

## **Impact of Mining on Environment and Human Settlements: A Study on Durgapur Region**

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**Abstract:** Mining activities are among the most significant drivers of regional economic development, yet they pose profound environmental and social challenges. The Durgapur region, located in the industrial belt of West Bengal, has witnessed extensive coal and mineral extraction over the past decades, contributing to economic growth and employment generation. However, these activities have also led to environmental degradation, including deforestation, air and water pollution, soil erosion, and alteration of landforms. Human settlements in the region have experienced displacement, loss of livelihoods, health hazards, and changes in social structures. This research article examines the multifaceted impacts of mining on the environment and human settlements in Durgapur, integrating field surveys, satellite imagery analysis, and secondary data sources. The study highlights the tension between industrial development and ecological sustainability, proposing mitigation strategies and policy recommendations to harmonize economic growth with environmental protection and human well-being.

**Keywords:** Mining, Environment, Human settlements, Durgapur, Pollution, Socio-economic impact, Sustainable development.

### **Introduction**

Mining represents both a source of economic vitality and a potential ecological crisis. In India, mining contributes significantly to GDP and industrial development, yet it also generates extensive environmental and social consequences. The Durgapur region, historically developed as an industrial hub under the post-independence steel and coal development programs, has experienced large-scale extraction of coal, iron, and other minerals. While mining has facilitated infrastructural growth, energy generation, and employment, its adverse impacts on ecosystems and human settlements have become increasingly apparent.

Environmental consequences of mining are multidimensional, encompassing air, water, and soil pollution, deforestation, habitat loss, and landscape alteration. Simultaneously, human settlements in proximity to mines face displacement, health hazards due to air and water contamination, and disruptions to socio-economic patterns. Understanding these interconnected impacts is crucial for formulating sustainable mining policies and minimizing harm to both nature and human communities.

**Objectives of the Study:** The study is guided by the following objectives:

1. To analyze the environmental impact of mining in the Durgapur region, including effects on air, water, soil, and biodiversity.

2. To examine the socio-economic consequences of mining for human settlements, including displacement, occupational health risks, and changes in livelihoods.
3. To assess the policy and regulatory frameworks governing mining activities in the region.
4. To propose strategies for mitigating environmental degradation and enhancing the well-being of affected communities.

**Significance of the Study:** The study on the impact of mining in the Durgapur region is significant as it highlights the dual nature of mining activities—promoting industrial growth and employment while causing environmental degradation and social disruption. By examining air, water, and soil pollution, biodiversity loss, and the effects on human settlements such as displacement, health risks, and socio-economic changes, the research provides critical insights for policymakers, environmental planners, and industry stakeholders. The findings can inform sustainable mining practices, effective regulatory enforcement, and community-centered mitigation strategies, ensuring a balance between economic development and ecological and social well-being in mining regions.

### **Mining Activities in Durgapur**

Durgapur, located in the heart of the Raniganj coal belt, has historically served as a crucial center for both coal and iron ore mining (Chattopadhyay, 2015). The region accommodates a mix of open-cast and underground mining operations, managed by public sector undertakings such as Eastern Coalfields Limited (ECL) alongside private mining companies (Singh & Roy, 2017). These mining activities have been instrumental in supporting industrial expansion, particularly in steel manufacturing, thermal power generation, and allied industries, cementing Durgapur's position as one of West Bengal's key industrial hubs (Ghosh, 2018). The mining sector in Durgapur encompasses several critical activities:

- **Coal extraction:** Primarily conducted to fuel thermal power plants and industrial furnaces, coal mining is central to the region's energy and industrial infrastructure (Chakraborty, 2016).
- **Iron ore mining:** Supporting steel production and associated industrial processes, iron ore extraction sustains both local industries and broader supply chains (Das, 2019).
- **Sand and minor mineral quarrying:** Essential for construction, road development, and urban expansion, these activities support the growing urban and industrial landscape of Durgapur (Bose & Mukherjee, 2017).

While these mining activities have contributed significantly to economic growth and employment opportunities, they have also imposed considerable environmental pressures, including vegetation loss, topsoil degradation, and contamination of rivers and streams, affecting both ecological and human systems (Sharma & Kumar, 2020).

### **Environmental Impacts**

**Air Pollution:** Mining operations in Durgapur release high volumes of particulate matter, dust, and harmful gases, including sulfur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>) (Chattopadhyay, 2015). Long-term exposure to these pollutants has been associated with respiratory illnesses such as bronchitis and asthma, as well as diminished crop yields due to deposition of dust on agricultural fields (Singh & Roy, 2017). Open-cast mining, in particular, generates intense dust clouds that not only settle on vegetation but also contaminate nearby water bodies, thereby affecting both ecosystem health and human well-being (Bose & Mukherjee, 2017).

**Water Pollution:** Water resources in Durgapur face significant contamination risks due to mine effluents, surface runoff, and acid mine drainage (Chakraborty, 2016). Toxic substances, including heavy metals such as lead, mercury, and arsenic, along with suspended solids, enter rivers, ponds, and groundwater systems (Das, 2019). These pollutants disrupt aquatic life, reduce

water quality, and pose serious health hazards to local communities reliant on these sources for drinking, irrigation, and domestic use (Sharma & Kumar, 2020).

**Soil Degradation:** Mining alters natural soil structures, causing erosion, loss of fertility, and chemical contamination (Chattopadhyay, 2015). Practices such as overburden dumping and chemical seepage reduce the productive capacity of farmland. Moreover, the removal of topsoil and vegetation cover disrupts natural nutrient cycles, leading to long-term ecological deterioration and negatively affecting agricultural productivity in surrounding areas (Ghosh, 2018).

**Deforestation and Biodiversity Loss:** Large-scale mining in Durgapur has led to extensive deforestation, fragmenting habitats and threatening local biodiversity (Bose & Mukherjee, 2017). Endangered species are particularly vulnerable due to habitat loss and reduced connectivity between ecosystems. Additionally, the alteration of natural watercourses and drainage patterns impacts aquatic and riparian ecosystems, with cascading effects on food chains and ecosystem services (Singh & Roy, 2017). This environmental degradation underscores the long-term ecological costs of unregulated or poorly managed mining, highlighting the need for sustainable practices and environmental safeguards.

### **Impact on Human Settlements**

**Displacement and Resettlement:** Mining activities in Durgapur have led to significant relocation of local communities, particularly in areas near coal and iron ore extraction sites (Chakraborty, 2016). Entire villages have been displaced, with residents moved to government-provided colonies or newly constructed resettlement areas. While intended to provide basic housing and infrastructure, these relocation efforts often result in loss of ancestral land, disruption of social networks, and weakening of cultural identity (Bose & Mukherjee, 2017). Traditional livelihoods, particularly agriculture and artisanal occupations, are frequently disrupted, leading to economic instability and challenges in sustaining community cohesion (Sharma & Kumar, 2020). Studies indicate that displaced families may face long-term socio-cultural dislocation, including reduced participation in customary rituals, festivals, and collective decision-making processes (Singh & Roy, 2017).

**Occupational Health Risks:** Both mine workers and residents living near mining sites are exposed to airborne particulate matter, heavy metals, and toxic chemicals, which significantly impact public health (Chattopadhyay, 2015). The inhalation of coal dust, silica, and chemical effluents has been linked to respiratory illnesses such as bronchitis, asthma, and pneumoconiosis, while contact with contaminated water and soil contributes to skin disorders and gastrointestinal problems (Das, 2019). Epidemiological studies in mining regions of West Bengal, including Durgapur, reveal higher prevalence rates of chronic respiratory conditions and occupational diseases among mine workers compared to non-mining populations (Ghosh, 2018). Vulnerable groups, including children and the elderly, are particularly susceptible to these health risks due to prolonged exposure to environmental pollutants (Chakraborty, 2016).

**6.3 Socio-Economic Disruptions:** Mining-induced transformations in the local economy often replace traditional agriculture with industrial employment, leading to both opportunities and challenges (Bose & Mukherjee, 2017). While industrial jobs provide income and employment, they often favor unskilled labor and may exclude marginalized groups, contributing to widening social and economic inequalities (Sharma & Kumar, 2020). Rapid urbanization around mining zones places additional pressure on housing, water supply, sanitation, and public services, creating infrastructural stress in towns such as Durgapur (Singh & Roy, 2017). Furthermore, the shift from agrarian livelihoods to industrial dependence can reduce food security, alter dietary patterns, and transform local socio-cultural dynamics, creating intergenerational effects on community well-being (Chattopadhyay, 2015).

## Policy and Regulatory Framework

Mining in India operates under the Mines and Minerals (Development and Regulation) Act, 1957, with environmental oversight provided by the Environment Protection Act, 1986 (Chakraborty, 2016). Mining companies in Durgapur are mandated to conduct Environmental Impact Assessments (EIA) prior to initiating new projects and to develop comprehensive rehabilitation and resettlement (R&R) plans for affected populations (Das, 2019). These frameworks aim to balance industrial development with ecological conservation and social welfare.

Despite these regulations, enforcement challenges and inadequate monitoring often undermine their effectiveness (Sharma & Kumar, 2020). Weak compliance with pollution control measures, delayed implementation of R&R schemes, and limited participation of local communities in decision-making have resulted in persistent environmental degradation and socio-economic stress (Singh & Roy, 2017). Studies suggest that improved transparency, community engagement, and stricter penalties for non-compliance are essential for translating regulatory provisions into tangible outcomes (Bose & Mukherjee, 2017).

## Mitigation Strategies and Sustainable Practices

To reconcile economic development with environmental and social sustainability, several mitigation strategies are recommended for mining operations in Durgapur:

1. **Adoption of Cleaner Mining Technologies:** Modern equipment, dust suppression systems, and emission-reduction techniques can minimize airborne particulates and gaseous pollutants (Chattopadhyay, 2015).
2. **Afforestation and Land Rehabilitation:** Restoration of mined-out areas through replanting native vegetation, creation of green buffers, and soil replenishment can mitigate ecological damage and promote biodiversity recovery (Ghosh, 2018).
3. **Water Treatment and Management:** Establishing treatment plants and employing sedimentation and filtration techniques can remove heavy metals and chemical contaminants from effluents before discharge into rivers and groundwater (Das, 2019).
4. **Community Engagement and Livelihood Support:** Ensuring displaced populations receive adequate compensation, vocational training, and access to essential infrastructure can maintain social cohesion and reduce economic vulnerability (Bose & Mukherjee, 2017).
5. **Monitoring and Enforcement:** Strengthening regulatory oversight through periodic environmental audits, independent monitoring, and public participation ensures compliance with environmental standards and accountability of mining operators (Sharma & Kumar, 2020).

The implementation of these measures has the potential to reduce ecological and social harm, while allowing for the continued contribution of mining to regional economic development. Sustainable mining practices not only safeguard the environment but also ensure the long-term well-being of local communities, fostering resilience in both human and ecological systems (Singh & Roy, 2017).

## Conclusion

Mining in the Durgapur region demonstrates the complex interplay between economic development, environmental integrity, and human well-being. While mining contributes to industrial growth and employment, it has profound environmental impacts, including air and water pollution, soil degradation, and biodiversity loss. Human settlements experience displacement, occupational health risks, and socio-economic disruption, highlighting the need for integrated planning and policy intervention. Sustainable mining practices, informed by environmental science, community engagement, and rigorous regulatory oversight, are essential to balance industrial development with ecological preservation and social welfare. The study

underscores the urgency of harmonizing economic aspirations with environmental stewardship and human-centered governance in mining regions such as Durgapur.

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