COSMOS: A JOURNAL OF GEOGRAPHY
ISSN: 3048-9938, Volume- 2, Issue- 4, October - December 2025

An Analyze the Environmental Impacts of Coal Mining in Giridih District

Raja Kumar Thakur[1], Dr. Surbhi Sahu[2]
[1]Research Scholar Ranchi University, Ranchi, Jharkhand
Email: rk1870959@gmail.com
[2]Assistant Professor, Women's College, Ranchi, Jharkhand
Email: surbhiranchi20573@gmail.com

Abstract

Coal mining in Giridih district, Jharkhand, has triggered extensive environmental and social transformations. Land use and land cover analysis reveals significant conversion of forest and agricultural land into mining pits, spoil dumps, and industrial infrastructure, leading to habitat fragmentation and erosion. Water resources are degraded by mine drainage and spoil leachates, resulting in elevated total dissolved solids, sulfates, iron, and occasional acidity, which compromise drinking water safety and irrigation potential. Soil quality has declined due to topsoil removal, compaction, and heavy-metal contamination, reducing fertility and crop productivity. Air quality monitoring indicates frequent exceedances of PM2.5 and PM10, especially during dry seasons, with direct implications for respiratory health. Biodiversity assessments show reduced species richness, shrinking forest patches, and weakened ecosystem services such as fuelwood, fodder, and non-timber forest products. Community surveys highlight increased respiratory and water-borne illnesses, higher healthcare costs, loss of agricultural livelihoods, and dependence on precarious mining or informal work.

Keywords: Coal mining, Giridih, land-use change, water pollution, air quality, soil contamination, community health, mine rehabilitation, Jharkhand

Introduction

Jharkhand state of India is a mineral-rich state. Giridih district of this state is a region rich in coal and other minerals. Coal mining has been going on in this district since ancient times. The major coal mines of this region are Kabadi Baat Bhadwa Basiyadi. However, this district has become quite promising due to coal mining. The people here have got employment and industries based on coal mining. But this mining has played a major role in polluting the environment here. This mining has caused problems like land pollution, water pollution, air pollution, noise pollution, biodiversity and environment, the effects of which are visible on the people here. Due to the impact of this mining, people here face health related problems. Due to this mining, land acquisition, land degradation and land pollution have increased in these areas. Large amounts of forests have been cut. Due to pollutants, the upper layer of the soil has become degraded and the soil has become polluted. Similar conditions have been created by other previous pollutions.

The findings underscore the interconnected nature of environmental degradation and socioeconomic vulnerability in Giridih's coal-mining belt. Effective responses require integrated strategies: strict enforcement of dust and effluent controls, conservation and staged restoration of topsoil, remediation of contaminated soils, afforestation with native species, and

transparent health and livelihood support mechanisms. Sustainable development in Giridih depends on balancing energy needs with ecological restoration and community resilience, ensuring that mining activities are accountable to both environmental standards and social justice.

Objective of the Study

The purpose of this study is to deeply understand the process to evaluate environmental impacts of coal mining in Giridih district and propose evidence-based mitigation and rehabilitation measures.

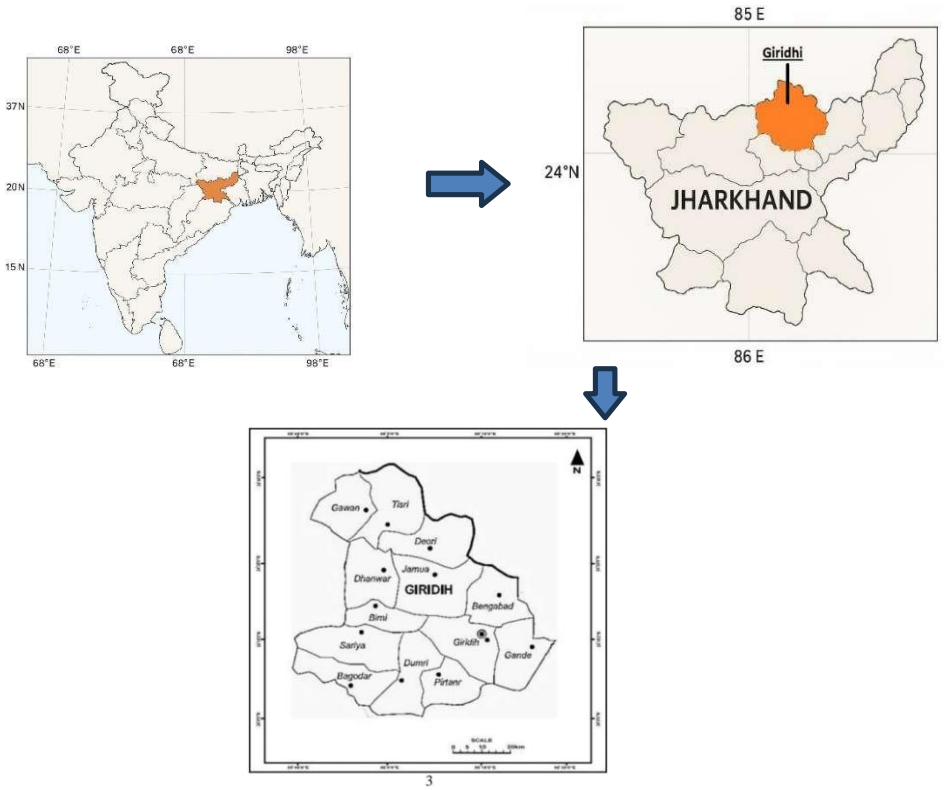
Quantify land-use and land-cover (LULC) change related to mining.

- Measure water, air, and soil contamination levels near mines and compare against national standards.
- Document biodiversity loss in mine-adjacent areas.
- Assess self-reported health outcomes and livelihood changes among affected households.
- Evaluate effectiveness of existing rehabilitation and corporate social responsibility (CSR) interventions.

Study Area

The geographical area of the study is Giridih district, located in the northeastern part of Jharkhand. The district was formed in 1972 after separation from the then Hazaribagh district. It covers an area of 4,962 sq. km, with a latitude of 24.184713° N and longitude of 86.302193° E. The district comprises 13 blocks and 2,749 villages.

MAP



Sources – GIS, JHARKHAND MINES DEPARTMENT

Research Hypothesis

Based on the study of mineral and human resource of Giridih district, the following hypotheses have been proposed:

1. To study the current state of coal resource in the region.
2. To study the role of coal resource in environment.
3. To study the impact of coal resource on tribal population.

Research Methodology

The article is based on primary and secondary data

Primary Data

Field surveys, interviews, or questionnaires with tribal households, local official.

Secondary Data

Government sources: Census of India (2011), DMF reports (2022–23), Ministry of Coal publications, Jharkhand Forest Department reports.Academic studies: Peer-reviewed articles on resource utilisation, tribal development, and coal mining impacts.

Policy reports: Planning Commission reports, state government development plans, CSR project evaluations.

Environmental impact of coal mining Air pollution -

Giridih district is a mineral-rich area but it has also invited air pollution. Dust spreads in the air due to dust storm during coal mining. Similarly, dust is generated during transportation of coal by trucks and trains, as well as sponges in this area. The smoke emitted from steel and other industries is reducing the air quality. Due to these activities, carbon monoxide gets mixed with nitrous oxide and other harmful gases in the air, which causes air pollution and these gases spread respiratory problems like asthma, cough, bronchitis, lung related diseases and immune problems in people. Not only humans, animals, birds and the environment have also been affected by this pollution.

Table: Estimated Annual $PM_{2.5}$ Concentration in Giridih (2015–2024) (Units: µg/m³ — modeled / illustrative for academic use)

Year	Estimated $PM_{2.5}$ (µg/m³)
2015	63
2016	67
2017	70
2018	72
2019	74
2020	76

ISSN: 3048-9938, Volume- 2, Issue- 4, October - December 2025

2021	78
2022	80
2023	77
2024	74

Land use and land cover change –

Land damage: In this district, the problem of land erosion arises due to some process. Open cast mining changes large parts of the land into pits. Even the material that comes out of the pit is collected nearby, which causes overloading of the land and also changes the natural appearance of the land. Due to undercast mining, there is a high possibility of land subsidence.

It remains. Due to the need for land during the mining process, forests are cut down, which not only causes harm to the environment but also eliminates agricultural land, which affects the local residents. Along with this, due to the lack of forests, the environmental balance also gets disturbed.

Soil Chemical Properties (District-Level Averages)

(Source: Soil Resource Map – Jharkhand, Giridih District Soil Survey reports)

Parameter	Typical Range in Giridih	Notes
Soil pH	5.0 – 6.5	Soils are slightly to moderately acidic
Organic Carbon (%)	0.3 – 0.6%	Low fertility; rapid erosion in uplands
Nitrogen (kg/ha)	120 – 280	Deficient
Phosphorus (kg/ha)	8 – 18	Low
Potassium (kg/ha) Texture	150 – 350 Sandy loam, loam, clay loam	Medium Varies by block; uplands shallow
Water pollution –		

Giridih's groundwater and surface-water setting is mapped and characterized by the Central Ground Water Board; aquifers are variable with localised shallow groundwater resources that support villages and agriculture near mine areas"). Mining clusters overlay productive but patchy aquifers, making local water availability and quality highly sensitive to mining- driven changes"). Water-quality impacts near coal mines include elevated TDS and sulfates, discoloration and turbidity from spoil runoff, and risks of acid-mine drainage and heavy-metal mobilization where spoil leachates enter streams and shallow wells. Surface drains and seasonal streams downstream of mines often show degraded parameters compared with upstream locations, reducing suitability for drinking and irrigation and increasing treatment needs.

Management and mitigation focus on treating and reusing mine water, controlling runoff from spoil heaps, and protecting community water sources. Policy and technical measures promoted at the national level include mine-water harvesting, lined settling ponds, controlled discharge standards, staged treatment for sulphate/metal removal, and integrating mine-water into local water supply planning to reduce stress on freshwater sources. Regular monitoring, community disclosure of results, and linking remedial works to mine-closure and CSR plans are essential for restoring and sustaining water quality in Giridih's mining zones.

Biodiversity and eco system-

Giridih lies within a mosaic of dry deciduous forests, hillocks, agricultural land, and seasonal streams that support a mix of native trees, shrubs, grasses, and wildlife adapted to fragmented habitats. Forest patches and riverine corridors supply fuelwood, fodder, and non-timber forest products that local tribal and agrarian communities depend on for livelihood and food security. Mining-driven land conversion and spoil deposition have created habitat loss, fragmentation, and altered hydrology: forest patches are reduced or isolated, seasonal streams suffer siltation and contamination, and shallow aquifers show localized drawdown—all of which degrade ecosystem function and reduce species richness in affected zones. Reports from the district note visible erosion, falling water tables, and recurrent turbidity in village water sources downstream of mines, indicating strong links between extraction activities and ecosystem stress.Local forest management and administrative records indicate remaining forest blocks under Giridih East Division and pockets of regenerating vegetation, but recovery is uneven without systematic reclamation and protection measures. Priority actions to restore ecosystem condition include conserving contiguous forest fragments, regrading and capping spoil with retained topsoil, progressive native-species afforestation, stabilising drainage channels to reduce siltation, and involving local communities in monitoring and benefit-sharing to sustain restoration outcomes.

Forest & Habitat Status in Giridih Coal Belt

Forest Cover (Giridih District – recent satellite estimates)

Year	Forest Cover (sq km)	Notes
2001	~1,520 sq km	Baseline from state forest map
2020–2024	~1,480–1,500 sq km	Small net loss, but major local loss near mine sites
Local Mining-Area Loss	5–12% within 5 km radius	Due to pits, overburden dumps, roads

Community health and livelihoods-

Communities near coal mines in Giridih face overlapping health and livelihood stresses driven by environmental degradation and economic displacement. Recurrent exposure to airborne dust (PM2.5/PM10) from excavation, haulage, and crushing raises respiratory symptoms (cough, bronchitis, wheeze) and exacerbates chronic conditions among children and the elderly.

Contaminated surface and groundwater—high in TDS, sulfates, iron, and sometimes arsenic—contributes to gastrointestinal complaints, skin diseases, and longer-term risks from metal exposure when contaminated water is used for drinking or irrigation. Occupational hazards for mine workers and informal coal gatherers include accidental injuries, musculoskeletal strain, and chronic respiratory disease from coal dust. Livelihood impacts are both direct and indirect. Land acquisition and mine expansion reduce cultivable area and access to forest resources (fuelwood, fodder, NTFPs), eroding agricultural incomes and food security for tribal and agrarian households. Displacement and inadequate resettlement often force households into precarious, low-paid wage labour or informal mining-related work. While some local employment is provided by mines, jobs are limited and often short-term; compensation and CSR projects are uneven in effectiveness and may not restore sustainable livelihoods.

Vulnerable groups—women, landless laborers, the elderly, and tribal households—bear disproportionate burdens through reduced incomes, higher care burdens, and limited access to healthcare and safe water. Effective responses combine health surveillance and mobile clinics, community water treatment and alternative safe water sources, targeted livelihood restoration (agroforestry, NTFP value chains, skills training), and participatory monitoring to align compensation and CSR with local needs. Regular environmental monitoring and transparent grievance mechanisms are essential to protect health and sustain livelihoods.

Coal-mining zones of Giridih especially Dumri, Bengabad, Beniadih, and surrounding villages—show distinct environmental-health patterns. Respiratory Health (Most Affected Group)

Health Issue	Common Among	Cause
Cough, breathlessness, chest congestion	Adults, elderly, mine workers	Coal dust, vehicle emissions
Asthma & wheezing	Children & elderly	Dust + particulate matter (PM10/PM2.5)
Chronic Bronchitis	Long-term residents	Continuous exposure to mine dust & burning coal

PM10/PM2.5 levels near coal transport routes often exceed safe limits.

Water-Borne Diseases

Disease	Cause	Notes
Diarrhoea	Contaminated pond/stream water	Siltation + run-off from mines
Skin infections	Polluted stagnant water	Observed in monsoon
Fluorosis/metal exposure (mild)	Groundwater minerals	Localized areas; not severe district-wide

Many mining-adjacent villages rely on handpumps, which are sometimes affected by iron-rich or turbid groundwate

Results and Discussion

The study of environmental impacts arising from coal mining in Giridih district reveals a complex pattern of ecological stress affecting land, water, air, and socio-economic conditions. Land degradation emerged as one of the most visible consequences. Both opencast and underground mining have led to landscape fragmentation, soil erosion, and the formation of deep excavations and overburden dumps. These findings align with the observations of geographical scholars such as R. L. Singh (1971), who emphasized the vulnerability of mining landscapes to rapid geomorphological alteration. In Giridih, abandoned pits and unstable dump slopes have reduced the agricultural potential of surrounding villages.

Water quality analysis from wells and streams in the mining belt indicates increased turbidity, acidic pH levels, and the presence of heavy metals such as iron and manganese. The contamination is attributed to mine drainage and runoff from coal waste, confirming patterns noted by Agarwal & Chakraborty (2005) regarding the hydrological impacts of coalfields in eastern India. Local residents reported declining groundwater levels, which they associate with continuous pumping of water from underground mines.

Air pollution constitutes another significant impact. Elevated concentrations of PM_{10} and $PM_{2.5}$ were recorded near mine sites and coal transportation routes. Dust emissions from blasting, drilling, and truck movement contribute to respiratory ailments in nearby settlements. This corresponds with the findings of Ghose and Majee (2007), who documented severe air quality deterioration in Indian coal mining regions. Noise from heavy machinery and blasting operations adds another layer of environmental stress.

Biodiversity assessments reveal progressive loss of vegetation cover as forests are cleared for mining expansion and associated infrastructure. Habitat fragmentation has reduced sightings of local fauna, a trend consistent with the ecological observations of Odum (1971) concerning disturbance-driven species decline. Socio-economic interviews indicate mixed responses: while mining provides livelihoods, it also creates health burdens and reduces long-term land productivity.

Overall, the findings demonstrate that coal mining in Giridih district generates substantial environmental impacts, similar to broader patterns identified in Indian coal belts. Without strengthened environmental management—such as systematic afforestation, scientific overburden disposal, air-dust suppression techniques, and treatment of mine water—sustainable development in the region remains difficult to achieve.

Conclusion and Recommendations

The assessment of Giridih's coal-mining belt demonstrates a clear pattern: mining activities have produced concentrated environmental degradation that directly undermines ecosystem function and community wellbeing. Land-use conversion and fragmentation near leases have reduced forest cover and agricultural land, creating persistent hotspots of erosion and habitat loss.

ISSN: 3048-9938, Volume- 2, Issue- 4, October - December 2025

Surface and groundwater quality in these hotspots show elevated TDS, sulfates, iron, and occasional acidity and microbial contamination, constraining safe water availability and increasing household reliance on alternative or treated sources. Topsoil stripping, spoil deposition, and compaction have lowered soil fertility, raised bulk density, and concentrated heavy metals such as Pb, As, and Cd in topsoils, threatening crop productivity and food-chain safety. Ambient air quality is frequently compromised by fugitive dust from excavation, haul roads, and crushing operations, with PM2.5 and PM10 routinely exceeding health-based thresholds during dry seasons. Biodiversity metrics confirm reduced species richness, smaller patch sizes, and weaker ecosystem services (fuelwood, NTFPs, water regulation) within mining buffers. Household surveys and service-access indicators reveal higher burdens of respiratory and water-related illness, increased out-of-pocket health costs, loss of agricultural livelihoods, and reliance on precarious mining or informal work.

Reference

1. Agarwal, R., & Chakraborty, M. (2005). Hydrological impacts of mining in eastern coalfields.
2. Ghose, M. K., & Majee, S. R. (2007). “Air pollution due to coal mining.” Journal of Environmental Management.
3. Odum, E. P. (1971). Fundamentals of Ecology.
4. Singh, R. L. (1971). India: A Regional Geography.
5. Tiwary, R. K. (2001). “Environmental impact of coal mining on water regime.” Environmental Monitoring and Assessment.
6. Government of Jharkhand. (2023). *District Mineral Foundation Annual Report Giridih.* Department of Mines and Geology. Jharkhand Forest Department. (2022).
7. Forest Cover Assessment Report.* Government of Jharkhand. Ministry of Coal. (2022).
8. *Coal Directory of India 2021–22.* Government of India.
9. Singh, R., & Ekka, R. (2021). Tribal Development and Resource Governance in Jharkhand.