

## Evaluation of the Levels of Heavy Metals, Dissolved Organic Phosphorus (DOP) and Nitrogen (DON) in Three Wetlands of Northern Nigerian

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The levels of some heavy metals (copper, Cu; lead, Pb; zinc, Zn; cadmium, Cd; chromium, Cr and nickel, Ni), dissolved organic phosphorus (DOP) and dissolved organic nitrogen (DON) were seasonally determined in water samples from 35 sites which include Jebba, Baturiya, Lokoja, Matara-Uku and Nguru wetlands. The water samples were digested with concentrated trioxonitrate (V) acid at 85 °C for 2 hours on a hot plate and the metal levels were measured using atomic absorption spectrophotometer; the phosphorus and nitrogen levels were determined using the persulphate wet-oxidation method. The following range of values were obtained for the heavy metals; Cu (0.00349±0.001 to 0.0750±0.04 mg/l), Pb (0.194±0.074 to 0.870±0.001 mg/l), Cd (0.00448±0.0033 to 0.0198±0.0001 mg/l), Cr (0.000 to 0.0469±0.001 mg/l), Zn (0.00849±0.009 to 0.144±0.296 mg/l) and Ni (0.0042±0.0056 to 0.0454±0.015 mg/l). Pearson correlation coefficient, analysis of variance, Tukey's test, principal component analysis (PCA) and cluster analysis (CA) were used to assess the data and it was observed that lead has the highest mean concentration out of the six heavy metals measured. When the metals levels were graduated, they were found to be in the order of Pb>Cr>Zn>Cu>Cd>Ni in the wet season but the order changed drastically in the dry season as Pb>Cu>Zn>Ni>Cd>Cr. The Pb and Cd concentrations in all the sites of the wetland were higher than the WHO and NAFDAC guidelines, indicating that they wetlands water samples are unsafe for human consumption, thus relying on these wetlands as sources of food would have serious public health implications. Generally, the metal concentrations increased in the dry but decreased in wet season. The average values for DON and DOP obtained ranged from 10.7±22.8 to 71.1±14.9 mg/l and 0.464±0.229 to 1.84±1.39 mg/l respectively in the wetlands. The values obtained for DON during the dry and wet seasons are 71.1±14.9, 10.7±22.8, 26.7±9.40, 10.8±7.20, 17.4±7.10 and 46.8±11.3, 36.6±4.50, 46.1±11.0, 39.7±3.40, 38.2±1.80 mg/l respectively for J, BR, LA, M and N wetlands. While 0.464±0.229, 0.917±0.120, 0.782±0.251, 1.84±1.39, 0.601±0.603 and 1.60±0.422, 1.80±0.368, 1.82±0.771, 1.07±0.307, 1.45±1.45 mg/l were recorded for DOP in the dry and wet seasons respectively for J, BR, LA, M and N wetlands. There is no significant difference in DON and DOP concentration in both the dry and the wet seasons. Principal Component analysis and Cluster analysis were used to analyse the relevance of different heavy metals and identify their major sources. The results showed three factors for the heavy metals variability (72.5% of the total variance) that Zn, were dominated by PC1, Cd and Pb were associated with high values in the second component whereas Cr and Ni are higher in the third component. Cluster Analysis (CA), for the sampling sites showed that industrial wastewater and atmospheric deposition were the major sources of heavy metals particularly Pb, Cd, Cr, Zn and Cu in these wetlands. High concentrations of DOP and DON in wetlands have been implicated for high yield of agricultural produce of the farmlands around the wetlands.

Keywords: Wetlands, water samples, heavy metals, DOP, DON.