate the water quality of Amsal River that receives effluents from the nearby municipal solid waste landfill of Ziama Mansouriah. The quality of water has been estimated using the River Pollution Index (RPI) depending on in-situ and laboratory analysis; (ii) to determine the levels of the toxic heavy metals (Pb and cd) in sediment; (iii) to explore the degree of contamination and pollution impacts using the following pollution indicators as: contamination factor (CF), pollution load index (PLI) and geo-accumulation index (Igeo); and (iv) to establish baseline data on the present status of the river that can be used by relevant authorities and other investigators.

MATERIALS AND METHODS

Study area

The municipal solid waste landfill site is located in the north east of Jijel, Algeria at latitude 36°39’51" North, longitude 5°28′27″ East, in the municipality of Ziama Mansouriah (Fig. 1). This landfill situated at the bank of Amsal River which was constructed without any lining preventing leaking of the leachate and served as the principal municipal waste disposal dump generated by the Ziama Mansouriah City.

The site covers an area of approximately 1.5 ha. It has been operating since 1993 and receives around 28000 m3 of municipal solid waste (MSW) per day (Henniche 2014). The climate in the study area is of Mediterranean type with dry warm summers and wet winters. During the winter months (November-February), there is an 80% of precipitation. The average temperature is 9 °C in January and 28 °C in July (Henniche 2014).

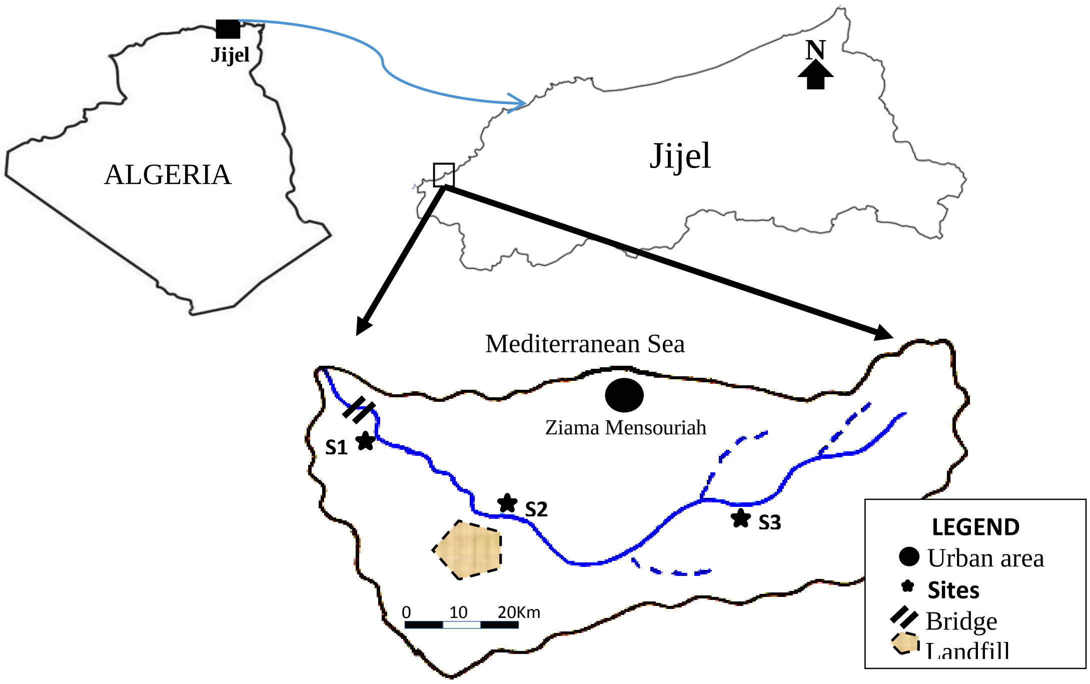

Fig. 1. Location of different sampling sites along Amsal River.

Data collection and analysis

According to the accessibility of the study area, three sampling points were chosen for river quality monitoring. Sampling site 1 (S1) is located at the upper part of the river, characterized by small rural communities, representing the background values, i.e. with little interference from anthropogenic activities. Site 2 (S2) is located at landfill effluent discharge and S3 at the upstream under Amsal Bridge with low level of agricultural development (Fig. 1).

Caspian J. Environ. Sci. Vol. 19 No. 1 pp. 115~125
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Water and sediment analysis

River water and bed sediments were collected along the main stream from February to May 2019. From each sampling points, the water samples were collected using sampler from a depth of 30 cm from the water surface. Before collection, samplers were thoroughly cleaned and rinsed three times with the river water. Water samples were collected in triplicates to estimate the variability resulting from the sampling and analytical procedures using 200 mL-polyethylene bottles and stored in an ice box before transporting to the laboratory (Talabi *et al.* 2020). Seven water quality parameters were selected for the quality assessment including dissolved oxygen (DO), biochemical oxygen demand (BOD), suspended solid (SS) and ammonia nitrogen. Standard methods of water and wastewater (AHPA 2005) were followed for the water sample collections and analyses. Otherwise, the analytical methods used for measuring the water quality parameters are presented in Table 1.

Table 1. Water quality parameters, units and analytical methods

Parameters	Unit	Analytical methods
pH	-	Digital multi-parameter system (Consort C561)
DO	mg L^{-1}	Numerical oxymeter
BOD_5	mg L^{-1}	BOD metre (OXITOP IS6)
NO_3-N	mg L^{-1}	Spectrophotometer (JENWAY 7315)
NO_2-N	mg L^{-1}	Spectrophotometer (JENWAY 7315)
NH_3-N	mg L^{-1}	Spectrophotometer (JENWAY 7315)
SS	mg L^{-1}	Filtration and gravimetric

Sediment samples from 0 to 60 cm depth were collected at low tide at each sampling site using plastic sampling utensils and latex gloves to avoid sample contamination with metals. All these samples were placed in polyethylene bags, brought to the laboratory, dried to a constant dry weight at 60°C, and sieved with a 63-µm stainless steel sieve (Wang *et al.* 2011). Generally, finer sediments contain more heavy metals than the coarser ones. This enrichment is mainly due to surface adsorption and ionic attraction (Szefer *et al.* 1996). The samples were chemically analysed for detection of heavy metals (Cd and Pb). Accurately 0.5 g dry powder of sample was weighed, and digested with HNO_3, H_2SO_4 and H_2O_2 (2:6:6) as prescribed by Saison *et al.* (2004). Heavy metals were analysed using atomic absorption spectrometry.

Water quality evaluation index

The river pollution index (RPI) is an index, which is employed to explore monitor trends for both planning and day-to-day management of surface water quality for the public currently.

The latter was computed, using the following equation (Liou et *al.* 2004).

$$RPI = \frac{1}{4} \sum_{i=1}^{4} Si \quad \textbf{(1)}$$

where Si represents the index scores and the RPI value ranges from 1 to 10.

The RPI involves four variables: dissolved oxygen (DO), biochemical oxygen demand (BOD_5), suspended solids (SS), and ammonia nitrogen (NH_3-N), each is ultimately converted to a four-state quality sub-index (1, 3, 6, and 10). The overall index is then divided into four pollution levels (non-polluted, lightly-polluted, moderately-polluted, and grossly-polluted) by averaging the four sub-indices (Table 2) (Liou et *al.* 2003).

Heavy metal evaluation index

Three indices of geo-accumulation index (Igeo), contamination factor (CF), and pollution load index (PLI) were used to gain information about the sources of metal pollutants and to assess the metal pollution status.

Table 2. The classification ranks defined by the existing river pollution index (RPI)

Items (mg L^{-1})	Ranks			
	Unpolluted	Negligibly polluted	Moderately polluted	Severely polluted
DO	Above 6.5	4.6-6.5	2.0-4.5	Under 2
BDO_5	Under 3	3.0-4.9	5.0-15	Above 15
SS	Under 20	20-49	50-100	Above 100
NH_3-N	Under 0.5	0.5-0.99	1.0-3.0	Above 3.0
Index Scores (S_i)	1	3	6	10
RPI	Under 2	2.0-3.0	3.1-6.0	Above 6.0

Caspian J. Environ. Sci. Vol. 19 No. 1 pp. 115~125 Received: April 19. 2020 Accepted: Sep. 12. 2020
DOI: Article type: Research

Geo-accumulation index (Igeo)

Geo-accumulation index (Igeo) was developed by Müller (1969) and was calculated by the following equation:

$$I_{geo} = Log_2 \frac{C_n}{1.5 \times B_n} \qquad \textbf{(2)}$$

where C_n is the measured concentration of the examined metal (n) in the sediment and B_n is the geochemical background concentration of the metal (n). Factor 1.5 is the background matrix correction factor due to lithogenic effects. The crustal abundance data of Turekian & Wedepohl (1961) were used as background data. The geo-accumulation index consists of seven grades or classes (Table 3).

Table 3. Descriptive classes for Igeo values (Müller 1981).

Sediment quality	I_{geo}	I_{geo} Class
Unpolluted	$I_{geo}<0$	0
Unpolluted to moderate polluted	$0< I_{geo}\leq 1$	1
Moderately polluted	$1< I_{geo}\leq 2$	2
Moderately to heavily polluted	$2< I_{geo}\leq 3$	3
Heavily polluted	$3< I_{geo}\leq 4$	4
Heavily to extremely polluted	$4< I_{geo}\leq 5$	5
Extremely polluted	$I_{geo}>5$	6

Contamination Factor (CF)

The contamination factor (CF) of a single trace element was calculated, as suggested by Min *et al.* (2013) and Kerolli-Mustafa *et al.* (2015). It was used to evaluate the contamination of the single heavy metal in our samples (Formula 3).

$$CF = \frac{C^i_{sample}}{C^i_{reference}} \qquad \textbf{(3)}$$

where CF is the contamination factor for a heavy metal; C^i_{sample} is the measured value of the heavy metal in the sediment; $C^i_{reference}$ is the parameter for calculation.

The contamination levels were classified based on their intensities on a scale ranging from 1 to 6 as shown in Table 4.

Table 4. Sediments contamination level based on contamination factor (CF) value (Hakanson 1980).

Contamination level	CF value
Low	CF<1
Moderate	1< CF≤3
considerable	3< CF≤6
Very high	CF >6

Pollution load index (PLI)

The PLI was originally used to determine the pollution load of sediments. It can also give a simple and relative means for the evaluation of the degree of metal pollution (Tomlinson *et al.* 1980). This parameter is expressed as:

$$PLI = \sqrt[n]{Cf_1 \times Cf_2 \times Cf_3 \times \ldots Cf_n} \qquad \textbf{(4)}$$

where *n* is the number of metals and Cf is the contamination factor. PLI can be classified as no pollution (PLI < 1), moderate pollution (1 < PLI < 2), heavy pollution (2 < PLI < 3), and extremely heavy pollution (3 < PLI) (Tomlinson et *al.* 1980).

Statistical analysis

The results were expressed as means ± S.D. One-Way ANOVA (Post-hoc Newman-Keuls test) was conducted to show the significant differences among the sites for water and sediment samples at 5% level of significance (Zar 1999). All statistical processes were performed using packaged STATISTICA software (version 8.0).

Caspian J. Environ. Sci. Vol. 19 No. 1 pp. 115~125
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RESULTS AND DISCUSSION

Physicochemical characteristics of water

The physicochemical parameters of the water samples are presented in Table 5.The results showed that there are significant variations in physicochemical parameters of water among the three different sites.

Table 5. Water quality parameters (mean ± SD) at the level of the sampling sites.

Parameters	S1	S2	S3
pH	7.57 ± 0.11^a	8.17 ± 0.21^b	7.77 ± 0.15^a
DO (mg L^{-1})	5.34 ± 0.03^a	1.79 ± 0.02^b	4.75 ± 0.57^a
BOD (mg L^{-1})	3.91 ± 0.03^a	25.65 ± 0.10^c	12.40 ± 0.27^b
SS (mg L^{-1})	12.76 ± 0.04^a	36.80 ± 0.01^c	25.41 ± 0.61^b
NH_3-N (mg L^{-1})	0.89 ± 0.03^a	7.53 ± 0.02^c	5.45 ± 0.17^b
NO_3-N (mg L^{-1})	30.53 ± 2.41^a	69.5 ± 0.52^c	42.8 ± 0.55^b
NO_2-N (mg L^{-1})	0.096 ± 0.006^a	0.342 ± 0.003^c	0.18 ± 0.01^b

a , b, c: homogeneous groups (Newman-Keuls test, $\alpha = 0.05$).

Water pH

Water pH affects biological processes in aquatic systems and chemical processing of water post abstraction (Chatanga *et al.* 2019). The lowest pH (7.57) was found in S1 while the highest (8.17) belonged to S2 (Table 5). In most cases, the samples collected at downstream the river from the landfill had lower pH in comparison with those at upstream (Melnyk *et al.* 2014). Alkalinity of river water at landfill effluent discharge (S2) may be due to the effect of leachate migration to the surface water of Amsal River from both the closed- and currently- exploited landfill. Bhouyan (1979) and Mahmood *et al.* (1992) reported that industrial and municipal waste can significantly affected the water pH at the dumped site.

Dissolved oxygen (DO)

The dissolved oxygen data are valuable in determining the water quality criteria of an aquatic system. In the system where the rates of respiration and organic decomposition are high, the DO values usually remain lower than those systems where the rate of photosynthesis is high (Tripathi *et al.* 1991). As shown in Table 5, in the S2, located close to the landfill point discharge oxygen concentration descends to 1.79 mg L^{-1}, while the highest values belonged to S1 (5.34 mg L^{-1}). Increased microbial decomposition of large amount of organic matter at Site 2 also caused a significant depletion of DO.

Ammoniacal nitrogen (NH_3-N)

The lowest NH_3 (0.89) was found in the S1 while the highest (7.53) belonged to S2 (Table 5). The increased NH_3 in water indicates the existence of highly active pollutants coming from landfill leachate as well as the decomposition of organic matters. According to Fang *et al.* (2012), ammonia is one of the odorous substances which are emitted from the landfill sites. In addition, decomposition of proteins may be responsible for the release of ammonia from the solid waste (De *et al.* 2016). According to Gupta *et al.* (2015), increase in oxygen demand and eutrophication of the aquatic resources are the notable consequences of nitrogen pollution by ammoniacal nitrogen.

Suspended solids (SS)

The SS consists of mud, fine sand, and microorganisms caused by soil erosion and are carried into the body of water (Effendi 2003). A high value of 36.80 mg L^{-1} was measured for S2, followed by S3 with 25.41 mg L^{-1} and 9.67 mg L^{-1} in S1 (Table 5).

Location of sampling site can be the factor for high result of SS at S2 which is located at landfill effluent discharge. Indeed, the presence of SS can result in turbidity of water, reduced rate of phytoplankton photosynthesis and dropped water productivity (Nartey *et al.* 2012). Such conditions can reduce the supply of dissolved oxygen in water bodies (Effendi 2003).

Caspian J. Environ. Sci. Vol. 19 No. 1 pp. 115~125 Received: April 19. 2020 Accepted: Sep. 12. 2020
DOI: Article type: Research

Biochemical oxygen demand (BOD_5)

Biochemical oxygen demand (BOD) is the amount of oxygen, used by the microbes to decay carbon-based materials in water within five days period (APHA 2005). The Lower values of BOD were observed in the upper and lower parts of the river, i.e., S1 and S3 (3.91 and 12.40 mg L^{-1} respectively). However, a high value of BOD (25.65 mg L^{-1}) was recorded at S2 suggesting that this site was rich in organic matter content discharged to the rivers by leachate landfill. Prasanna & Ranjan (2010) and Mishra *et al.* (2014) also reported that BOD_5 of water can be affected by organic content of the water body.

Nitrate (NO_3-N) and nitrite (NO_2-N)

The higher NO_3-N level was observed in S2 (7.53 mg L^{-1}) followed by 5.45 and 0.89 mg L^{-1} at S3 and S1 respectively (Table 5). In the case of NO_2-N, the highest level was recorded in S2 (0.342 mg L^{-1}), whereas the lowest belonged to S3 and S1 (0.18 and 0.096 mg L^{-1} respectively) (Table 5).

In the study area, the higher values of NO_3-N and NO_2-N at S2 may be due to leachate from the landfill site indicating that the studied river is exposed to a risk of the nitrate and nitrite pollution. Indeed, nitrogen is recorded at high levels in most landfill leachate studies with Robinson (1995) and Kjeldsen *et al.* (2002) both describing it as the dominant pollutant.

Estimation of RPI

Based on Table 2, water is classified as unpolluted for RPI values lower than 2.0; negligibly polluted when its values ranged between 2.0 and 3.0; moderately polluted when it is above 3.0 and less than 6.0. RPI values above 6.0 is classified as severely-polluted.

According to Table 6, the water quality of Amsal River was classified as severely polluted at S2, moderately polluted at S3 and negligibly polluted at S1. Indeed, at S2, discharged effluent from the landfill was clearly the point source of water pollution and caused higher pollution rate.

Table 6. Results of river pollution index (RPI) of studied sites.

	S1	**S2**	**S3**
RPI	**2.5** Negligibly polluted	**8.25** Severely polluted	**5.5** Moderately polluted

Heavy metal concentration in sediment

The concentrations of lead and cadmium in the bed sediment samples are presented in Table 7. It was found that cadmium was the least concentrated heavy metal in all the sites sampled, consistent with results of Seshan *et al.* (2010) and Azizi *et al.* (2019). In One-Way ANOVA test, the concentrations of all metals showed significant differences among the sites ($p < 0.05$) (Table 7). The S2 showed maximum concentrations of all metals, due to landfill leaching into the river, hence, identified as hot spot. The mean lowest values of Cd and Pb were observed at S1, which can be explained by the fact that this site is far from the studied landfill compared to S2 and S3. The presence of lead in the water may be due to lead-acid batteries, plastics and rubber remnants, lead foils such as bottle closures, used motor oils and discarded electronic gadgets including televisions, electronic calculators and stereos (WHO 2004) where leachates from the waste dumpsites may find their way into the rivers. However, the highest Cd concentrations observed at S2 could be attributed to the discharge of contaminants including nickel and cadmium batteries used in domestic and urban activities, representing almost 50% of Cd in the urban solid waste (Segura-Muñoz *et al.* 2004). There are numerous reports on metal contamination in river sediments around the world. Comparing heavy metal concentrations in Amsal River (Table 7) revealed that the extent of Pb and Cd pollutions in the study area was higher than in some rivers (Banu et *al.* 2013; Hassan *et al.* 2015; Islam *et al.* 2015), while less than the others (Grosbois *et al.* 2001; Mohiuddin *et al.* 2011).

Assessment of sediment contamination

To assess the impacts of trace elements in sediments, the metal levels in Amsal River were compared with metal background concentrations obtained by Krauskopt & Bird (1995) followed by applying numerical sediment quality guidelines (SQGs) (MacDonald *et al.* 2000). Two consensus-based values were reported for each potential contaminant: (1) the threshold effect concentration (TEC), which is the concentration below which harmful effects are unlikely to be observed; and (2) the probable effects concentration (PEC), i.e., the concentration above which

Caspian J. Environ. Sci. Vol. 19 No. 1 pp. 115~125
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harmful effects are likely to be appeared (Ahdy & khaled 2009). As shown in Table 7, the average sediment metal levels from Amsal River are higher than the background concentrations. In addition, the mean concentrations of Pb and Cd in all sediment samples are evidently greater than TEC, suggesting that adverse biological effect could occasionally be observed. Besides, the mean level of Pb in all of the sediment samples exceed PEC, representing that adverse biologic effects could frequently occur.

Table 7. Mean concentrations of metals (µg.g-1) in bed sediment comparison with background values, selected rivers in the world and sediment quality guidelines (SQGs).

Sites	Cd (µg g^{-1})	Pb (µg g^{-1})	References
S1	0.02±0.004^{a}	9.43 ± 0.61^{a}	
S2	5.10±0.22^{b}	405.6 ± 21.6^{c}	
S3	0.16±0.05^{a}	53.5 ± 5.20^{b}	
Mean	1.76	156.20	Present study
Meghna River	0.23	9.47	Hassan et *al.* (2015)
Turag River	0.28	32.78	Banu et *al.* (2013)
Korotoa River	1.20	58.0	Islam et *al.* (2015)
Boriganga River	5.30	476.50	Mohiuddin *et al.* (2011)
Upper Spokane River	6.90	390.0	Grosbois *et al.* (2001)
Background	0.2	13	Krauskopt & Bird (1995)
SQGs			MacDonald et *al.* (2000)
TEC	0.99	35.8	
PEC	4.98	128	

Evaluation of heavy metal pollution

In Amsal River, the calculated values of I_{geo} (Table 8) indicated that, in the case of Pb, sediment quality ranges from unpolluted (I_{geo}<0) at S1, unpolluted to moderately-polluted (0< Igeo≤1) at S3 and heavily-polluted (3<I_{geo}< 4) at S2. I_{geo} values of Cd (I_{geo}<0) at S1 and S3 indicated that these sites were unpolluted with this metal. In contrast, the I_{geo} value of Cd at S2 was above 3, suggesting that this site was heavily polluted. On the basis of the mean values of I_{geo}, the sediments were enriched with metals in the following order: Pb > Cd.

Table 8. Geo-accumulation Index (I_{geo}) , Contamination Factor (CF) and Pollution Load index (PLI) values.

Sites	I_{geo}		PLI	CF	
	Pb	Cd		Pb	Cd
S1	-1.68	-5.11	0.19	0.46	0.08
S2	3.75	3.50	18.50	20.14	17.02
S3	0.85	-1.52	1.20	2.67	0.54
Total mean	0.97	-1.04	6.63	7.75	5.88

On the other hand, both CF and PLI are widely used to evaluate the degree of heavy metal pollution in the sediments (Vural 2015). Table 8 presents CF values for heavy metals, recorded at different sampling sites. The mean CF values for metals in the studied area appeared in the following sequence Pb> Cd>. The highest CF value was 20.14 for Pb at S2 which is categorized as a very high-contaminated. The CF values for Pb indicated low and moderate contaminations at S1 and S3, respectively. In the case of Cd, the highest CF value was 17.02 at S2 which is categorized as a very high-contaminated. The CF values for heavy metals were below 1 at other sites, suggesting that these elements in sampling sediments had low contamination. The maximum and minimum PLI were 0.19 and 18.50, respectively. Based on the PLI values, Amsal River should be classified as having no pollution (PLI < 1) in S1; moderate pollution (1< PLI <2) in S3 and extremely heavy pollution (3 < PLI) in S2. As a rule, S2 located close to landfill had the highest PLI values and therefore, exhibiting characteristics of baseline pollution.

CONCLUSION

The main environmental concern in this study is the effect of landfills leachate on the surface water quality. Results obtained in this study reveal that the quality of the surface water near the municipal landfill has been strongly affected when the effluent mixed with the river water. The physicochemical water analysis of the studied sites showed that, all measured parameters were important in site 2 (S2) compared to the others sites (S1 and S3), with the exception of DO. According to the river pollution index (RPI), surface water quality of Amsal River is unpolluted at S1, severely polluted at landfill effluent discharge S2 and moderately polluted at S3. In case of the

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DOI: Article type: Research

sediments, abundance of heavy metals was ranked as follows: Pb > Cd. However, all metal concentrations exceeded background values. The contamination factor (CF), pollution load index (PLI) and geoaccumulation index (I_{geo}) revealed that sediments were unpolluted to extremely polluted by heavy metals. Obtained results confirm that the leachates from the studied municipal landfill pose a potential source of the Amsal River pollution. Hence, the authors recommend that, the open landfill should be closed and treated to minimize the impact of these pollutants by application of different remedial action like phytoremediation and bioremediation in order to preserve quality of this ecosystem

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اثر مواد جامد زباله شهری بر روی رسوبات و کیفیت آب سطحی رود امصال: مطالعه موردی زباله دان زیاما منصوریا (شمال شرقی الجزایر

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چکیده

مکان‌های دفن زباله منبع احتمالی آلاینده‌های متنوعی هستند که می‌توانند مشکلات بهداشت انسانی و بوم شناختی ایجاد کنند. هدف این مطالعه ارزیابی آلودگی ایجاد شده توسط نشت مکان دفن زباله زیاما منصوریا (شمال شرقی الجزایر) بر روی رسوبات و آب سطحی است. کیفیت آب توسط شاخص آلودگی رودخانه (RPI) ارزیابی شد. ارزیابی آلودگی رسوبات با استفاده از شاخص های آلودگی مانند فاکتور آلودگی (CF) ، شاخص بار آلودگی (PLI) و شاخص تجمع زمین شناختی (Igeo) انجام شد. بر اساس نتایج RPI رود امصال نشان داد که ایستگاه ۱ غیر آلوده است (RPI = 2.5)؛ ایستگاه ۲ شدیداً آلوده است (RPI =8.25)؛ و ایستگاه ۳ آلودگی متوسط دارد (RPI = 5.5). در رسوبات ترتیب میانگین غلظت عناصر سرب با ۱۵۶٫۲ بیشتر از کادمیوم با ۱٫۶۷ میکروگرم بر گرم بود. به علاوه، انتشار مکانی این دو عنصر نشان داد ایستگاه ۲ غلظت بالاتری از بقه ایستگاه ها به خاطر نشت از محل دفن زباله دارد. مقادیر Igeo نشان داد که سرب بیش از کادمیوم تجمع داشته است. بالاترین مقادیر CF (بیش از ۶) مربوط به سرب و کادمیوم در ایستگاه ۲ نشاندهنده آلودگی بیشتراین دو عنصر در این ایستگاه بود. نتایج PLI نشان داد که همه ایستگاه ها بجز ایستگاه ۱ آلودگی متوسط تا شدید داشتند.

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