Monte Carlo Simulation

The Monte Carlo simulation was used to manage the uncertainty inherent in calculating potential ecological risk by utilizing fixed-point metal concentration values. For this analysis, river sediment metal concentration data were employed to determine a suitable probability distribution, facilitating the Risk Index (RI) simulation through 10,000 Monte Carlo iterations. Figure X shows the normal and log-normal distributions of the simulation.

The simulation incorporated ecological risk factors based on the concentrations of Mn, Fe, Cu, Zn, As, and Pb, which were then aggregated to determine the overall ecological risk index, RI. The RI had a mean of 8.1, with 75% of values exceeding 12.97. The log-normal distribution yielded a mean RI of 8.24, with 75% of values above 8.44. Figure X shows the contribution percentages to the RI, with the metals contributing as follows: Fe (39.68%), As (19.72%), Zn (19.44%), Cu (10.14%), and Mn (9.06%). At the 75th percentile, the minimum contributions were Fe (49.18%), As (28.12%), Zn (24.88%), Cu (12.57%), and Mn (11.4%).

The RI values clearly fall within the low-risk category, suggesting that, based on current metal concentrations in river sediments, the ecological risk remains within a range indicative of limited pollution. However, individual metals, such as Fe and As, which show significant contributions to the RI, may still warrant focused attention, especially under conditions that might increase their bioavailability or toxicity.