Table 2: Measured K_d of radiotracer (at pH = 5) in sediments (L kg^{-1}) at the sampling sites after five days.

	Sampling sites				
Metals	S1	S2	S3	S4	S5
Pb	3165.9	4958.5	396.1	726.1	3841.5
Cd	289.4	1963.1	360.4	436.8	958.1
Cr	554.3	1226.8	550.9	541.6	428.0
Cu	954.5	801.4	1099.9	384.4	141.1

4. Discussion

In the current study, the concentrations of all metal in the lake shore sediments at sites S1 and S3 were higher than in the average shale or mean crustal average [14] suggesting anthropogenic enrichments. The metal concentrations in the lake shores depicted clear differences relative to anthropogenic activities in the catchments. Site S3 had the highest concentration of contaminant metals: Pb, Cd and Cr in agreement with previous findings [8, 15-18]. The reference site S2 had the lowest concentration of all the metals due to minimal human activities within the catchment of the inlet river. High Cu in another reference site S4 as well as in site 5 was from the geological basin [9-13].

In this study, sequential extraction showed metal specific partitioning pattern. The fractionation profile of Pb, Cd and Cr indicated that sites along the river inlets with intense anthropogenic activities (sites S1 and S3) were dominated by Pb, Cd and Cr in exchangeable fractions followed by those bound to carbonates. The exchangeable and metals bound to carbonates, which are considered to be weakly bound and may equilibrate with an aqueous phase, thus becoming more rapidly bioavailable are considered to be signs of recent or continuous enrichment with metals from anthropogenic pathways [19]. The larger the percentage of the exchangeable fractions and/or metals bound to carbonate fraction, the greater the metal pollution problem of the area under consideration. Thus, at S1 and S3, may contain more biovailable metals from the anthropogenic activities in their respective catchment areas. Site S5, fractionation profile indicated that a major portion of Cu was bound to residual fraction constituting up to 90% to the sediment fraction. It has been previously reported that metal present in the residual phase, is of detrital and lattice origin, and could be regarded as a measurement of the potential concentration of the sediment [20]. Therefore the high residual Cu in S5 may be associated with oxidisable phase, where it is likely to occur as organically complexed metal species.

The K_d of most metals in the sediments increased with increasing sediment enrichment with the specific metals. Such an increase may be attributed to the increase in the relative site density available for binding due to the interaction between the particles [21]. However, K_d of Pb increased at all sediment Pb enrichment levels, suggesting that the concentration of Pb in the sediments was less saturated. The K_d of Cd and Cr decreased due to increasing Cd and Cr enrichment respectively at site S3, suggesting high sediment enrichment with Cd and Cr at this site. The K_d of Cu reduced at site S5 with increased Cu enrichment in the sediments, which may be associated with saturated Cu in the sediments from geological sources [13], possibly from the nearby Gucha River. Therefore, the K_d quantified by the radiotracer technique may be useful in simulating the possible transformation and mobility of metals in sediments under a diverse metal enrichment regimen. Based on the partitioning coefficient, the metals investigated have different pollution values due to the varied sources of metal inputs into the lake environment from catchment areas varying in anthropogenic pollution.

5. Conclusions

Metals from sites located near the rivers traversing areas with an agro-industrial and municipal discharges partitioned in exchangeable phase indicating recent ources of contaminants. However, sites with fewer anthropogenic impacts, metals were bound to the residual phase. This study, therefore demonstrates that the partitioning of metals is a geochemical fingerprint for delineating metal contaminant pathways in a lacustrine environment from the catchment areas.

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