

A Comprehensive Analysis of Coal Mining's Impact on LULC, and Environment in Ib Valley, Odisha, India (1976–2024)

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Abstract

The Ib Valley Coalfield in Odisha, one of India's major coal-producing regions, has the third-highest coal reserves in the country. The study assesses how mining expansion and associated developments have reshaped the landscape over nearly five decades. Guided by the research goal of quantifying the impacts of coal mining activity on land use and land cover (LULC) changes, the study leverages multi-spectral/multi-temporal satellite imagery from multiple Landsat missions (2, 5, 7, 8, and 9) acquired between 1976 and 2024. The images were processed and divided into six primary LULC classes—Vegetation, Waterbodies, Mining Regions, Settlements, Industries, and Others—which were identified by employing visual interpretation techniques alongside using advanced band indices, namely, Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI) to validate the actual features on the ground, along with Google Earth Engine for ground truth. Results show a pronounced expansion in Mining Regions, from 0.12 km² in 1976 to 49.49 km² in 2024, reflecting the increasing dominance of open-cast mining. Concurrently, Settlements grew from 10.67 km² to 97.06 km², underscoring rapid urbanisation. By contrast, Vegetation declined from 1304.08 km² to 1142.14 km², underscoring pressures on natural ecosystems, and the open land available for agriculture was severely affected as 111.84 km² of open land was converted into mines, settlements and industries. Waterbodies exhibited modest fluctuations, influenced by reservoir management and rainfall patterns. Moreover, the transition matrix of the findings highlights the substantial environmental transformations occurring in the Ib Valley Coalfield, highlighting severe air and water pollution stemming from open-cast mining operations with implications for habitat integrity, water resource management, and regional socio-economic dynamics—environmental assessments.

Keywords

Coal Mining, Ib Valley, Land Use/Land Cover (LULC), Environment, Remote Sensing Themes: Mining Induced Environmental Transformations.