Data Article

Dataset for spatial distribution and pollution indices of heavy metals in the surface sediments of Emerald Lake, Tamil Nadu, India

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ABSTRACT

The dataset for this manuscript with the spatial distribution of heavy metals such as Mn, Zn, Ni, Co, Pb, Cr, Cu and Fe, pollution indices of the surface sediments in the Emerald Lake, India, the significant source of pollution, are determined. The methods for calculation of pollution indices such as Enrichment Factor (EF), Contamination Degree (CD), modified Contamination degree (mCd) and Contamination factor (CF) are considered to know the level of heavy metal pollution in the study area. In this data, the results of pollution indices suggest that almost all the sites are polluted by heavy metals. The data could be very useful to metal pollutants and their sources in the surface sediments. © 2019 Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
1. Data

The data includes pollution indices of surface sediment of the Emerald Lake, Salem District, Tamil Nadu, India. The prime data are first collected using Toposheet No: 58 I/1 by Survey of India (1973) then the surface sediment samples from 25 different locations were collected in the study area (Fig. 1). ArcGIS 10.1 and ESRI software packages are utilized for the development of spatial distribution maps. The spatial distribution maps of heavy metals are evaluated using inverse distance weighted technique (Fig. 2a–h). The average, maximum and minimum concentration of the heavy metals in the surface sediments of the Emerald Lake is presented in Table 1. By using the pollution indices such as Enrichment Factor (EF), Contamination Degree (CD), modified Contamination degree (mCd) and Contamination factor (CF) heavy metals like Mn, Co, Fe, Cu, Cr, Pb, Zn and Ni are calculated and given in Table 2.

2. Experimental design, methods and materials

2.1. Study area

The Emerald lake is situated in the Yercaud hill station, which has the moderate humid subtropical climate, located in Salem District of Tamil Nadu. The study area lies in the latitudes of 11°47’07.6″N and 11°46’58.5″N and longitudes of 78°12’32.6″E and 78°12’37.7″E. By using the pollution indices such as Enrichment factor, Contamination degree, modified Contamination degree and Contamination factor heavy metals like Mn, Co, Fe, Cu, Cr, Pb, Zn and Ni are analyzed from 25 surface sediments samples taken from different locations of the Emerald Lake during January 2017 by using Grab sampler and stored in clean polyethylene bags. In the laboratory, the samples were first dried in air and to prevent contamination, they are passed through a 100-mesh nylon sieve and stored in plastic bottles. The sampling locations were determined by GPS. Fig. 1 shows the distribution of sampling locations. The particle size distribution of the surface sediments were determined by the Mastersizer 2000. Colorimetric method is used to determine OM (potassium dichromate oxidation) by Ref. [1]; CaCO3 was determined by Ref. [2]. For analyzing, the sediments samples were initially dried in air and grained in an agate mortar prior to the chemical treatment. Then each sediment samples of about 1 gram is completely absorbed to near dryness with a concentrated Perchloric acid solution (2 ml). Then, for the second time a mixture of Perchloric acid and hydrogen fluoride (10 ml) addition was prepared and evaporated to near dryness. Lastly, Perchloric acid was added alone to the sample and dried until white
fumes appear. By using concentrated hydrochloric acid, the deposited residues were dissolved and then diluted to 25 ml. The acid solution was filtered by using Grade A filters and the analysis of metals such as Fe, Mn, Cr, Co, Zn, Cu, Ni and Pb were done by IC-PMS, NGRI, CSIR, Hyderabad. The accuracy of the present study is compared with the analytical procedures using the MESS-1 from the NRCC.

2.2. Geospatial analysis using inverse distance weighted technique

The spatial maps of OM, CaCO$_3$ and heavy metals is using by inverse distance weighted technique of Arc GIS 10.3. The Spatial distributions maps are shown in Fig. 2a–h. In present study, OM content varies from 4.6 to 9.8%; average of 7.35%. The content of CaCO$_3$ varies from 2.5 to 9.8%; average of 5.95%. The values of C/N ratio vary from 6.1 to 10.7 with mean value of 8.95% in the surface sediments of the Emerald Lake. During transportation of sediments there is a high loss of organic matter in the lake [3]. The content of OM ranges from 3.8 to 13.8% and very low carbonate content which ranges from 0.2 to 1.0%. In the marginal and middle parts of the lake, turbulences and the wind generated waves gradually shifts the organic matter in the sediments [4]. Therefore comparatively sediments in the lake surface

![Fig. 1. The base map of the emerald lake.](image-url)
Fig. 2. a–f spatial distribution map of Fe, Mn, Cr, Cu, Pb, Zn. g–h spatial distribution map of Co and Ni.
seem to have high organic content due to lake turbulences, tourist activities and soil erosion. Due to the increase of organic matter in the lake sediments 12% of organic carbon and minimal quantity of CaCO₃ is sustained in the sediments. The high content of organic matter and dissolution CaCO₃ in the sediments occurred thousands of years ago by natural eutrophication in lakes. This condition increase the pH value of the lake which causes precipitation of CaCO₃ and affect the entire biogeochemical cycles of other elements in the lake, predominantly redoxsensitive elements [5]. Reported that during summer season Williams Lake precipitates CaCO₃; still the surface sediments are free from carbonates. However, in the aquatic environment, the proportions of macrophytes to the phytoplankton determine the C/N ratio. If there is rich growth of aquatic phytoplankton (diatom) in the lake, the C/N ratio varies from 6.1 to 10.7. The combination of aquatic and terrestrial phytoplankton shows a high value of C/N ratio.

Table 1
Summary of the sediments characteristics, organic matter, calcium carbonate, C/N ratio and heavy metal (µg g⁻¹) in the Emerald Lake.

| OM % | CaCO₃% | C/N ratio | Fe   | Mn   | Cr   | Cu   | Pb   | Zn   | Co   | Ni   |
|------|-------|----------|------|------|------|------|------|------|------|------|
| Ave  | 7.3   | 5.9      | 8.9  | 114,900 | 370.95 | 411.48 | 611.32 | 34.04 | 174.4 | 112.64 | 154.24 |
| Max  | 9.8   | 9.8      | 10.7 | 132,900 | 462    | 523    | 701    | 53.21 | 215   | 129.9  | 158   |
| Min  | 4.6   | 2.5      | 6.1  | 7.81   | 314    | 336    | 520    | 20.1  | 128   | 91    | 151   |
| "Taylor SR (1964) Background" | 47,200 | 850 | 90 | 45 | 20 | 95 | 19 | 68 |  |  |

Table 2
Evaluation criteria of different risk assessment methods.

| Methods               | Formula                                      | Reference | Level Values | Designation of Sediment quality |
|-----------------------|----------------------------------------------|-----------|--------------|---------------------------------|
| Enrichment Factor     | EF = (Cx/Mn_ref) sample/(Cx/Mn_ref) background where (Cx/Mn_ref) sample is the concentration ratio of heavy metal (Cx) and the normalization elements Mn_ref in the sample, (Cx/Mn_ref) background is the same ratio in a suitable background sample. EF is classified into six categories of enrichment depending on the values. | [11] | 6 | EF > 50 | Extremely severe enrichment |
|                       |                                              |           | 5 | 25 < EF ≤ 50 | Very severe enrichment |
|                       |                                              |           | 4 | 10 < EF ≤ 25 | Severe enrichment |
|                       |                                              |           | 3 | 5 < EF ≤ 10 | Moderately severe enrichment |
|                       |                                              |           | 2 | 3 < EF ≤ 5 | Moderate Enrichment |
|                       |                                              |           | 1 | 1 < EF ≤ 3 | Minor enrichment |
|                       |                                              |           | 0 | EF = <1 | No enrichment |
| Contamination Factor  | CF = C_sample/C_Reference where C_sample is the concentration of a given metal in the sediments and C_Reference is the preindustrial concentration of the individual metal in the sediments. CF is classified into four classes. | [12] | 4 | CF > 6 | Very high contamination factor |
|                       |                                              |           | 3 | 3 < CF < 6 | Considerable contamination factor |
|                       |                                              |           | 2 | 1 < CF < 3 | Moderate contamination factor |
|                       |                                              |           | 1 | CF = 1 | Low contamination factor |
| Contamination degree  | Cd = ∑_i=1^n CF | [12] | 4 | CD ≥ 24 | Very high contamination |
|                       |                                              |           | 3 | 12 < CD < 24 | Considerable contamination |
|                       |                                              |           | 2 | 6 < CD < 12 | Moderate contamination |
|                       |                                              |           | 1 | CD < 6 | Low contamination |
| modified Contamination degree | mCd = ∑_i=1^n Ci | [13] | 7 | mCD ≥ 32 | Ultra high contamination |
|                       |                                              |           | 6 | 16 < mCD ≤ 32 | Extremely high contamination |
|                       |                                              |           | 5 | 8 < mCD ≤ 16 | Very high contamination |
|                       |                                              |           | 4 | 4 < mCD ≤ 8 | High contamination |
|                       |                                              |           | 3 | 2 < mCD ≤ 4 | Moderate contamination |
|                       |                                              |           | 2 | 1.5 < mCD < 2 | Low contamination |
|                       |                                              |           | 1 | mCD ≤ 1.5 | Very low contamination |
(10–20). In general C/N ratio value greater than 10 indicates aquatic freshwater phytoplankton in the lake.

2.3. Heavy metals concentration in surface sediments

The total concentration of the heavy metals in the surface sediments of the Emerald Lake are presented in Table 1. The ranges of metal concentration are 78,128 to 132,126 μg g⁻¹ for Fe, 314–462 μg g⁻¹ for Cu, 336–523 μg g⁻¹ for Cr, 520–701 μg g⁻¹ for Mn, 20.1–53.21 μg g⁻¹ for Zn, 128–215 μg g⁻¹ for Ni, 91–129.9 μg g⁻¹ for Co and 151–158 μg g⁻¹ for Pb. The components were positioned in the preceding order: Ni < Co < Zn < Pb < Cu < Cr < Mn < Fe. The concentration of Fe is high in the North East part of the lake at site no: 15. The Ataturk Dam in Turkey has the high Fe value that ranges from 12.59 to 19.27 mg/kg as reported [6]. [7] Concluded that the Fe is the most commonly occurring element in the earth crust from the observation of highest concentration of Fe the in the lake sediments. By cation exchange process, iron hydroxides can absorb huge quantities of metals and it acts as a key source in trapping other metals in the lake sediments [8].

In this study, due to the exposure of abutting rock having an abundance of charnockite rock the values of Ni (151–158 μg g⁻¹) and Cr (336–523 μg g⁻¹) are found to be rich in the sediment [9]. Reported that the contamination nature of the trace elements such as Ni, Cr, Cu and Pb have analogous characteristics in Taihu and Dianchi lakes. The result shows that the Zn values to be 128–215 μg g⁻¹ in the Emerald Lake and its source might be from the transmission fluids, usage of sewage sludge, grease, concrete, and boat oil. The main sources of Cu, Cr and Co are from leachates due to landfill, wastewater from urban areas, sewages and other geogenic materials. From the result it is very clear that the Emerald Lake suffers from rigorous Pb contamination and its higher concentration originated from sewage discharges and the basin like structure of the lake [10].

In this data, the level of pollution accredited to trace elements was estimated using several pollution indicators such as Enrichment factor, Contamination degree, modified Contamination degree and Contamination factor in order to figure out the contamination which is anthropogenic in nature. In result, the mean Enrichment Factor decreases in the order of Zn > Pb > Zn > Ni > Cr > Co > Cu. Enrichment factor reveals the anthropogenic sources of Cu values indicating moderately severe enrichment. Similar results were also obtained by using Contamination degree, modified Contamination degree and Contamination factor. The results of all indices suggest that almost all the sites are polluted by heavy metals. This metal combination can be defined as an anthropogenic component due to its high-level of presence in the sediment. Regarding the metals Cu, Fe, Ni, Cr and Pb involves a maximum part of the research area have high potential hazard when compared to the other individual metals.

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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