

Geochemical and Environmental Impacts of Coal Mines/Waste on Soil and Water in Tirah Valley, District Khyber Muhammad

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To assess soil and drinking water quality deterioration in the Tirah coal mining area of Pakistan, the present study examines the environmental repercussions associated with coal mining activities. A total of 26 water samples, 31 soil samples, and 5 coal waste samples were collected from weathered soil and coal mines, respectively. These samples were analyzed for major and trace elements using atomic absorption spectrometer and ICPMS at the National Center of Excellence in Geology, University of Peshawar. Various methods, including descriptive statistics, correlation analysis, and pollutant quantification factor, were employed to process the results. For soil samples, an ecological risk assessment for several hazardous metals was computed. Groundwater samples from the Tirah coal mining area exhibited pH, EC, TDS, and salinity levels below the WHO-recommended guidelines. However, research on groundwater cations revealed that calcium and potassium levels exceeded WHO criteria. Analysis of heavy metals in water using ICPMS indicated that cadmium (Cd) and lead (Pb) levels surpassed WHO standards, with the HQ for Cd indicating high risk exposure in the area. Comparison of minor elements in soil with Bohn et al. (2001) showed that only cobalt (Co) was within regulatory limits, while concentrations of all other metals exceeded background values. Strong correlations among heavy metals were observed in coal waste samples, such as Cu-Pb, Co-Zn, Co-Cd, and Cr-Cu. The research area was found to be polluted with heavy metals (HMs), as indicated by pollution load index (PLI) values exceeding 1 for soil and coal waste samples. According to the study's findings, coal mining activities have impacted water and soil in the area, resulting in contamination. Heavy metals produced during blasting, quarrying, and crushing of coal-polluted soil in Tirah, District Khyber, directly affect vegetation and have significant effects on the local community and environment.