10.48047/jocaaa.2024.33.07.37

JHARIA COALFIELD: RESOURCE POTENTIAL, ENVIRONMENTAL CRISIS, AND PATHWAYS TOWARD SUSTAINABLE MINING

Bhanu Kumar[1], Dr Rajni Kant[2] and Shailendra Bomanwar[3]

[1]Research Scholar, Department of Mining Engineering, BIT, Ballarpur (MS), India.

[2]Principal, Ballarpur Institute of Technology Ballarpur Dist.-Chandrapur (MS)-442701

[3]Assistant Professor, Department of Mining Engineering, BIT, Ballarpur (MS)

ABSTRACT

The Jharia Coalfield in eastern India is acclaimed for its premium coking coal reserves, serving as the backbone of India's metallurgical and thermal energy capabilities. The region's protracted mining legacy, tracing back to the late nineteenth century, has resulted in profound economic benefits but catastrophic environmental and social costs. This review synthesizes available research on Jharia's geology, mining practices, socio-economic contributions, environmental impacts including the globally notorious coal fires public health consequences, policy responses, and future management strategies. Up-to-date data, critical discussions, and expert recommendations are woven throughout. Tables and figures illustrate field conditions and trends, underscoring the urgent need for integrated, sustainable solutions in balancing extraction with environmental stewardship.

Keywords: Jharia coalfield, mining, environmental crisis, resources.

1. INTRODUCTION

1.1 Background and Significance

The Jharia Coalfield is recognized globally as a major coal-bearing region, supplying high-grade coking coal key to India's steel and energy sectors. Its unique geological make-up, coupled with extensive mining operations, has rendered the coalfield central to national industrialization (Singh et al., 2022). However, the region has also become emblematic of the challenges that accompany natural resource exploitation, particularly in emerging economies (Boral et al., 2021).

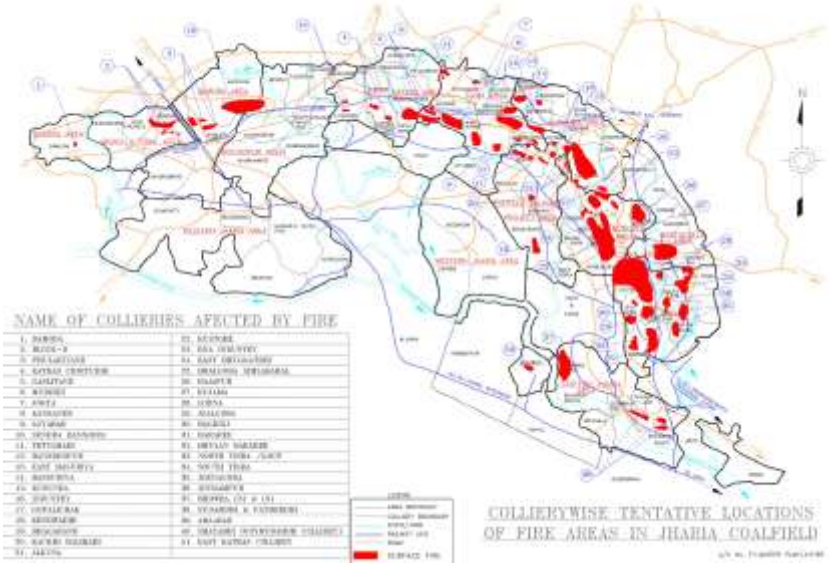

Figure 1 The map of study area of JCF and affected coal mine fires (Published from BCCL 2008)

10.48047/jocaaa.2024.33.07.37

1.2 Objectives and Structure

This paper's goal is to critically review the natural endowment of the Jharia Coalfield, mining history, techniques, industrial contributions, environmental and social detriments, remediation efforts, and pathways to sustainability. The analysis is structured to guide both technical specialists and policy planners (Asif et al., 2022) (Pandey et al., 2024).

2. GEOGRAPHICAL AND GEOLOGICAL OVERVIEW

2.1 Location and Boundaries

Spanning parts of the Dhanbad district in Jharkhand, the Jharia Coalfield extends between latitudes 23°37′ and 23°52′ N and longitudes 86°06′ and 86°30′ E. Covering approximately 450 square kilometers, it forms a synclinal basin delineated by the Damodar River to the north (Das et al., 2021Rawalwasia, 2025).

Table 1 Geographical Features of Jharia Coalfield

Feature	Detail
Latitude	23°37′ – 23°52′ N
Longitude	86°06′ – 86°30′ E
Area	~450 sq. km
Major Towns	Dhanbad, Jharia, Katras
Rivers	Damodar, Katri, Jamunia

2.2 Geological Setting

Jharia's geological strata are dominated by Gondwana sediments, divided into the Talcher, Barakar, Barren Measures, and Raniganj formations. The Barakar Formation's thick seams of prime coking coal are the field's economic backbone. Major faulting and intrusive volcanic rocks further complicate seam continuity and mining (Sahu, K., & Sharma, R., 2023).

Table 2 Principal Coal Seams and Characteristics

Seam	Average Thickness (m)	Depth Range (m)	Moisture (%)	Carbon Content (%)
II	4.1	900–950	2.5–3.0	84–93
V	11.6	850–900	1.8–2.5	84–93
XI	9.8	1000–1040	2.2–2.8	85–92
XV	1.8–6.5	925–1100	2.0–3.1	84–93

10.48047/jocaaa.2024.33.07.37

2.3 Structural Complexity

The coalfield's structure features a central syncline with multiple faults and igneous intrusions, impacting mining operations and potentially fostering spontaneous combustion in coal seams (Jharia Coalfield, 2025).

3. HISTORICAL DEVELOPMENT OF MINING

3.1 Early Beginnings

Commercial mining in Jharia began in the late 1800s, initially relying on underground (bord and pillar, longwall) extraction. The lack of systematic planning in early decades resulted in unscientific mining, poor record-keeping, and minimal safety considerations (Saikia et al., 2013).

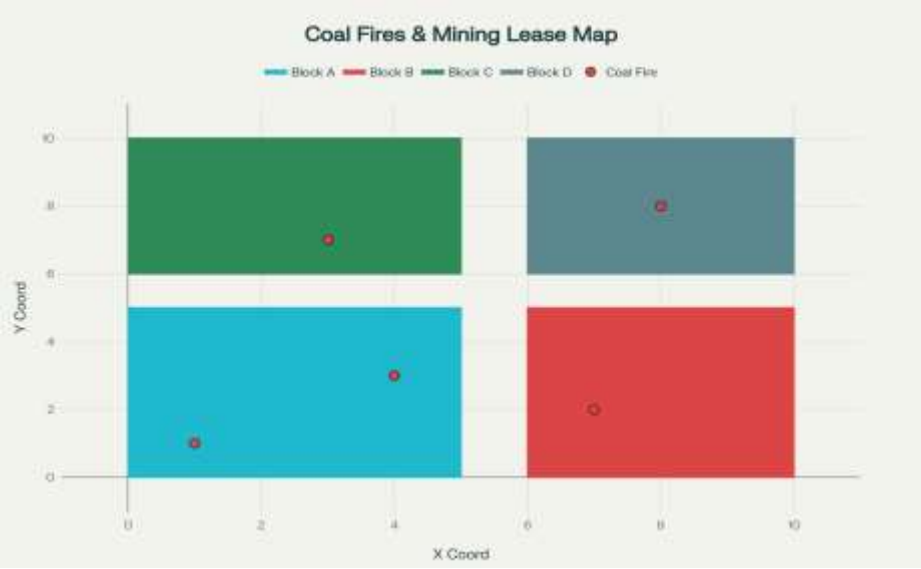

Figure 2 Distribution map of coal seam fires overlaid on mining lease map in Jharia Coalfield

3.2 Transition to Large-Scale Operations

Over time, increasing demand for coking coal pushed operators to expand the mining footprint. The 1970s nationalization spurred technological upgrades, including mechanized open-cast mining, which now dominates production (Socio-Economic Perspective with Reference to Jharia Coalfield, 2014).

Table 3 Mining Methods Used in Jharia Coalfield

Mining Method	Brief Description	Current Share of Output (%)
Bord and Pillar	Underground, pillar support	15
Longwall Mining	Underground, self-advancing supports	1
Open-cast/Surface	Large-scale overburden removal	84

10.48047/jocaaa.2024.33.07.37

3.3 Current Operators and Governance

The dominant operator is Bharat Coking Coal Limited (BCCL), a subsidiary of Coal India Ltd., overseeing nearly all mines following the nationalization wave in the 1970s(Bharat Coking Coal Limited, 2019).

4. RESOURCE ASSESSMENT AND ECONOMIC SIGNIFICANCE

4.1 Coal Reserve Estimates

Jharia boasts nearly 19 billion tons of assessed coal reserves, with coking coal comprising the bulk—essential for steel manufacture (Krishna Gopal, 2025).

4.2 Production and Supply Chain

Annual output fluctuates near 45 million tons, serving integrated steel plants, thermal power stations, and the chemical sector. Jharia's proximity to railways and urban centers strengthens its logistical advantage.

Table 4 Production and Utilization Profile (Recent Years)

Year	Total Output (mt)	% Coking Coal	Largest Consumer
2020	41.5	62	Steel plants
2022	43.8	64	Steel and power
2023	44.2	65	Steel/cement/exports

4.3 Role in Regional Economy

The coalfield underpins local economies, supporting tens of thousands of direct and indirect jobs. Downstream industries cluster in the region, forming an industrial corridor along the Damodar valley.

5. ENVIRONMENTAL IMPACT

5.1 Air Quality Degradation

Mining activities, coal fires, and coal transport networks result in airborne emissions including particulates, sulfur dioxide, oxides of nitrogen, and volatile organic compounds.

10.48047/jocaaa.2024.33.07.37

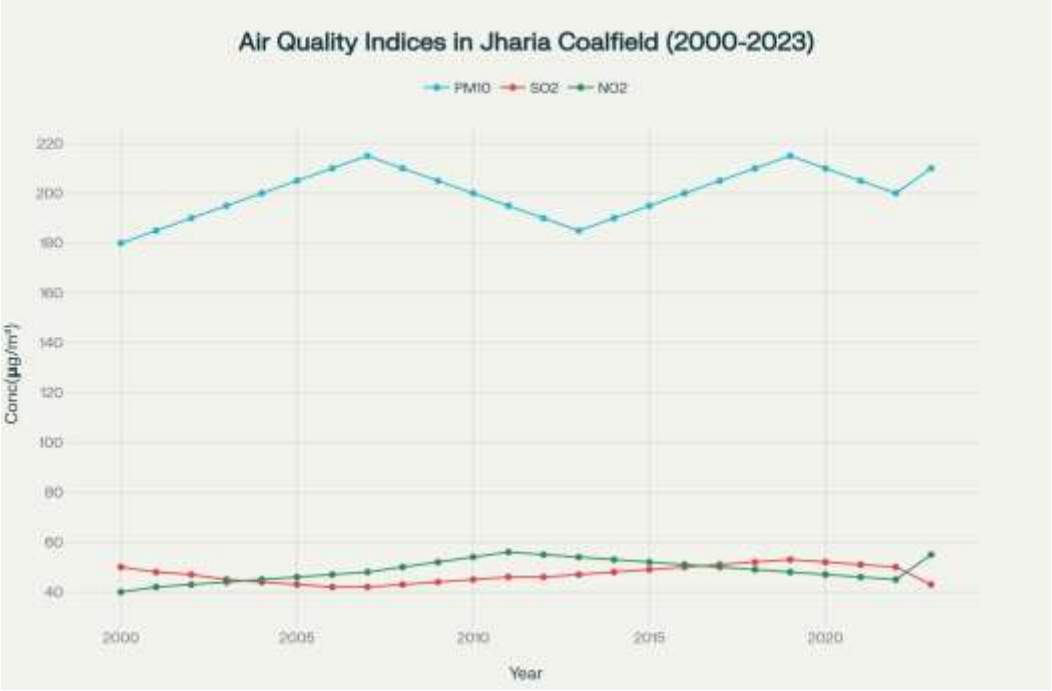

Figure 3 Air quality indices time-series graph for PM10, SO2, and NO2 from 2000 to 2023 at Jharia Coalfield

Air quality indices routinely exceed public health standards, and visible haze blankets much of the coalfield (Jharia Coalfield, Dhanbad District, Jharkhand, India, 2025).

Table 5 Average Air Pollutant Levels Recorded (Recent Survey)

Pollutant	Measured Value (µg/m³)	Standard Limit (µg/m³)
PM10	210	100
SO_2	43	80
NO_2	55	80

5.2 Water Pollution and Hydrological Disruption

Acid mine drainage, coal washery effluent, and leaching of heavy metals (e.g., arsenic, cadmium) contaminate groundwater and river systems. This pollution imperils drinking water supplies and aquatic life in the Damodar River and tributaries (Chandra, K., & Chakraborty, A., 1989).

5.3 Land Degradation and Subsidence

Continuous extraction leads to land subsidence, crater formation, and the transformation of fertile fields into wastelands. The ground may subside several meters in affected blocks, damaging homes and infrastructure (Gupta, D., & Sahu, R., 1979).

10.48047/jocaaa.2024.33.07.37

Table 6 Selected Land Use Changes (2000–2023)

Year	Mining Area (km²)	Forest Area (km²)	Agricultural Area (km²)
2000	65	37	210
2010	91	28	173
2023	104	18	135

5.4 Coal Seam Fires—A Global Concern

Jharia is infamous for chronic underground coal fires, some burning for over a century. Spontaneous combustion, promoted by air ingress and broken pillars, releases toxic gases, destroys reserves, and renders large zones uninhabitable (Mongabay India, 2019).

6. SOCIAL AND PUBLIC HEALTH IMPACTS

6.1 Morbidity and Mortality Trends

Residents are exposed to heavy air pollution and poisonous gases. Respiratory infections, chronic obstructive pulmonary disease (COPD), tuberculosis, asthma, and skin disorders are markedly elevated among all age groups. Mental health stress arises from forced displacement and persistent threat of land collapse.

6.2 Displacement and Urban Stress

Land subsidence and mine fires have rendered large neighborhoods unsafe. More than 100,000 residents are estimated to have been internally displaced, some multiple times. Social services, sanitation, and education are severely disrupted in temporary settlements (Jharia Coalfield, 2025).

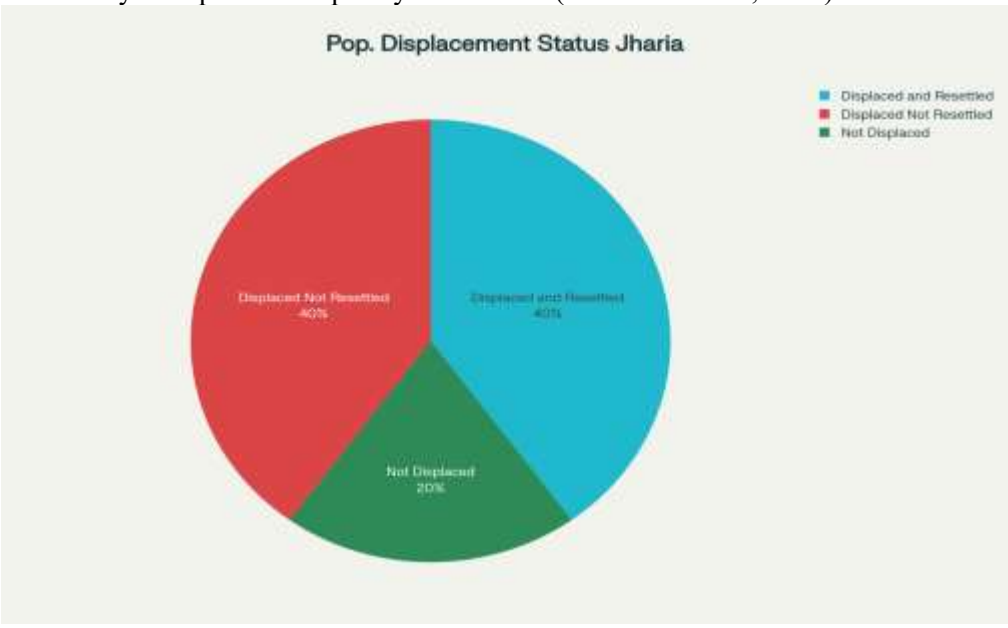

Figure 4 Population displacement and resettlement status in Jharia region

10.48047/jocaaa.2024.33.07.37

Table 7 Select Social Indicators, Jharia Region

Indicator	Value (2011)	Comment
Population Affected	>700,000	Direct and indirect
Number Displaced	~100,000	Due to fires/subsidence
Literacy Rate	60%	Lower than state avg.
Infant Mortality Rate	44/1000	Higher than state avg.

6.3 Gender and Child Welfare

Women and children are disproportionately affected—suffering from reproductive health problems, malnutrition, and lack of access to schools and healthcare(Jharia Coalfield, 2025).

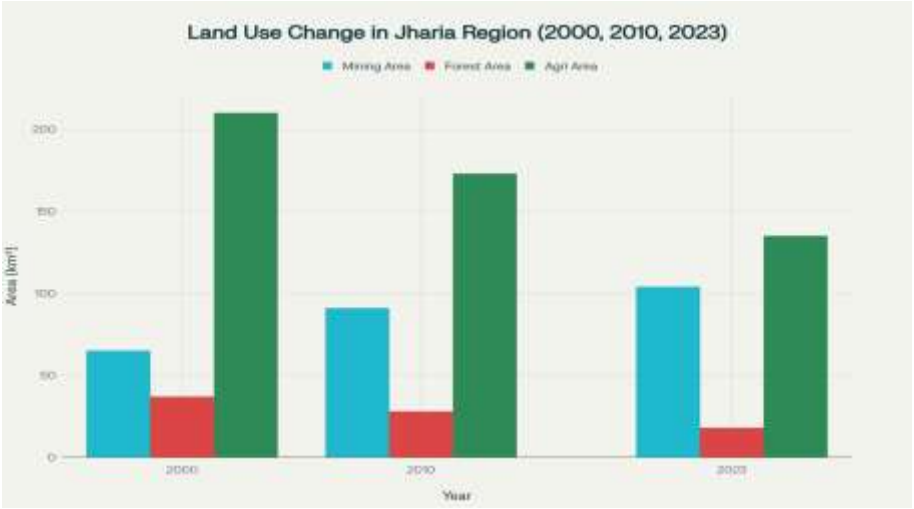

Figure 5 Land use change in the Jharia region showing mining, forest, and agricultural areas in 2000, 2010, and 2023

7. TECHNOLOGICAL AND POLICY RESPONSES

7.1 Fire Suppression and Remediation

Fire control employs a blend of surface blanketing (inert material covers), in-situ flushing, trench cutting, and relocating hazardous settlements. Success has been limited due to scale, complexity, and new firings (Jharia Coalfield, 2025).

10.48047/jocaaa.2024.33.07.37

7.2 Land Reclamation Strategies

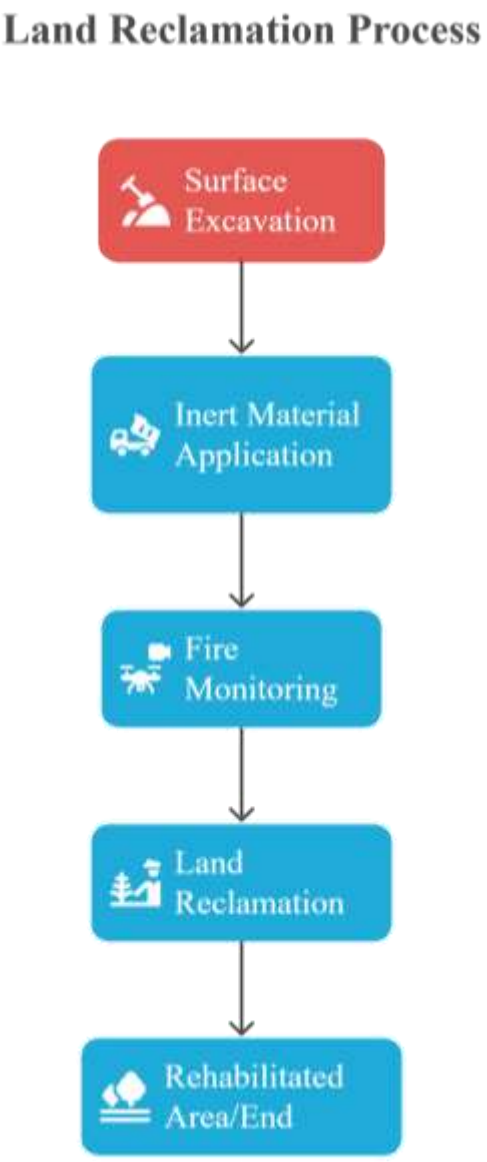

Figure 6 Land subsidence events compared with mining intensity from 2000 to 2023 in Jharia Coalfield

Advances in geo-spatial mapping guide reclamation. Afforestation, topsoil restoration, and conversion of mined-out pits to wetlands are being piloted, with modest success.

10.48047/jocaaa.2024.33.07.37

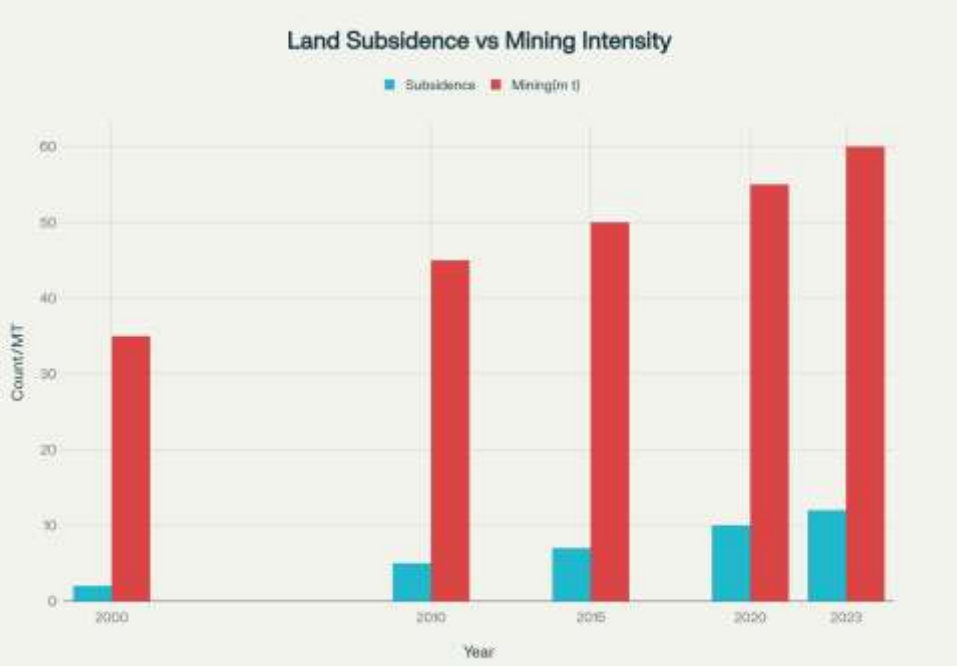

Figure 7 Land subsidence events compared with mining intensity from 2000 to 2023 in Jharia Coalfield

7.3 Policy and Regulatory Enhancements

Government initiatives, largely post-2000, emphasize "scientific" mining, environmental clearance, CSR obligations, and comprehensive resettlement packages. Enforcement, however, is variably effective (Jharia Coalfield, 2025).

Table 8 Major Policy Interventions Over Time

Policy/Action	Implementation Period	Reported Success
Coal Nationalization	1971–1973	Production up; legacy issues
Environment Protection Act	1986	Enhanced oversight
Jharia Rehabilitation Plan	2009–present	Mixed; slow progress
District Environmental Plans	2016–present	Ongoing

8. SUSTAINABLE DEVELOPMENT & FUTURE PROSPECTS

8.1 Transition to Greener Mining Practices

Prospects for eco-friendly mining include:

- Waterless coal beneficiation
- Methane capture and power generation from fired seams
- In-pit micro-forestry (phytoremediation)

10.48047/jocaaa.2024.33.07.37

8.2 Renewable Energy from Mine Fires

Novel research explores geothermal power generation using subterranean heat from burning seams. However, these projects remain experimental.

8.3 Community Engagement and Corporate Responsibility

Activated local participation and transparent processes are essential for successful rehabilitation, health care, and alternative livelihoods, such as skills training for former miners.

8.4 Climate Change and the Global Energy Transition

Pressure is mounting to reduce dependence on coal. India's commitments to emission reductions in international climate accords urge a gradual transition to cleaner fuels, for which the Jharia experience offers important lessons in mitigating social fallout.

9. DISCUSSION

The Jharia Coalfield encapsulates both the promise and peril that accompany fossil-fuel-based development. While resource extraction has transformed economies and living standards, it has simultaneously imposed immense environmental and human hardship. Current challenges—raging fires, persistent pollution, and large-scale displacement—are reminders of the need for a new paradigm that fuses economic utility with ecological responsibility. Properly implemented, ongoing technological and policy innovations could render Jharia a global case study in post-extraction sustainability.

10. CONCLUSIONS

Jharia's strategic importance for India's industrial base is undeniable, yet the grave costs imposed on the land, air, water, and people challenge its continued primacy. Real solutions require integrating remediation technologies, robust environmental governance, inclusive community planning, and a gradual shift toward energy alternatives. The lessons of Jharia will resonate across the globe wherever extractive frontiers and human sustainability are in conflict.

ACKNOWLEDGMENTS

The author gratefully acknowledges the efforts of geoscientists, community activists, and policy-makers who have contributed to the understanding and improvement of conditions in the Jharia Coalfield.

REFERENCES

1. Adhikary, T., Bhattacharji, M., & Krishna Ghosh, A. (2014). "Quality of life analysis: Socio-economic perspective with reference to Jharia coalfield." *IOSR J. Humanit. Soc. Sci*, *19*, 33-45.
2. Asif, M., Wang, L., Panigrahi, D. C., Ojha, K., & Hazlett, R. (2022). "Integrated assessment of CO2-ECBM potential in Jharia Coalfield, India." *Scientific Reports*, *12*(1), 7533.
3. BCCL. (2020–21). "Delineation of Surface Coal Fire and Land Subsidence in the Jharia Coalfield: ClusterXV."
4. Bharat Coking Coal Limited (2019). "Report on Land Use / Vegetation Cover Mapping of Jharia Coalfield." https://bcclweb.in/environment/jharia_veg_cover_report_2019.pdf
5. Boral, P., Varma, A. K., & Maity, S. (2021). "Nitration of Jharia basin coals, India: a study of structural modifications by XRD and FTIR techniques." International Journal of Coal Science & Technology, 8(5), 1034-1053.

10.48047/jocaaa.2024.33.07.37

6. Chandra, K., & Chakraborty, A. (1989). "Structure and tectonics of the Jharia coalfield." Geological Society of India, 33, 100–109.
7. Copernicus Meetings. (2025). "Techno-Economic Assessment of Geothermal Energy Resource in Jharia Coalfield." https://meetingorganizer.copernicus.org/EGU25/EGU25-17341.html?pdf
8. Das, P.R., et al. (2021). "Petrographic and Geochemical Controls on Methane ..." ACS Omega, 6(15), 10217–10235. https://doi.org/10.1021/acsomega.1c00396
9. Gopal, K. (2025). "Environmental Impact of Mining-A Study of Jharia Coal Field Region." *International Journal of Scientific Research in Science and Technology*, *12*(1), 444-449.
10. Gupta, D., & Sahu, R. (1979). "Geology, structure and tectonics of the Jharia coalfield, India." Earth-Science Reviews, 15(3), 405–428.
11. Pandey, J., Kumar, D., Chaudhari, S. K., Khalkho, A., & Pandey, J. K. (2024). Detection of Surface and Sub-surface Coal Mine Fire of Jharia Coalfields using Remotely Sensed and Ground Thermal Data. *Journal of Mining and Environment*, 15(1), 1-19.
12. Rawalwasia, A. (2025). "Jharia Coalfield: India's Largest and Most Significant Coal Reserve!" Rawalwasia Insights. Retrieved from https://rawalwasia.in/jharia-coalfield-largest-most-significant-reserve/
13. Sahu, K., & Sharma, R. (2023). "Environmental Impact of Mining: A Study of Jharia Coal Field Region." *International Journal of Scientific Research in Science and Technology*, *9*(1), 58–68. https://ijsrst.com/index.php/home/article/view/IJSRST25121186
14. Saikia, K., & Sarkar, B. C. (2013). "Coal exploration modelling using geostatistics in Jharia coalfield, India." *International Journal of Coal Geology*, *112*, 36-52.
15. Singh, S. K., Singh, R. K., Singh, K. K., Singh, R. K., & Singh, S. (2022). "Concentration, sources and health effects of silica in ambient respirable dust of Jharia Coalfields Region, India." *Environmental Sciences Europe*, 34(1), 68.
16. Tandon, A. (2019). "The burning coalfields of Jharia belch poison for local residents."
17. "Jharia Coalfield, Dhanbad District, Jharkhand, India." (2025). Mindat.org. https://www.mindat.org/loc-147189.html
18. "Jharia Coalfield." (2025). Shale & Sandstone Geology [Scribd]. https://www.scribd.com/document/606098414/JHARIA-COALFIELD-1