UNDERSTANDING THE IMPLICATION OF COAL TRANSITION

THE SCENARIO IN CHHATTISGARH, JHARKHAND, AND ODISHA

THE ENERGY AND RESOURCES INSTITUTE
Creating Innovative Solutions for a Sustainable Future

MacArthur Foundation

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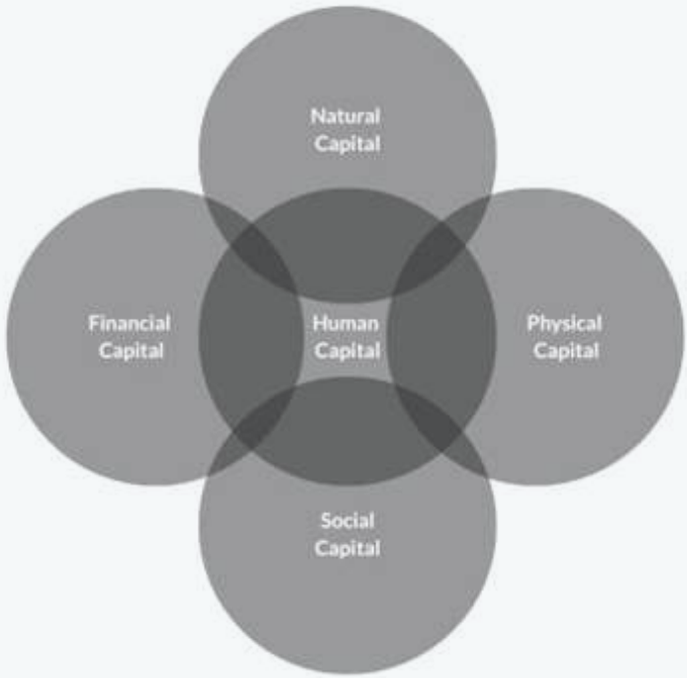
List of Abbreviations

ASHA	Accredited Social Health Activist
BCCL	Bharat Coking Coal Limited
CHC	Community Health Centre
CIL	Coal India Limited
CSR	Corporate Social Responsibility
DMF	District Mineral Foundation
FGD	Focus Group Discussion
KPI	Key Persons' Interview
MCL	Mahanadi Coalfields Limited
MNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
NTFP	Non Timber Forest Products
OBC	Other Backward Class
PHC	Primary Health Centre
SC	Scheduled Caste
ST	Scheduled Tribe

Executive Summary

India's coal sector plays a critical role in energy production, contributing to 70% of the country's electricity generation. However, with the nation's commitment to achieving net-zero emissions by 2070, there is a pressing need to transition towards cleaner energy sources while protecting the livelihoods of communities dependent on the coal economy. In 2022–23, coal production reached 893.19 million tonne, a significant increase over previous years, emphasizing the ongoing reliance on coal. The states of Odisha, Jharkhand, Chhattisgarh, and Madhya Pradesh produce nearly 80% of the country's coal, making them particularly vulnerable to disruptions due to a shift towards less carbon intensive energy sources. A study was carried out by TERI in Odisha, Jharkhand and Chhattisgarh **to analyse the socio-economic and environmental challenges faced by coal-dependent regions in India, with a focus on ensuring an equitable transition to clean energy.** The research adopted a mixed-method approach to examine the coal-dependent states of Odisha, Jharkhand, and Chhattisgarh and used a variety of tools such as community interviews, Key Persons' Interviews (KPIs), Focus Group Discussions (FGDs), and socio-economic household surveys, to elicit multiple views of a wide range of stakeholders. An in-depth analysis of the socio-economic conditions and the obstacles encountered by communities in coal mining regions led to **996 individuals** being interviewed and **50 FGDs** being conducted in various districts of these states.



The report identifies vulnerabilities to coal mine closure through the **Five Capitals Framework** comprising human capital, natural capital, physical capital, social capital and financial capital. It is important to note that while many of the problems afflicting the local communities in coal mining regions are common across rural India, the coal mono-economy adds an extra blanket of vulnerability. This can present itself in the form of a reduction in revenue collection from coal production, a downturn in economic activity, and a loss of service/tertiary sector jobs which has a ripple effect on the quality of life of locals.

1. Human Capital

Human capital includes the **skills, education,** and **health** of individuals, and is a critical factor in determining the resilience of communities in coal mining regions. Challenges faced by the coal mining communities in Odisha, Jharkhand, and Chhattisgarh highlight vulnerabilities in education, employment, economic status, and health, requiring tailored interventions.

- Educational **infrastructure** in coal mining regions was found to be inadequate, with schools lacking basic facilities like classrooms and sanitation. In Jharkhand, although educational attainment is good, many still depend on informal coal sector jobs such as truck driving and coal shoveling. In Odisha, many youth, despite completing their education, remain unemployed due to a lack of job opportunities.
- Health problems such as respiratory diseases and joint pain were common in these regions, driven by environmental pollution. For instance in Odisha, women travel long distances to access medical care. In Jharkhand's Jharia coalfield, like high blood pressure was frequently reported. Limited and distantly located healthcare access further exacerbates these challenges, making it difficult for communities to address their health concerns.

2. Natural Capital

Natural capital refers to the world's stock of natural resources, which includes ecosystems, land, water, air, and biodiversity, that provide essential goods and services to human societies. In all the three states, the livelihoods of communities have been disproportionately impacted by the degradation of natural capital.

- Environmental degradation has significantly reduced the natural capital of these regions. Coal mining has led to air and water pollution, deforestation, and the depletion of agricultural productivity. In Jharkhand, approximately 30% of residents reported severe impacts on water quality, and in Odisha, women relying on forest products like tendu leaves for their income have seen their livelihoods diminish due to deforestation.

- The depletion of natural resources has eroded the economic resilience of communities, particularly those who rely on agriculture or forest-based incomes.

3. Physical Capital

Physical capital refers to the tangible assets that contribute to the production process and the well-being of communities. Severe gaps in infrastructure—land, utilities, and public services—have hindered resilience across coal-dependent states.

- Frequent blackouts and unreliable access to electricity affect daily life, education, and healthcare. In Jharkhand, 99.6% of households report daily power cuts, and sanitation infrastructure remains inadequate across states like Chhattisgarh, where only 11.9% of households have access to in-house toilets.
- Many communities, especially in Jharkhand, are landless, leaving them with few options for economic fallback or earning their livelihood, in the event of mine closure.

4. Social Capital

Social capital, the networks and relationships within a community, is crucial in coal mining regions for resilience and adaptation to changes. Social cohesion has weakened due to rising unemployment, outmigration, and governance issues in all three states.

- Social disintegration is evident in coal-dependent regions, particularly following mine closures. Unemployment has led to rising alcoholism and domestic violence in Chhattisgarh and Odisha.
- Communities face growing uncertainty, with outmigration becoming a common coping mechanism for young people seeking better employment opportunities in urban areas, further weakening community bonds and local economies.

5. Financial Capital

- Financial capital refers to the **monetary resources** individuals, households, or communities have access to, including income, savings, credit, and assets. Limited financial inclusion and reliance on informal systems exacerbate vulnerabilities in Odisha, Jharkhand, and Chhattisgarh.
- Households in these states are heavily reliant on informal financial mechanisms, leaving them vulnerable to financial instability. In Jharkhand, 17% of households still keep their savings at home, and in Odisha, 55.3% of households invest in informal chit funds, which carry higher financial risks. Many households take out loans for non-productive purposes such as marriages or repaying old debts, further compounding their financial insecurity. Very few loans are used for income-generating activities like education or agriculture.

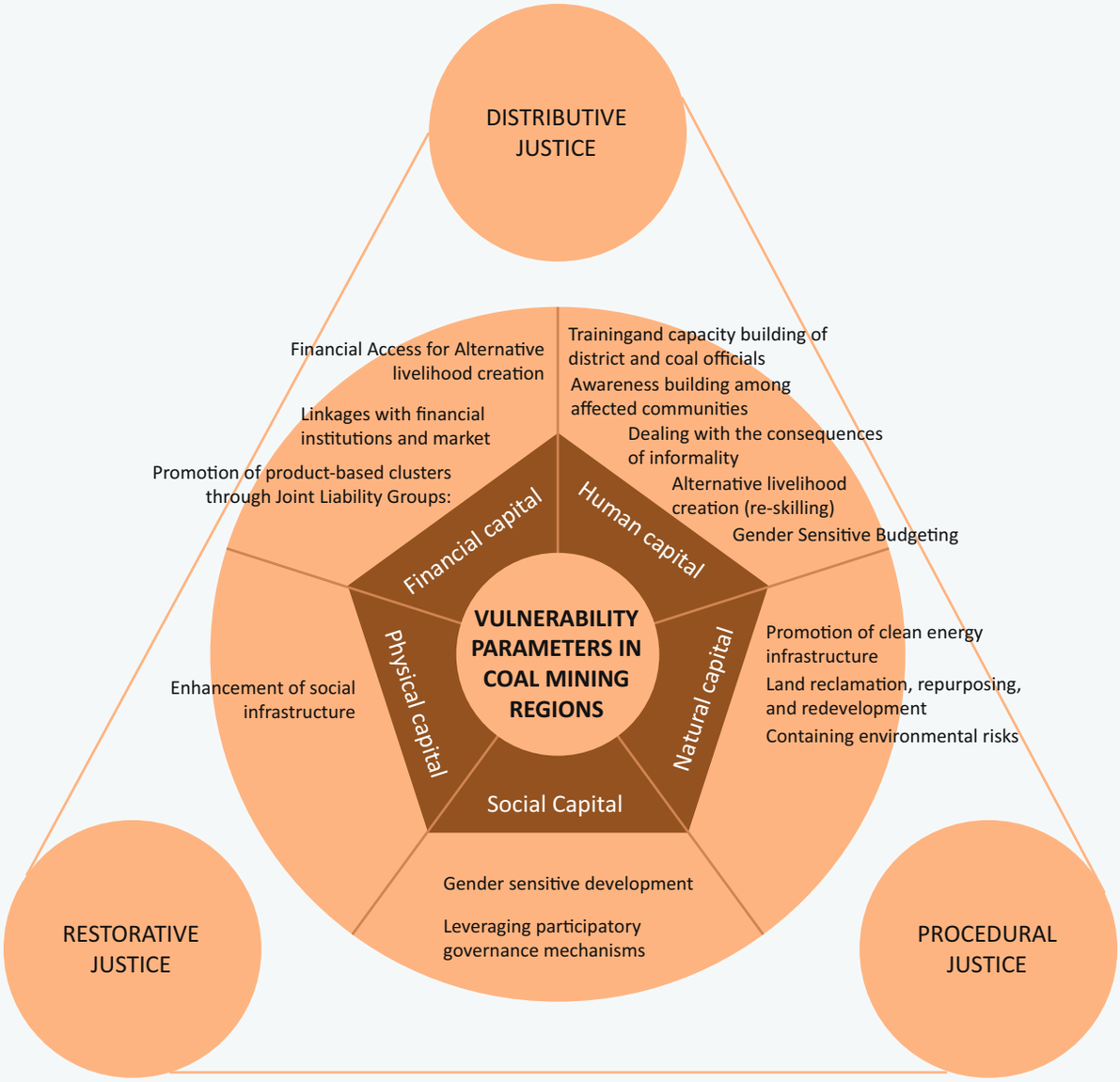
Recommendation

The report also recommended pathways for addressing challenges across the Five Capitals. These recommendations aim to empower coal-dependent communities, foster sustainable development, and ensure an inclusive transition that balances socio-economic and environmental priorities.

CAPITAL WISE RECOMMENDATIONS FOR A JUST TRANSITION IN COAL MINING REGIONS	
1. Human Capital	• Increase interactions of district and coal officials for enhanced understanding and recognition of the ecosystem around coal mining areas is imperative. • Provide targeted support for local youth, especially girls, backward segments, and individuals with disabilities. • Formally integrate the large informal workforce into the local economy by re-skilling them for beyond coal. • Focus on creating new job opportunities for informal and temporary workers. • Implement gender-sensitive budgeting to support an inclusive transition by ensuring targeted re-skilling programs and fostering women-centric enterprises.
2. Natural Capital	• Promote clean energy infrastructure and repurpose land with abandoned coal mines for the revival of a land-based economy and supporting local farmers. • Address environmental risks by restoring degraded lands, ensuring access to safe water and sanitation facilities. • Implement measures to ensure cleaner water and air in coal-affected regions and facilitate a smoother and more sustainable transition towards a post-coal future.
3. Physical Capital	• Enhance social infrastructure by improving access to basic amenities like low-cost housing, sanitation, and healthcare. • Leverage government schemes, such as the PM Awas Yojana, can provide low-cost housing solutions in coal belts. • Introduce mobile healthcare services can improve community health and play a vital role in preventing outbreaks of diseases.

CAPITAL WISE RECOMMENDATIONS FOR A JUST TRANSITION IN COAL MINING REGIONS	
4. Social Capital	• Enhance local engagement of collectives such as Self-Help Groups(SHGs), farmer cooperatives, and Community Resource Persons (CRPs) in decision-making for participatory governance. • Prioritize gender-sensitive development, including campaigns against substance abuse and improved access to support services. • Empower women's and youth groups through cooperative formation and leadership skills to strengthen social cohesion and foster community resilience.
5. Financial Capital	• Enhance financial access is crucial for alternative livelihood creation, utilizing SHG funds and forming Joint Liability Groups (JLGs). • Develop micro enterprises through a combination of financial literacy, vocational skilling, entrepreneurship initiatives, market and credit linkages. • Promote local banks by providing collateral-free seed capital, while impact investors and CSR funds can facilitate the establishment of backward and forward linkages for sustainable supply chains and value addition. • Pilot women-centric business models through JLGs, promoting sustainable livelihoods and creating a positive socio-economic impact.

The recommendations outlined in this report, categorized by human, natural, physical, social, and financial capitals, offer actionable steps aligned with TERI's report titled, Just Transition Framework for a Sustainable Future in India's Coal Mining Regions. These recommendations address key concerns identified through research in coal-producing states like Odisha, Jharkhand, and Chhattisgarh. They emphasize procedural justice, focusing on participatory governance and community awareness, distributive justice, through socio-economic transformation and livelihood diversification, and restorative justice, by promoting environmental restoration and clean energy infrastructure as shown in the diagram below. Together, they provide a comprehensive roadmap for an equitable and sustainable transition that enables vulnerable communities have access to new opportunities, fosters green development, and supports long-term resilience.



Reversing vulnerabilities and solutions for a sustainable future in India's coal mining regions

1. INTRODUCTION

Figure 1: Timeline of Just Transition

The earliest mention of 'Just Transition' was as a demand among American labour unions representing workers in the oil, chemical and atomic industries to address issues of safety and health that affected workers in the Shell company. This was in the 1970s when the discourse was more along the lines of jobs vs environment instead of climate action and achieving net zero targets. This discourse was triggered by environmental protectionist policies like the National Environmental Policy Act of 1970 and the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund), 1980, which increased regulations on industries causing environmental damage, including the fossil fuel industry, triggering job losses as companies chose to shut down their operations. This is how campaigns against job losses due to "unfair" job losses came to be at the core of the just transition debate.[1], [2] This issue was taken up at the Rio Earth Summit in 1992 as well where it figured in the negotiations of the United Nations Framework Convention on Climate Change.[3], [4] Figure 1 presents the timeline of Just Transition.

In 2008, the International Labour Organisation (ILO) initiated the Green job Initiative which focused on the social and employment aspect of transitioning to low carbon economy and placed a strong emphasis on job creation in emerging green industries. It also aimed at the creation of sustainable job opportunities for people who were displaced due to previous or upcoming environmental policies.

"THE MACROECONOMIC COSTS OF CLIMATE INACTION FAR OUTWEIGH THE COSTS OF ORDERLY AND JUST TRANSITIONS"

Later in 2015 at the Paris Agreement, for the first time the labour impact of climate change was mentioned when it took "into account the imperatives of a just transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities" in its preamble.[5] The same year saw ILO release its just transition guidelines as part of its "Decent Work Agenda" and define just transition as "greening the economy in a way that is as fair and inclusive as possible to everyone concerned, creating decent work opportunities and leaving no one behind" .[6]

In 2023, during the COP28 sessions, countries focused their efforts on energy transition and focused on stakeholder collaborations. The Powering Past Coal Alliance added new governments into their efforts for transitioning from coal power generation to newer clean energy. Gender equality was another important aspect of the COP28 session with 78 new countries coming to support just and inclusive transition.[7]

At the G20 Summit in New Delhi in September 2023, global leaders emphasized the importance of just energy transitions as a means to improve jobs, livelihoods, and economic resilience. They reaffirmed that no country should have to choose between fighting poverty and protecting the planet. In the Green Development Pact for a Sustainable Future, G20 leaders committed to clean, sustainable, just, affordable, and inclusive energy transitions, while acknowledging the need to support developing countries in their low-carbon transitions. The G20 also stressed the importance of international cooperation in technology transfer and financing to achieve these goals. The discussions highlighted that the macroeconomic costs of climate inaction far outweigh the costs of orderly and just transitions, leading to the endorsement of a report on the macroeconomic risks associated with climate change and transition pathways.[8]

In this context, just transition has, in contemporary times, become a word that is being used most often in the context of climate change induced job losses, especially those caused by efforts at mitigating the negative effects of climate change. The concept of a just transition must ideally go beyond the purview of an energy transition and acknowledge the socio-economic damages caused by the shutdown of an entire industry. A just transition plan would involve transitional support, retraining and remedial action with regard to workers' rights and the environment. The reasons for this may vary however depending on the approach one takes to justify such action.

"IN 2015 THE PARIS AGREEMENT, ... TOOK "INTO ACCOUNT THE IMPERATIVES OF A JUST TRANSITION OF THE WORKFORCE AND THE CREATION OF DECENT WORK AND QUALITY JOBS IN ACCORDANCE WITH NATIONALLY DEFINED DEVELOPMENT PRIORITIES"

The conceptualization of just transition by various individuals and interest groups has occurred on a spectrum—on one end are those experts for whom it primarily concerns only on labour engaged in the fossil fuel industry and their communities [9], [10] while on the other end are those for whom the scope of just transition is much broader. This second group sees the idea of a just transition from fossil fuels as not just being about the workers but also about addressing issues of injustices at the overlap of energy, climate and environmental justice—broadening the scope of issues and people who will have an interest. This research is fuelled by the definition of just transition given by the International Labour Organisation (2015):

> *"A process towards an environmentally sustainable economy, which needs to be well managed and contribute to the goals of decent work for all, social inclusion, and the eradication of poverty."*

This definition aptly captures the essence of just transition as it is understood by scholars [11], [12] as being relevant in the prevalent climate, energy, and environmental justice in addition to the space it allows for not just fossil fuel workers but also the larger coal communities—making it more applicable to the Indian scenario in which regular formal employees in the coal ecosystem form a much smaller share of the coal labour force.

The project focused on the coal mining industry (i.e., upstream side) in order to explore opportunities of addressing the implications on coal-dependent communities among coal-rich states in India and it also focused on the coal-dependent MSME sector (i.e., downstream side) to ascertain impact on MSME workforce in selected coal consuming sectors/regions and their reskilling needs.

This research report will attempt to capture perspectives of a range of stakeholders in the coal value chain and analyse quantitative and qualitative data to portray the complexities and challenges of the coal producing geographies. Through a multi-pronged approach, we have aimed at highlighting the issues of human capital, social capital, financial capital, and natural capital.

2. Methodology

This research aimed to explore the profound dependence on coal within local economies and how this reliance generates vulnerabilities among communities. The following section outlines the methodology employed to gather the necessary data.

2.1 Research Tools

A mixed-method approach was adopted for data collection, utilizing tools such as Focus Group Discussions (FGDs), Key Persons' Interviews (KPIs), extensive community interactions, and socio-economic household surveys across three key coal-producing states: Odisha, Jharkhand, and Chhattisgarh (Table 1). Relevant indicators from the surveys were applied to meet the research objectives, while the insights drawn from FGDs and KPIs provided valuable perspectives on the impacts of coal mining and its closure on the local communities.

State	Districts Covered	Surveys done	Time taken
Odisha	Angul	208	14 days
	Jharsuguda	101	
	Sundargarh	75	
Chhattisgarh	Surguja	67	10 days
	Surajpur	225	
	Manendragarh-Chirmiri-Bharatpur district	47	
Jharkhand	Dhanbad	273	7 days
Total		996	

Table 1: State and district-wise household survey carried out

2.2 Data Collection

Image 1: Collection of data out in the field

- Primary Data: A mixed-method strategy was employed, combining household surveys with FGDs, KPIs, and in-depth interviews to gain a comprehensive understanding of ground realities.
- Secondary Data: The primary data was complemented by a thorough literature review, which included journal articles, media reports, and grey literature covering topics such as just energy transition, coal mining effects, and coal mine closure impacts. This secondary data was used to validate and cross-reference the findings from the field.

2.3 Study Sample Collection

For the household surveys, a **purposive sampling technique** was used to select villages located near closed, abandoned, or discontinued coal mining areas. Within these villages, **purposive random sampling** was applied to cover 20% of the population, as indicated by local authorities (sarpanch). Quantitative data was gathered by field partners, while qualitative data was obtained through FGDs, KPIs, and in-depth interviews conducted by TERI researchers.

- Odisha, as the second-largest coal-producing state, was chosen for its significant production in 2022–23, where villages around Ib Valley and Talcher Coalfields in Sundargarh, Jharsuguda, and Angul districts were selected for the study (Figure 2).

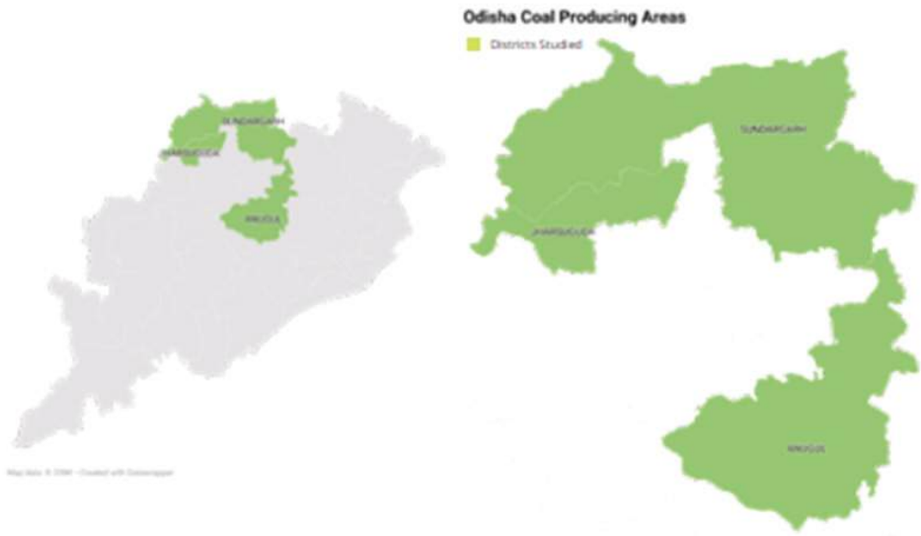


Figure 2: Study area in Odisha

- In Chhattisgarh (Figure 3), the research focused on areas with a high number of closed mines, particularly in Surajpur, Surguja, and Koriya (now Chirimiri-Bharatpur Manendragarh), where coal mines have been shut down due to unprofitability or depletion of reserves.

Figure 3: Study area in Chhattisgarh

- In Jharkhand (Figure 4), the study centred around Dhanbad, known as the "Coal Capital of India," with particular attention to Jharia, an area plagued by recurring coal field fires.

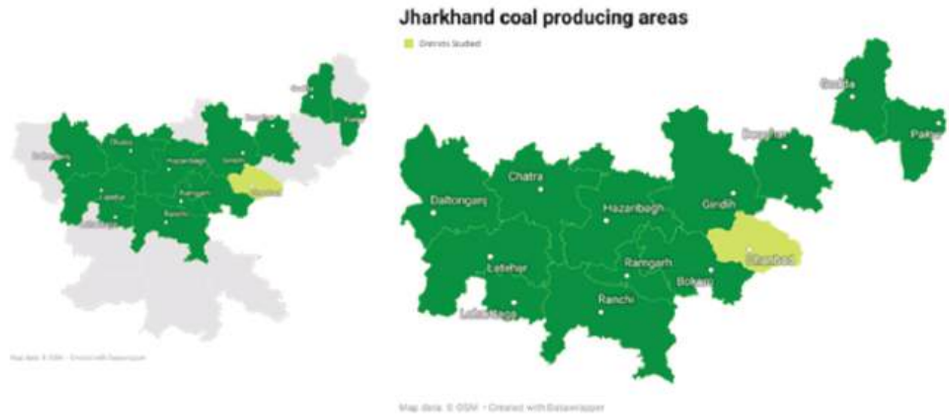


Figure 4: Study area in Jharkhand

This methodology ensured a robust and comprehensive data set, combining quantitative and qualitative insights to understand the socio-economic and environmental effects of coal mining and its transition impacts.

3. Coal Sector: An overview

3.1. National Scenario – Coal Producing Regions, Production Capacities

The coal industry in India is essential to the country's economy, providing a critical source of energy and making significant contributions to industries including power generation, steel manufacturing, cement production, and various industrial operations. India is the world's second-largest producer and consumer of coal, with proved coal reserves ranking fifth. In 2019, coal constituted 44% of India's primary energy demand, a significant increase from 33% in 2000. India's coal industry has shown to be a pillar of the nation's energy framework, growing and adapting admirably throughout time. Currently, coal is responsible for generating 70% of India's total electricity. CIL has subsidies in various states such as the Western Coalfields Limited (WCL) in Maharashtra, Eastern Coalfields Limited (ECL) in West Bengal, South Eastern Coalfields Limited (SECL) in Chhattisgarh, Madhya Pradesh's and Uttar Pradesh's Northern Coalfields Limited (NCL), and Odisha's Mahanadi Coalfields Limited (MCL). Each of these subsidiaries contributes significantly to both maintaining and raising the levels of coal production. These businesses oversee large-scale mining activities and make sure the coal supply chain is reliable and effective. During 2022–2023 fiscal year, CIL produced 703.22 MT of coal, an increase of 12.94% from the previous fiscal year. This expansion has been focused in the eastern states of Odisha, Chhattisgarh, Jharkhand, and Madhya Pradesh. Odisha alone contributed for 24.52% of total output, followed by Chhattisgarh (20.70%), Jharkhand (17.52%), and Madhya Pradesh (16.35%). These four states combined accounted for approximately 79.08% of total coal production in the country. The largest coal producer, Coal India Limited (CIL), accounted for 78.73% of total production, with Singareni Collieries Company Limited (SCCL) contributing 7.52%. Figure 5 shows production of raw coal in India.

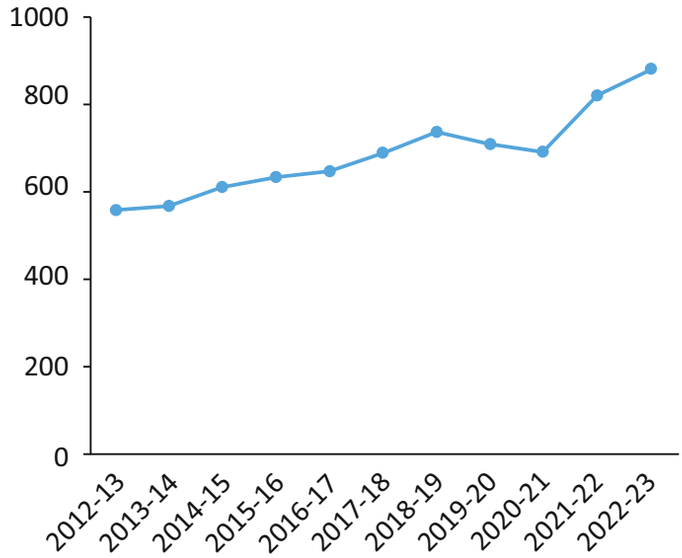


Figure 5: Raw coal produced in India

Source: coalindia.in

Image 2: Mined coal transported via trains

Coal is the backbone of India's power generation, accounting for 89.60% of total coal dispatch. In 2022–23, the power sector got 786.088 MT of coal, emphasizing its importance in providing energy security. The dependability of coal as a fuel source is critical, particularly considering the intermittent nature of renewable energy sources. A stable supply of coal to power plants assures unabated or steady electricity generation, which is critical for industrial activities, residential consumption, and general economic stability. [13]

Coal is used in a variety of industrial areas in addition to power generation. The steel sector, for example, depends significantly on coking coal. In 2022–23, 13.826 MT of coal was shipped to the steel industry. Steel production, a critical component of infrastructure development, industry, and construction, is inextricably connected to the supply of high-quality coking coal. Similarly, the cement sector received 8.119 MT of coal, while the sponge iron sector used 8.059 MT, demonstrating coal's significant impact on industrial productivity and economic growth.

The coal industry employs millions of people, both directly and indirectly. Mining operations in states such as Odisha, Chhattisgarh, and Jharkhand is very crucial as the mining operations boost local economies and provide jobs to the people living close to the coal mines, making coal mines very crucial for regional development. [14]

"IN ADDITION TO PROMOTING ENERGY SECURITY, INDIA'S COAL INDUSTRY MAKES A MAJOR CONTRIBUTION TO JOB CREATION AND ECONOMIC EXPANSION."

Despite significant domestic output, India imports coal to meet its high-quality needs. In 2022–23, India imported 237.668 MT of coal, up 13.92% from the previous year. Imports primarily meet the demand for high-quality coking and non-coking coal utilized in a variety of industries. Indonesia remains the leading provider, accounting for 46.21% of total imports, followed by Australia, Russia, South Africa, and the United States. The reliance on imported coal emphasizes the importance of strategic international trade strategies and the exploration of domestic reserves in order to lessen import dependence. Exports, on the other hand, are limited, with 1.163 MT of coal shipped mostly to neighbouring countries such as Nepal and Bangladesh. The restricted export capacity reflects the domestic priority of servicing internal demand and guaranteeing energy security.

The coal industry has numerous obstacles, including fluctuating international pricing and environmental laws. However, with the government focusing on increasing production efficiency, investing in sustainable mining practices, and discovering new reserves, the coal industry's future seems bright. Investment in coal supply roughly doubled between 2010 and 2019, driven by the increased demand for electricity. Coal's importance in the energy sector remains significant but its capacity for expansion is impacted by the government's actions in accordance with the Nationally Determined Contributions (NDCs) of the Paris Agreement. These endeavours seek to reduce the carbon intensity of the energy supply and are enhanced by the growing competitiveness of solar power. Collectively, these measures will have substantial effect on the future demand for coal, improving air quality, decreasing greenhouse gas emissions, and encouraging a more varied energy mix. [15]

The Indian coal industry is undergoing significant changes due to technological advancements, geographical shifts, and industry structure changes. Open-cast mining is becoming more mechanized and less labour-intensive, while underground mines are transitioning from semi-mechanized to blast-free continuous miner-based production. This shift will lead to quicker resource exhaustion and shorter mine life. Future production will focus on Odisha, Chhattisgarh, and Upper Jharkhand, reducing resources in West Bengal and Southeast Jharkhand. Additionally, new mines are being allocated to private entities to maintain competitiveness against new energy sources and increased captive ownership.

The Ministry of Coal has implemented several policy initiatives and reforms to provide support to the coal industry. These measures include strategies to enhance the efficiency of commercial coal mine auctions, boost domestic coal production, and incorporate Mine Developer cum Operators (MDOs) to amplify output. In the ninth round of commercial coal mine auctions in 2023, a total of 31 coal mines situated in Jharkhand, Chhattisgarh, Madhya Pradesh, and Telangana were available for acquisition. These auctions are part of a comprehensive strategy to reduce reliance on imported coal and increase the availability of coal for various industries. The auctions aim to enhance resource efficiency and management by fostering higher competition, providing cash injection, and attracting private investment. Coal's importance in the energy sector remains significant but its capacity for expansion is impacted by the government's actions in accordance with the NDCs of the Paris Agreement.

The Ministry has also implemented First Mile Connectivity projects to enhance the efficiency of coal transportation. These initiatives aim to reduce the reliance on road transportation for coal by implementing computerized loading into railway rakes and automated conveyor systems. This aims to not only enhance the overall logistics of coal transportation

but also minimize the amount of coal transported by road. These projects also optimize the transportation process to minimize transit losses, mitigate environmental effect, and ensure the timely delivery of coal to power plants and other industrial consumers. [16]

In order to ensure sustainable development, the industry also gave priority to environmental initiatives and technological breakthroughs. The Coal Mine Surveillance and Management System (CMSMS) and the 'Khan Prahari' App are a big step in the right direction towards assuring regulatory compliance, raising safety standards in the coal mining industry, and keeping an eye on illegal mining activities. These digital technologies use mobile technology and satellite photos to find unlawful mining operations and quickly address safety concerns.

Through initiatives like surface coal gasification, which turns coal into synthesis gas that can be used as a cleaner fuel for power generation or as a chemical feedstock, the Ministry of Coal has also concentrated on expanding the uses of coal. Surface coal gasification is viewed as a means of effectively utilizing the enormous coal reserves while minimizing the negative environmental effects of coal use. Furthermore, the creation of a Coal Trading Exchange seeks to improve market dynamics and accessibility for a variety of stakeholders by facilitating efficient and transparent online coal trading. It is anticipated that this platform will offer real-time data on coal availability, pricing, and demand, enhancing the efficiency and transparency of the market.

In addition to promoting energy security, India's coal industry makes a major contribution to job creation and economic expansion. The industry is now recognized as an essential part of India's core industries, propelling progress and guaranteeing that the country's energy demands are satisfied effectively and sustainably. Millions of people are employed directly or indirectly by the coal business, mostly in the rural and semi-rural areas where mining operations are concentrated. This contributes to the growth and stability of these regions by having a significant effect on their socioeconomic circumstances. The industry's economic impact is further increased by supporting ancillary sectors such as transportation, equipment manufacture, and maintenance services.

The industry contributes to the economy in ways other than only direct employment and production. The construction of roads, schools, and hospitals in mining districts is a result of investments made by coal mining companies. Furthermore, the money made from the extraction of coal goes towards funding public welfare programmes and other government initiatives such as the DMF and company CSR, which promotes overall socioeconomic development. Since it makes up a sizable portion of their budgets, state governments—especially those in coal-rich regions—depend heavily on the money they receive from coal mining operations.

Although the coal sector in India plays a vital role in the country's energy and economic development through its high production levels, strategic policy reforms, and technological breakthroughs, it is necessary to gradually phase it out in a just and measured manner. Shifting from carbon intensive energy to cleaner energy sources is essential for a sustainable future. However, it is crucial that this transition guarantees an equal and fair process for all stakeholders involved. This entails tackling the social and economic consequences faced by communities reliant on the coal sector, by offering them fresh prospects and assistance to transition into a more environmentally friendly energy framework.

3.2. Employment Rate (Upstream, Downstream)

The coal sector has long been a critical pillar of India's economy, providing substantial employment opportunities and significantly contributing to energy production. However, the landscape is shifting due to technological advancements, automation, mine closures, and a transition towards renewable energy sources. This evolving scenario poses significant challenges, particularly for the informal workforce that forms a large part of the sector. Employment in India's coal industry is multifaceted, encompassing distinctions between formal and informal work, upstream and downstream activities, wage structures, and the implications of this transition. India's economy relies heavily on coal, supporting industries like power generation, steel, and cement production. Long-term coal sector adjustments require strategic planning, and early preparation helps manage impacts better. States such as Assam, Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Telangana, and West Bengal are heavily reliant on coal, with limited employment opportunities outside the sector. Region-specific interventions are necessary to build local capacity and effectively run adjustment programmes.

Despite its importance in energy generation, India's coal industry is characterized by its extensive informal sector. The coal sector has a large informal labour that performs a variety of tasks linked to coal mining, transportation, and sales. Informal workers in this sector include those involved in direct coal mining, coal transportation, and informal coal gathering and sales. Workers without formal employment contracts, social security benefits, or job security are especially susceptible during the transition to renewable energy sources.

"GENDER DISPARITY IS ANOTHER MAJOR CONCERN IN THE INFORMAL COAL WORKFORCE. WOMEN ARE FREQUENTLY ASSIGNED TO THE MOST PRECARIOUS AND LOW-PAYING PROFESSIONS, SUCH AS COAL GATHERING AND CLEANING."

The informal coal workforce is expanding, particularly in regions with a long history of coal mining, such as Jharkhand, West Bengal, and Odisha. For example, in Jharkhand's Ramgarh area, informal labourers engaged in coal-related industries outnumber formal workers by a large margin. These informal workers include coal miners and sellers, casual labourers, and others involved in various elements of the coal supply chain. Their monthly incomes range from ₹5,000 to ₹10,000, depending on their employment and market conditions.

One of the most pressing concerns for informal coal workers is a lack of accurate statistics. Official data on the number of informal workers in the coal sector are limited, making it difficult to organize effective actions. While independent surveys and research provide insights, complete data at the local or state level remains lacking.

Informal coal workers frequently face poor working conditions. They are often engaged on a temporary or ad hoc basis by private contractors, who may also be subcontractors for larger coal firms. This results in a fragmented job structure with low wages and unpredictable employment conditions. Unskilled informal workers often earn between ₹300 and ₹400 per day, with monthly earnings ranging from ₹6,000 to ₹8,000. Semi-skilled workers, such those in technical repair or driving, get slightly higher earnings but lack job security and benefits.

Gender disparity is another major concern in the informal coal workforce. Women are frequently assigned to the most precarious and low-paying professions, such as coal gathering and cleaning. These roles are not only low-paid but also hazardous, with women often working in risky situations without enough safety equipment or health precautions. [17]

The ongoing energy transition in India, which aims to reduce reliance on coal while increasing renewable energy production, presents substantial hurdles for informal coal miners. Many of these workers are concerned about losing their jobs and have few other options. Younger workers may want to create their own enterprises or work in different fields, but lack of skills and education limit their opportunities.

"ONE OF THE MOST PRESSING CONCERNS FOR INFORMAL COAL WORKERS IS A LACK OF ACCURATE STATISTICS. OFFICIAL DATA ON THE NUMBER OF INFORMAL WORKERS IN THE COAL SECTOR ARE LIMITED, MAKING IT DIFFICULT TO ORGANIZE EFFECTIVE ACTIONS."

To achieve a fair transition, a blueprint must be developed that accommodates the unique needs of informal coal miners. This includes offering possibilities for skill development, assuring fair remuneration, and establishing alternative work prospects in burgeoning green businesses. Without targeted interventions, the shift away from coal might worsen socio-economic inequality and leave a significant portion of the workforce jobless.

3.3. Coal-dependent Industries and their Share in National GDP

Coal is an important part of India's economy, underpinning much of its energy infrastructure and contributing significantly to national GDP with key industries such as power generation, steel, cement, aluminium, railways, etc. are heavily reliant on its coal as shown in Table 2. Under the leadership of Coal India Limited (CIL), the industry not only supplies 50% of the country's commercial primary energy, but it also sustains a substantial number of employment and generates significant revenue for both the central and state government. In 2019, CIL paid around ₹500 billion in taxes and royalties, contributing for roughly 3% of the federal government's yearly revenue collection. This significant fiscal contribution is critical for the central government, particularly in coal-producing states such as Jharkhand, where coal levies can account for up to 7% of the state budget. Furthermore, the sector provided ₹33.46 billion to District Mineral Foundation (DMF) money in 52 districts, which aided the development of mining-affected people. [18]

Year	Cement	Power	Steel & Washery
2010	15	425.05	30.95
2011	15.5	431.23	30.21
2012	14.18	451.88	24.16
2013	14	494.19	25.49
2014	13.2	492.06	23.15

Year	Cement	Power	Steel & Washery
2015	7.47	546.79	19.19
2016	9	559.79	16.45
2017	6.66	577.79	11.53
2018	8.88	626.65	15.24
2019	10.62	689.26	17.23
2020	9.56	661.83	17.39
2021	7.57	638	15.46
2022	8.99	740.81	22.77
2023	9.04	826.64	8.66

Table 2: Sector-wise consumption of coal (in million tonnes)

Source: NITI Aayog, 2023 [21]

Coal mining directly employs millions, with CIL alone employing over 270,000 people. Millions more people work in adjacent areas, such as transportation and ancillary industries, indirectly supporting the economy in coal-rich regions. This employment is critical to many towns, making the coal industry an important social and economic pillar. In the fiscal year 2019–2020, coal mining and power corporations spent ₹10.11 billion on Corporate Social Responsibility (CSR) operations, with a large share going to coal-dependent areas. These initiatives boost infrastructure, healthcare, and education in these communities, raising the standard of living and supporting local growth. Coal-fired power stations remain the backbone of India's energy generation, accounting for a significant share of the country's installed capacity. Despite the growing use of renewable energy sources, coal is expected to continue its leading position in the energy mix until 2030 and beyond, with a 4.6% annual increase in power generation.

The Indian Railways, another essential component of the economy, is heavily reliant on coal as a significant freight commodity. Plans to increase coal freight confront obstacles such as congestion and logistical concerns. The railways' ability to handle higher coal loads is strained, reducing overall network efficiency and generating operational concerns. Network congestion reduces the system's ability to handle significant increases in coal traffic, impacting train speeds and punctuality. The prioritization of coal freight above passenger services, particularly in coal-rich regions, has an impact on the availability of resources for necessary maintenance and upgrades. The Indian Railways and the economy as a whole face a long-term risk due to their reliance on coal revenue. As renewable energy becomes more competitive, coal transportation infrastructure could become stranded assets.

Coal is profoundly embedded in India's economic fabric, supplying vital energy, employment, and revenue. While India is making great progress towards renewable energy, coal will remain an important part of the country's energy and economic landscape for the foreseeable future. Effective management and strategic planning are required to enable a fair transition for coal-dependent areas, balancing the expansion of renewable energy with

the continued usage of coal. This balanced approach will contribute to economic stability while moving towards a sustainable and resilient energy future.

3.4. Striking a Balance between Net Zero Targets and Coal Peak

By 2030, India aims to cut its GDP's emissions intensity by 45% from 2005 levels and generate half of its electricity from non-fossil fuel sources by the same year. Coal continues to be a vital component of India's energy landscape, providing 75% of the country's energy needs. [19] The significant rise in coal production over the past few years demonstrates this dependence on coal. India produced 726 million tonnes of coal in 2017, most of it thermal coal, which is essential for producing electricity.

Over the past ten years, coal power generation has grown at an astounding rate of 8% per year in India's electrical sector—the country's largest consumer of coal—beating the 6.5% growth in power consumption. Coal's dominance in the energy mix was demonstrated in India in 2017, when it accounted for 73% of electricity output in the country.

India plans to ramp up domestic coal output in order to meet its growing energy demands while reducing reliance on imports until 2040 while also announcing plans to close about 30 coal mines over the next few years. [20] This is essential for ensuring both economic stability and domestic energy security.

Reducing emissions associated with coal is essential to meeting global climate targets. India still uses a lot of coal because it needs reliable and inexpensive energy, even in the face of the tremendous growth of renewable energy sources. The nation is making progress in renewable energy, but due to concerns about energy security and the economy, coal consumption is still expanding. The necessity for a more comprehensive approach to the energy transition that can balance short-term energy requirements with long-term environmental objectives is highlighted by this continued reliance on coal.

Coal has been a dominant element of India's energy and economy domain for the last few decades and has been a provider of livelihood to a large number of the population in the country, for both the formal and informal sector workers. The local population who live close to the coal mines will be the most affected by the closure of coal mines, which so far have occurred due to the lack of financial viability, safety concerns, coal reserve exhaustion, and obsolete technologies. Studying the impact of such coal mine closure prompts us to reflect deeper on sustainable coal mine closure that keeps the interests of the local community at the centre.

A fair and just transition is of utmost need for the people whose lives and livelihoods are dependent on the coal mines and the coal economy. The country must ensure these communities are supported with alternative livelihoods, skill development, and opportunities like the rest of the people in the country. As India moves towards a greener economy, it must also ensure that no one is left behind in this transition to a low carbon future.

4. Understanding Vulnerability to Transition through the Five Capitals

IIn the context of transitioning from coal to sustainable energy sources, understanding and addressing the vulnerabilities faced by local communities in coal mining regions is crucial. The utilization of the five capitals framework—human, social, financial, natural, and physical capital—allows a comprehensive approach to examine these vulnerabilities and develop strategies for a just, people-centric transition. Using this framework to identify the multifaceted impacts of coal mining activities and their closure on the well-being of communities, this chapter builds a holistic understanding of the vulnerabilities in coal mining regions through the various ways in which coal mining and coal mine closure affects the quality of life of local communities in the eastern coal belt of India.

4.1. In Terms of Human Capital

Human capital, which includes the skills, education, and health of individuals, is a critical factor in determining the resilience of communities in coal mining regions. As mines close or coal production declines, populations with higher human capital are better equipped to adapt, diversify livelihoods, and seek new opportunities. Conversely, low levels of education, poor health, and limited skills increase vulnerability, making it harder for individuals to respond to economic and environmental disruptions.

In mining regions, human capital is also tied to public health, with frequent issues such as respiratory diseases and joint pain due to mining-related pollution. Strengthening human capital through education, healthcare, and skill development is essential for helping these communities navigate the challenges of a just energy transition and build more sustainable futures.

Analysing the data collected from the study area using tools like surveys, FGDs and key stakeholder interviews provided valuable insights into the status of human capital in the study area and suggested avenues for enhancement to promote more sustainable livelihoods. Several factors were considered to gauge the readiness of the local populace to adapt to socio-economic challenges stemming from coal mine closures, including literacy rates, educational attainment, and current employment status and health.

4.1.1. Education

- Limited job prospects after completing education in coal mining areas leave many youths frustrated, with aspirations for white-collar jobs remaining largely unfulfilled.
- Women face significant barriers to economic participation, and social challenges like alcoholism and domestic violence are more prevalent, affecting their well-being and opportunities.
- Poor educational infrastructure, combined with financial constraints, limits the ability of many children to complete their schooling, particularly in backward class communities.

- There is a clear disconnect between education and employment opportunities, emphasizing the need for better job integration and support in just transition efforts for coal-dependent regions.

Education plays a crucial role in human capital development, but employment opportunities in the vicinity of closed coal mines in the Jharkhand study area (Figure 6) remain scarce despite educational attainment in coal mining affected communities. Qualitative data showed that coal mining communities in Jharkhand performed relatively well compared to Chhattisgarh. However, discussions with the locals also revealed that while schools and colleges are accessible, job prospects after graduation are limited, leading to disillusionment among the youth. As a result, aspirations for better employment opportunities are common but white-collar jobs are still far-fetched. Social issues such as alcoholism and domestic violence also persist, exacerbating challenges faced by the community particularly by women, who are disproportionately affected, facing barriers to economic participation and experiencing higher rates of domestic violence.

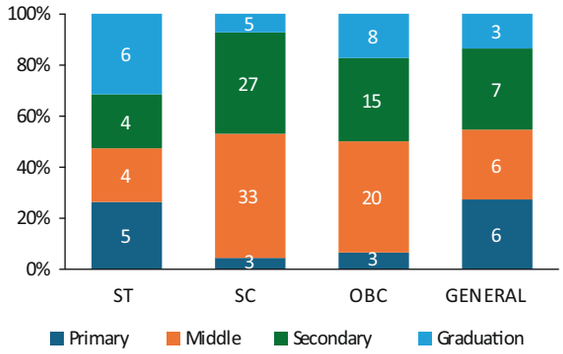


Figure 6: Formal education by category in Jharkhand study area

In the Chhattisgarh study area consisting of villages in the vicinity of non-functional/ closed mines in the districts of Surguja, Surajpur, and Manendragarh-Chirmiri-Bharatpur, varying levels of access to education were evident as seen in the data on formal education attainment. Survey data revealed the relatively low levels of school completion among respondents living in coal mining areas—particularly among the backward classes of ST, SC, and OBC populations (Figure 7).

In the villages selected for study in Chhattisgarh's coal mining regions, far from ideal access to education presented multifaceted challenges across various villages. Education infrastructure varied, with some villages lacking even basic facilities such as classrooms and resources. Interaction with locals in five villages (out of a total of seven in three districts of Chhattisgarh) showed that locals grappled with inadequate educational infrastructure; lack of proper sanitation and running water in the schools, inadequate mid-day meals, lacking the requisite infrastructure or hard access to schools.

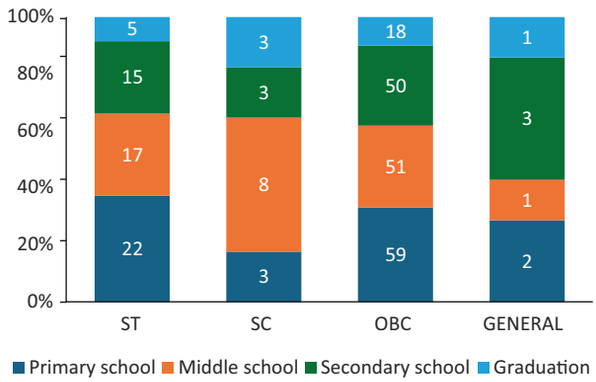


Figure 7: Formal education by category in Chhattisgarh study area

In Odisha's Bantabori-sahi, Chhendipada Gram Panchayat in Angul district, many youngsters remained at home after completing their education, in the absence of any viable employment opportunities accessible to them. While girls typically assist their mothers in household chores, only families with greater financial resources could afford to send their children to private schools with better quality of education. Focus group discussions (FGDs) revealed that only one woman had her children educated beyond high school. The reasons for such reports are varied: some children lacked interest in studying and preferred playing, others did not perform well academically, and many families simply couldn't afford to continue their children's education. All of this points to a mismatch in aspirations and the reality of the job scenario in a coal mono-economy.

Image 3: Mid-day meals provide strong incentive to families to send their children to school

At Rampur Colliery in Brajrajnagar, Jharsuguda district, the closure of mines exacerbated financial difficulties, making it challenging for locals to fund education and basic necessities like food. Despite these hardships, girls in this region do attend college. It is more typical for girls to be sent for tertiary education; boys would be sent to earn money as soon as they were able to do so. The capital intensive nature of higher education with limited guarantee of returns in the form of employment meant that people do not view it as essential to their income earning capabilities in the area. In Tiklipara Gram Panchayat, of the same district, children attended school a half-hour walk away but only offered education up to the matriculation level. For further education, children need to travel to Duduka, 60 kilometres away. Despite these efforts, there is a notable lack of employment opportunities for educated individuals, leading to a disconnect between education and economic prospects.

This data from coal mining regions illustrate a complex picture of education. While some children manage to attend school and even college, financial constraints, lack of motivation, and limited job prospects hinder the broader educational advancement of the community. These insights underscore the importance of addressing both educational access and the economic integration of educated youth in any just transition plan for coal mining areas.

4.1.2. Employment

jobs such as truck driving and coal shovelling, making them particularly vulnerable to the downturn of the coal economy.

- In Chhattisgarh and Odisha, the closure of coal mines has led to economic uncertainty, with communities turning to daily wage labour and government schemes such as Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA), which are often inadequate to address their employment needs.
- In Odisha's Harijan-sahi and Bantabori-sahi, the loss of coal-related jobs has driven residents to low-paying, unstable alternatives like working in cotton mills or as rented tempo drivers, increasing economic vulnerability.

An analysis of educational and employment factors highlight the precarious situation faced by backward communities in particular, as their lower levels of education and dependence on daily wage labour limit their ability to transition to alternative employment opportunities and diminish their financial resilience. A high prevalence of daily wage labour and intermittent employment in Jharkhand is seen in Figures 8 and 9.

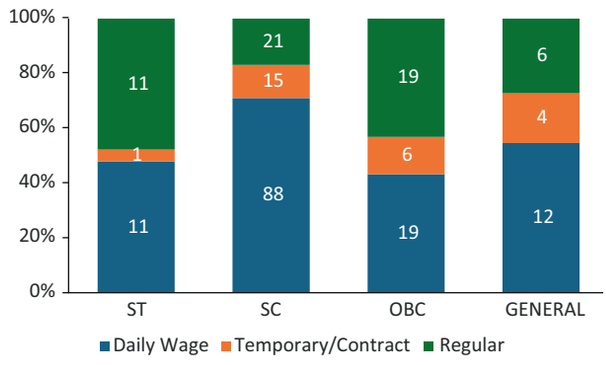


Figure 8: Kind of employment by category in Jharkhand study area

Figure 9: Employment status by category in Jharkhand study area

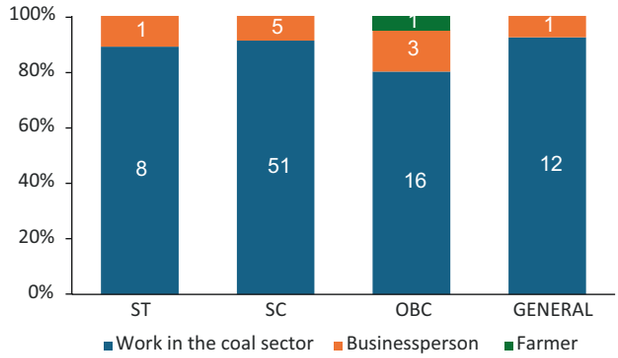


Figure 10: Primary occupation by category in Jharkhand study area

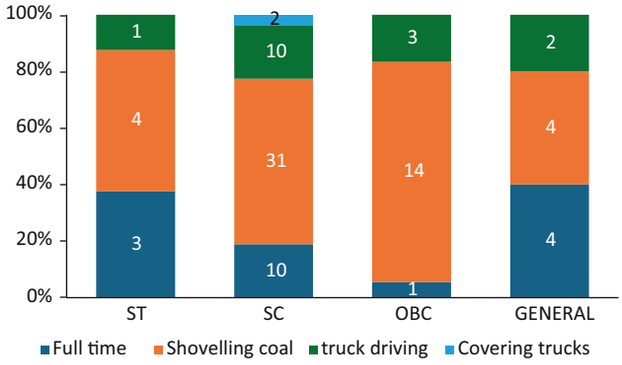


Figure 11: Nature of engagement in the coal sector by category in Jharkhand study area

In addition to this, a high dependence on the coal sector for employment and income in Jharkhand's coal mining areas was observed, particularly through informal means like truck driving, coal shovelling, and covering coal laden trucks with tarpaulin. This is further established by the high share (88.9% of ST respondents, 91.1% of SC respondents, 80% of OBC respondents, 92.3% of general respondents) of the study population working in the coal sector of whom a majority are informally engaged as seen in Figure 11. This shows that the already socio-economically backward classes dependent on the coal mining economy are more vulnerable to a potential downturn of the coal economy.

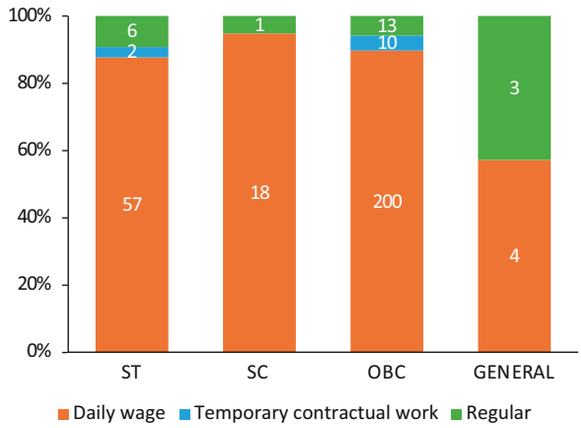


Figure 12: Kind of employment by category in Chhattisgarh

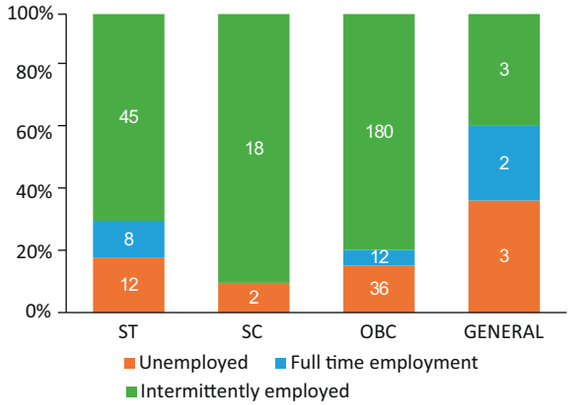


Figure 13: Kind of employment status by category in Chhattisgarh

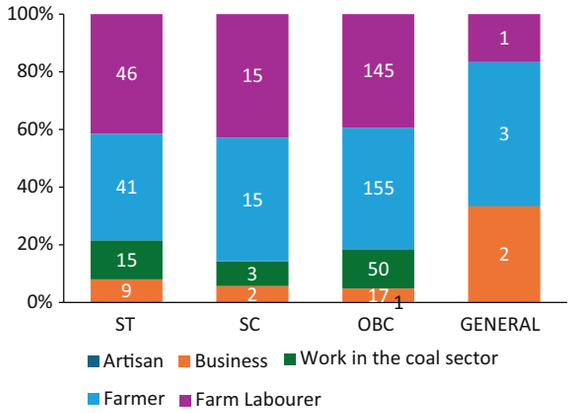


Figure 14: Primary occupation by category in Chhattisgarh

As compared to Jharkhand, there is a relatively lower rate of engagement in the coal sector for employment in Chhattisgarh (Figure 12). However, discussions with locals revealed a historical reliance on mining industries; many villages have experienced economic uncertainty post-coal mine closure. Market places in Chirmiri which were once hubs of commercial activity driven by mining activities, are now increasingly deserted with the

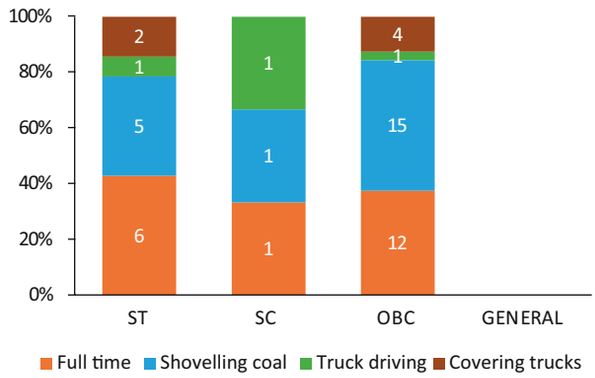


Figure 15: Nature of employment in the coal sector by category in Chhattisgarh

phasing out of old coal mines. Once reliant on mining industries, villages like Dhumadan-para now face economic uncertainty post-closure. Consequently, communities turn to alternative sources of income such as daily wage labour and government schemes like MNREGA. Moreover, outmigration patterns underscore the search for better employment prospects, with young men leaving villages like Sarna-para for urban opportunities. Government schemes, though present, often encounter bureaucratic hurdles and fail to fully address employment challenges. For instance, Bansipur struggled with debt and limited employment opportunities despite government initiatives.

In Harijan-sahi of Chhendipada Gram Panchayat, in Angul district of Odisha, with the closure of mines, traditional employment opportunities in coal-related activities have vanished. Alternative employment, such as working in cotton mills or as rented tempo drivers, offer lower wages and unstable income. The lack of land ownership among the local coal mining community exacerbates the economic vulnerability due to the lack of a social security cushion. In Bantabori-sahi, another hamlet in the same gram panchayat, closure of coal mines has led to a loss of livelihoods for those involved in coal transportation. Despite some finding contract work at the nearby JSW plant, the income is inadequate, and job opportunities remain limited. Other hamlets also reported an inability to secure jobs or compensation after losing agricultural land to coal mining activities, combined with the lack of new job opportunities, which increases economic vulnerability.

4.1.3. Economic status

- The high percentage of ration cardholders in coal mining regions indicates significant reliance on government support for food.
- A large portion of the population across all study areas, especially in Jharkhand and Chhattisgarh, holds BPL or Antyodaya cards.
- The disproportionate share of Antyodaya cardholders in Jharkhand and BPL cardholders among backward classes in Chhattisgarh underscores the urgent need for socio-economic development initiatives.

Data on ration card holding through the survey provided valuable insights into the socioeconomic vulnerabilities of the local community in coal mining regions. Categorized based on income levels—Below Poverty Line (BPL), Above Poverty Line (APL), and Antyodaya (for the poorest of the poor)—the distribution of these cards within a community indicates the proportion of households living in poverty or extreme poverty. Holding a ration card is mainly associated with access to subsidized food grains and other essential commodities. High percentages of ration cardholders suggest significant reliance on government support for basic food needs, highlighting food insecurity within the community. Secondly, communities with a high number of ration cardholders may have a greater dependency on government welfare schemes. This dependency can indicate economic vulnerability and a lack of sufficient income-generating opportunities.

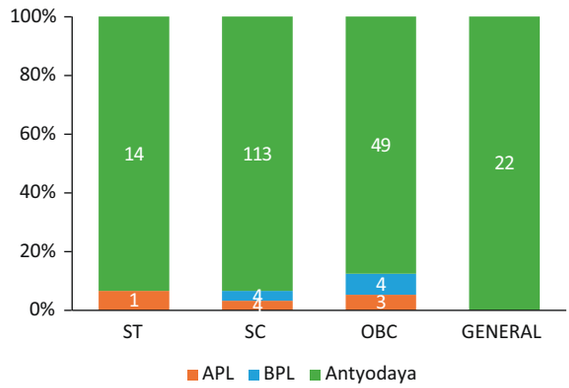


Figure 16: Ration card by category in Jharkhand

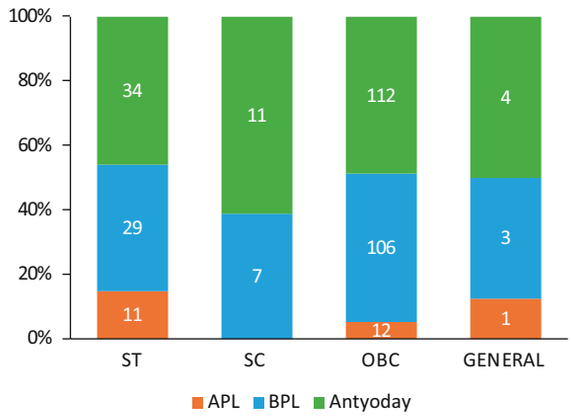


Figure 17: Ration card by category in Chhattisgarh

A significant number of respondents across categories in all study areas in the coal belt had ration cards that marked them as below the poverty line—Below Poverty Line (BPL) or Antyodaya cards. This suggests that the economic benefits of coal mining have not been adequately distributed among the local population holding BPL or Antyodaya ration cards and that a significant portion of the population relies on government assistance for basic necessities like food as seen in Figure 16. This reliance indicates that their incomes are insufficient to meet basic needs, pointing to broader issues of food insecurity and

inadequate social safety nets. The high percentage of residents below the poverty line in Chhattisgarh and Jharkhand's coal mining areas underscores the urgent need for comprehensive socio-economic development initiatives for a just transition away from a coal reliant mono economy.

In Jharkhand, a disproportionate share of the respondents held Antyodaya Cards across all categories, especially in the general population. On the other hand, in Chhattisgarh's coal mining areas a significant proportion of residents, including Scheduled Tribes (STs), Scheduled Castes (SCs), Other Backward Classes (OBCs), and even general category individuals, are below the poverty line, holding either BPL or Antyodaya ration cards as depicted in Figure 17. A greater share of the SC respondents in the coal mining regions was found to be below the poverty line, underlining the greater vulnerability of the backward classes to transition.

4.1.4. Health

- Communities in Odisha's coal mining areas face significant health challenges, including respiratory issues and joint pain, exacerbated by coal dust, environmental degradation, and the lack of adequate healthcare infrastructure, forcing many to travel long distances for medical care.
- Financial strain is a recurring theme, with many families forced to take loans or sell land to cover medical expenses, further compounding their economic vulnerability, especially in areas where local healthcare facilities are insufficient or charge fees.
- Contaminated water sources with high mineral content contribute to widespread health problems like skin diseases, gastritis, and joint pain, particularly in Sundargarh and Chhendipada, where groundwater contamination from coal mining is prevalent.
- Health infrastructure remains inadequate, with a lack of de-addiction centers, insufficient maternal care facilities, and limited access to treatment for common ailments such as pulmonary diseases, skin infections, and non-communicable diseases, increasing the overall health burden in coal mining regions.

The health of communities in Odisha's coal mining areas is quite compromised, due to a multitude of challenges exacerbated by coal mining activities and subsequent mine closures.

Women in Harijan-sahi, Chhendipada, face significant health difficulties due to the closure of mines, which has limited their ability to access healthcare services. The lack of a Primary Health Centre (PHC) and the insufficiency of the Community Health Centre (CHC) force residents to travel to Angul or Cuttack for medical treatment, often necessitating loans from friends and family. The long working hours in construction and farming, coupled with the physical labour involved in fetching water, contribute to widespread joint pain among women. Additionally, respiratory problems are commonly reported, attributed to the increased coal dust in the environment.

In Bantabori sahi, Chhendipada, despite the presence of a nearby CHC, the lack of adequate services compels villagers to seek medical care in Angul or Cuttack. This situation often leads to financial strain, with some individuals having to sell land to cover medical expenses. The high iron content in borewell and tap water has led to skin problems, further complicating the health scenario. The situation in Majhi-sahi, Tentuloi Gram Panchayat, reflects similar challenges, with women having to travel 7.5 km to the subdivision hospital, making it difficult to access care during emergencies. Joint pain is prevalent, likely due to the physical strain of carrying water and the pervasive coal dust requiring frequent cleaning. The presence of an MCL hospital that charges fees further restricts access to healthcare for the economically vulnerable population.

In Majhidipo-sahi, Gobra Gram Panchayat, complaints of joint pain and pulmonary issues are common among both men and women, with serious illnesses necessitating travel to Cuttack. This travel often requires taking informal loans to finance travel and stay, adding to the financial burden. The situation in Rampur Colliery, Brajrajnagar, is slightly better with a nearby CHC, but major health issues still require travel to Jharsuguda town. High blood pressure (hypertension) and stress-related ailments are prevalent, exacerbated by the socio-economic conditions following the mine closures.

In Oram-pada, Tiklipara Gram Panchayat in Sundargarh, skin diseases from bathing in open water tanks and joint pain are common. This can be attributed to the contamination of fresh/-groundwater due to overburden runoff and the receding levels of groundwater causing high mineral concentration. Groundwater is also the source of drinking water for most locals and high mineral content has the potential to cause health complications like gastritis and joint pains.

Image 4: Women carry heavy coal loads over long distances for sale and home use, causing long-term health issues and adding to their hardships

Contractual labourers in the locality reported lack of medical cards provided either by the mining company or the government, necessitating out-of-pocket expenditure for medicines. The dispensary's distance and the lack of immediate medical facilities for childbirth further complicate healthcare access, with a report of a woman dying in childbirth due to delayed medical intervention. Residents of Khuishira/Kusopada, Balinga Gram Panchayat (also in Sundargarh), reported joint pain due to old age and breathing problems from coal dust. In Gopalpur Main Basti, Gopalpur GP, coal dust causes respiratory issues like cough and cold, and women frequently travel to Sundargarh or Jharsuguda for major health concerns, highlighting the inadequacy of local healthcare facilities. The chief medical superintendent from MCL Basundhara Hospital highlighted respiratory infections due to coal dust, high uric acid levels from groundwater, and fungal skin infections. The lack of a de-addiction centre and the limited healthcare infrastructure necessitate referrals for serious cases, often involving long travel distances. With coal mining locals did claim an increase in the cases of drug and alcohol abuse, especially among youth.

An interview with an Accredited Social Health Activist (ASHA) worker, Babita Barik, in Gobra Gram Panchayat, revealed that gastric issues and joint pain were pervasive, often recurring after medication courses. Pulmonary problems and skin diseases due to unhygienic bathing conditions were also reported to be common. Alcoholism adds to the health burden, with liver problems and related complications widespread among the local population. A general physician at the Community Health Centre (CHC) in Brajrajnagar, in Jharsuguda district, skin diseases, gastric issues, non-communicable diseases (NCDs), and arthritis were reported to be prevalent among the local population. Mental health issues such as depression and anxiety, stunting among children, and high infant and maternal mortality rates further illustrate health- related vulnerabilities of the local community in the vicinity of coal mines. Interviews with a gynaecologist and emergency doctors at MCL Ib Valley Area General Hospital emphasized the prevalence of respiratory issues, malnutrition-related menstrual irregularities, anaemia, and cervical cancer associated with coal dust and poor hygiene. The high maternal and infant mortality rates, respiratory diseases in children, and the need for institutional births underscore the critical need for improved healthcare infrastructure and services in these regions that are acutely affected by the fallout of open cast coal mining and its associated activities.

Overall, the health situation in Odisha's coal mining areas is marked by widespread physical ailments, inadequate healthcare facilities, financial strain from medical expenses, and the pervasive impact of coal dust and environmental degradation on the community's well-being.

In Jharkhand's Lodna No. 7 mines area in Jharia, health issues such as hypertension and diabetes were commonly reported. Although there was once a BCCL hospital in the area, residents now rely on private healthcare services, which are expensive and less accessible. For lower-risk health concerns, local ASHA workers provide basic healthcare support and ensure institutional deliveries. In Burnpur North Railway, Nepali Dhaura, residents continue to suffer from pollution-related ailments. Tuberculosis (TB) and thyroid problems are particularly prevalent, underscoring the impact of air and environmental pollution on respiratory and endocrine health in the area. In Mahtadih Gram Panchayat, common health issues include hypertension and gastrointestinal problems such as blood in stool. Residents attribute these conditions to pollution from coal transportation along nearby

highways. The continuous exposure to coal dust and other pollutants in the air is believed to exacerbate these health problems.

RESIDENTS NOW RELY ON PRIVATE HEALTHCARE SERVICES, WHICH ARE EXPENSIVE AND LESS ACCESSIBLE.

These accounts demonstrate the adverse health effects that coal mining and related activities have on local communities, with pollution-induced conditions such as respiratory problems, hypertension, diabetes, TB, and gastrointestinal issues being particularly prevalent. Addressing these health crises requires both immediate healthcare interventions and long-term environmental rehabilitation to reduce the harmful impacts of coal mining on public health.

The health of local populations in coal mining areas of Chhattisgarh is also severely impacted by the environmental conditions associated with mining activities. The qualitative data from various study areas provide a clear illustration of the health issues faced by these communities, with skin, respiratory, and joint ailments being particularly prominent.

In Patel-para, Kapsara Gram Panchayat, Surguja district, residents report skin issues caused by high mineral content in the water, which they say "sticks" to the body, leading to itching and tearing of the skin. This suggests the presence of harmful substances in the water, likely a result of coal mining activities that significantly affect skin health. Throat irritation, sore throat (due to dust pollution), and joint pain (likely because of high mineral content in drinking water) are some common health problems reported in Jhilmil-para, another hamlet in the same panchayat. While skin ailments were not reported, residents confirmed that health issues had previously been a major concern due to mining activities, though these have somewhat subsided since mining ceased. In Bansipur Gram Panchayat of the same district, women frequently experience joint pain and skin itching, pointing to the pervasive health impacts of pollution from mining operations. In another gram panchayat in Surguja, Bansipur, residents reportedly suffer from respiratory problems, joint pain, and skin irritation—typical symptoms of prolonged exposure to poor air and water quality due to coal mining.

RESIDENTS REPORT SKIN ISSUES CAUSED BY HIGH MINERAL CONTENT IN THE WATER, WHICH THEY SAY "STICKS" TO THE BODY, LEADING TO ITCHING AND TEARING OF THE SKIN. THIS SUGGESTS THE PRESENCE OF HARMFUL SUBSTANCES IN THE WATER, LIKELY A RESULT OF COAL MINING ACTIVITIES THAT SIGNIFICANTLY AFFECT SKIN HEALTH.

In Govindpur Gram Panchayat, Surajpur district, a group of 15–20 women highlighted joint pain, gum issues, skin irritation, and particularly severe hair fall as the primary health challenges they face. These conditions are exacerbated by environmental pollution caused by mining. In Baraudhi Gram Panchayat, also in Surajpur district, the presence of "red water" containing high levels of iron oxides during the summer months has been reported by locals to cause significant hair fall and skin infections. The seasonal increase in mineral content in water during the hot months exacerbates these health issues.

These accounts illustrate the ongoing public health crisis in coal mining areas of Chhattisgarh. Health conditions such as joint pain, respiratory issues, and skin irritation are widespread and directly linked to the environmental degradation caused by coal mining. Addressing these health concerns requires not only improved access to clean water and healthcare services but also the rehabilitation of the local environment to mitigate the long-term effects of mining on community health.

4.2. In terms of Natural Capital

- Communities in Odisha's coal mining areas face significant health challenges, including respiratory issues and joint pain, exacerbated by coal dust, environmental degradation, and the lack of adequate healthcare infrastructure, forcing many to travel long distances for medical care.
- Financial strain is a recurring theme, with many families forced to take loans or sell land to cover medical expenses, further compounding their economic vulnerability, especially in areas where local healthcare facilities are insufficient or charge fees.
- Contaminated water sources with high mineral content contribute to widespread health problems like skin diseases, gastritis, and joint pain, particularly in Sundargarh and Chhendipada, where groundwater contamination from coal mining is prevalent.
- Health infrastructure remains inadequate, with a lack of de-addiction centres, insufficient maternal care facilities, and limited access to treatment for common ailments such as pulmonary diseases, skin infections, and non-communicable diseases, increasing the overall health burden in coal mining regions.

Natural capital refers to the world's stock of natural resources, which includes ecosystems, land, water, air, and biodiversity that provide essential goods and services to human societies. In regions dependent on coal mining, natural capital plays a critical role in supporting the livelihoods of local communities, particularly those engaged in agriculture, forest produce collection, and other resource-based activities. The degradation of natural capital—through air and water pollution, deforestation, soil depletion, and biodiversity loss—due to coal mining activities has profound consequences on the environment and the well-being of these communities.

Image 5: Farming is becoming less viable as coal dust settles on the soil, reducing its fertility and making it harder to cultivate

In coal mining regions, natural capital is a key variable for assessing the vulnerability of communities, as it directly impacts their access to essential resources and services. Communities living in these areas are often reliant on natural ecosystems for agriculture, clean water, non-timber forest products (NTFPs), and overall sustenance. When coal mining operations deplete these resources, it results in a cascading effect on the livelihoods, health, and social stability of local populations. Moreover, environmental degradation can exacerbate climate vulnerability, as communities face greater risks from drought, soil erosion, and reduced agricultural productivity. Data from Chhattisgarh, Jharkhand and Odisha highlight the detrimental effects of coal mining on various aspects of natural capital, including water quality, air quality, soil quality, water scarcity, and crop quality.

Qualitative survey data from Figure 18, reveals that in Jharkhand, respondents claimed that coal mining has severely affected the quality of water (30.3%), air (27.3%), and soil (12.1%), leading to poor crop production quality (3%) and significant water scarcity (27.3%).As shown

in Figure 19, Chhattisgarh shows similar trends, with negative impacts on water quality (23.3%), air quality (17.1%), and soil quality (18.6%). This state also faces the highest water scarcity (32.6%) and a notable decrease in crop quality (8.4%) due to mining activities. As shown in Figure 20, the most significant impact in Odisha is on air quality, accounting for 64.6%, followed by water quality at 17.5%, soil quality at 7.4%, and crop quality at 5.7%. Water scarcity, in comparison, is relatively less pronounced, affecting only 4.8% of the region.

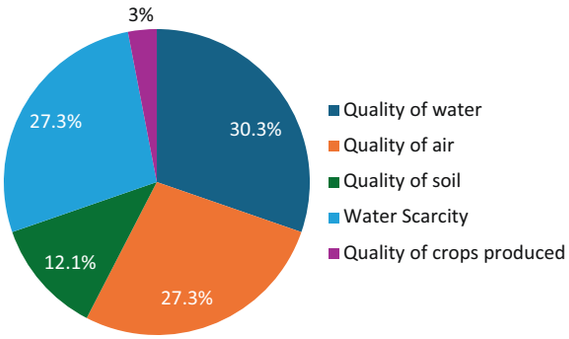


Figure 18: Negative impact of coal mining on natural capital in Jharkhand

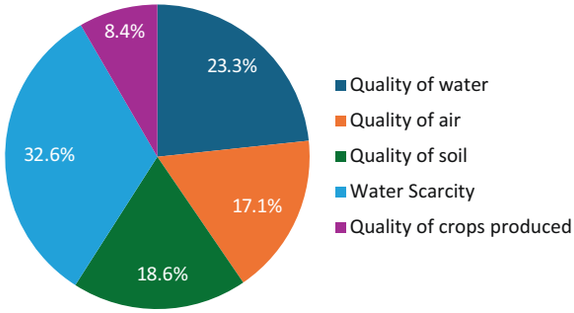


Figure 19: Negative impact of coal mining on natural capital in Chhattisgarh

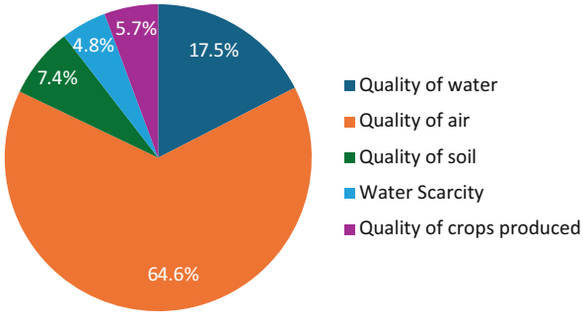


Figure 20: Negative impact of coal mining on natural capital in Odisha

Jharkhand shows a significant negative impact on water and air quality, indicating severe environmental pollution from mining activities. Water scarcity is also a major issue, further worsening the living conditions of local communities. On the other hand, there are relatively fewer responses indicating an impact on soil and crop quality suggesting that not many people are engaged in agricultural activities, typical of an urban/semi-urban industrialized region which has been a centre of coal mining for centuries.

In Chhattisgarh, water scarcity and soil quality are major concerns. In Jhilmil-para, Kapsara gram panchayat in Surajpur district and Piparkhar Gram Panchayat in Rajnandgaon district, women mentioned that there is barely any groundwater and that whatever little is available has a red tint due to high mineral content (which worsens in the summers), and that they have to make do with that water for household consumption after boiling. Similar quality of groundwater was reported by residents of Sarna-para in Govindpur Gram Panchayat

of Surguja district. In Devala-para of Kasalgiri Gram Panchayat, residents mentioned that they used to get water at a depth of 200 feet but that now they can't get that even at 300 feet below the ground.

Odisha faces the most severe air quality issues, with 64.6% of respondents reporting that coal mining has a negative impact on air quality, which is significantly higher than in Jharkhand and Chhattisgarh. This suggests that air pollution from coal mining activities, mostly open cast mining, is a critical issue in the state.

Many respondents across the three states also reported substantial involvement in NTFP- related livelihoods especially in Chhattisgarh and Odisha. Coal mining is reported to have impacted NTFP collection through pollution which reduced availability/quality of such produce or through the loss of the forests themselves. Since women are the primary beneficiaries of the sale or manufacturing of NTFP-related products, such as bidis made from tendu (Diospyros melanoxylon) leaves or plates made from sal leaves, the decline of NTFPs threatens this important income source.

Coal mining activities in Chhattisgarh and Odisha have significantly affected the local population's access to forests and the collection of NTFPs, which are crucial for their livelihoods.

In Odisha, women in Kumbhar Sahi, Chhendipada rely on NTFP collection, including tendu patta and mahua (Madhuca longifolia), to earn money. They collect tendu patta in March, April, and May to make bidis, selling a thousand pieces for ₹135. However, a power imbalance exists, as the middlemen take large commissions, leaving the women with minimal earnings. In Bantabori Sahi, Chhendipada, the situation is similar, with women collecting tendu patta and mahua, but the income from mahua, collected only in summers, is insufficient to meet the needs of the household.

In Rampur Colliery, Brajrajnagar, women used to collect various NTFPs like tendu leaves, chironji (Buchanania lanzan Spreng.), and sal sticks from the nearby Lajkura forest. However, due to coal mining, the forest has reduced and is now farther away, impacting their ability to collect these resources. Women also collect grass to make brooms. In Rampur village, Brajrajnagar, a few households make tendu bidis supplied by a bidi karkhana, earning ₹90 for 1000 bidis, and women can make 3000 bidis in a week.

In Orampada, Tiklipara GP, women collect tendu leaves, with 100 bida (A unit amount indicating 2500 leaves) selling for ₹100. They can collect 300–400 bida in a day for 15 days a month. Mahua collection, which is sold to a local liquor producer, and chironji are also significant sources of income. However, the time-consuming process of mahua collection yields only ₹30 per kilogram. In Khuishira/Kusopada, Balinga GP, women collect chironji, tendu, and mahua, selling mahua for ₹30 per kilogram, but the negative impact of coal mines has reduced their ability to collect these resources. In Gopalpur Main Basti, Gopalpur GP, women collect mahua and tendu leaves, but the quantities have reduced, and the forest is now two hours away. They also collect sal leaves to make plates, which takes 5–6 hours. The overall NTFP collection has reduced, and they no longer get the same quantity as before.

In Chhattisgarh, the situation is similar. In Dhumadan-para, Bansipur, women go into the forest to collect NTFPs between 6 am and 10 am. However, in Junapara, Bansipur GP, the forest has reduced to half of what it used to be, and NTFP collection has also reduced by

half due to the acquisition by the coal mining company. They cannot sell to the forester because the quantity is so low.

These cases illustrate the significant impact of coal mining on the access to and availability of NTFPs, which are critical for the livelihoods of local communities. The reduction in forest areas and the resultant decrease in NTFP availability have forced many to seek alternative, often less stable, sources of income. This underscores the need for a just transition plan that addresses these impacts, ensuring that the local communities are supported as coal mines close and mining companies move away.

4.3. In Terms of Physical Capital

- The reliance on mining companies for utilities such as water and electricity means that when mines close, communities potentially face severe hardships, including erratic service delivery, disrupted daily life, and the potential for health crises due to poor sanitation.
- Housing infrastructure in coal mining areas is often compromised by environmental degradation like subsidence, further increasing the vulnerability of local populations as unsafe housing adds to their risks during economic downturns.
- The gaps in physical infrastructure, such as unreliable access to water, electricity, sanitation, and cooking fuels, leave coal mining communities particularly vulnerable during the transition away from coal dependence.

Physical capital refers to the tangible assets that contribute to the production process and the well-being of communities. These assets include infrastructure such as buildings, roads, transportation systems, machinery, and utilities like water supply, electricity, and sanitation facilities. In the context of coal mining regions, physical capital plays a crucial role in determining the resilience and vulnerability of local communities.

Assessing physical capital is essential for several reasons. First, the presence and quality of infrastructure significantly affects the capacity of communities to adapt to changes like the closure of coal mines and its impact on the local economy. Adequate infrastructure can facilitate economic diversification, enabling communities to transition to new forms of employment and sources of income. For instance, good road networks and transportation systems can improve access to markets, education, and healthcare, thereby enhancing overall resilience. Second, the availability and reliability of utilities like water, electricity, and sanitation are fundamental to the health and productivity of communities and in many coal mining regions, these services are often provided by mining companies.

When mines close, the discontinuation of these services can lead to severe hardships, exacerbating vulnerability. For example, erratic water and electricity supply can disrupt daily life and economic activities, while poor sanitation can lead to health crises. Third, housing and other built environments are critical components of physical capital, as the quality and stability of housing impacts the safety and well-being of residents. In coal mining areas, subsidence and other forms of environmental degradation can compromise housing structures, making them unsafe and contributing to the vulnerability of the

population. Lastly, physical capital is interconnected with other forms of capital, such as human and natural capital. For example, access to good healthcare facilities (physical capital) is vital for maintaining a healthy workforce (human capital), while sustainable infrastructure development can minimize environmental degradation (natural capital).

In this section, physical capital is examined through the aspects of land ownership, access to water supply and sanitation, healthcare access, access to electricity and household cooking fuels to understand the gaps in existing physical infrastructure that leaves the local population vulnerable to an impending economic transition.

4.3.1. Land ownership

- In Jharkhand, landless families are particularly vulnerable to economic insecurity following mine closures, with limited livelihood options and a higher likelihood of migration in search of work.
- Odisha also faces landlessness, though to a lesser extent, but land quality is often degraded by mining activities, making agriculture less viable as an alternative livelihood.

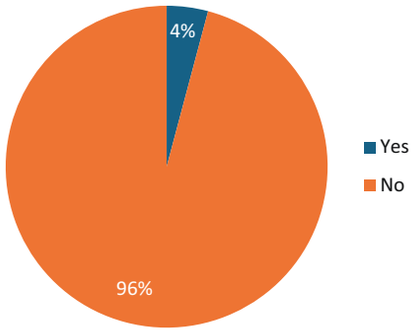


Figure 21: Land ownership in Jharkhand

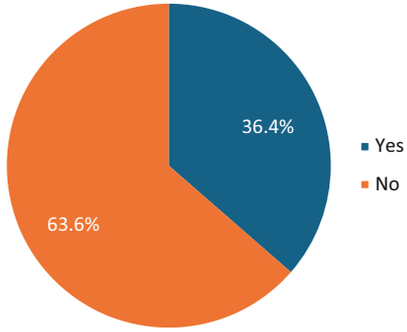


Figure 22: Land ownership in Odisha

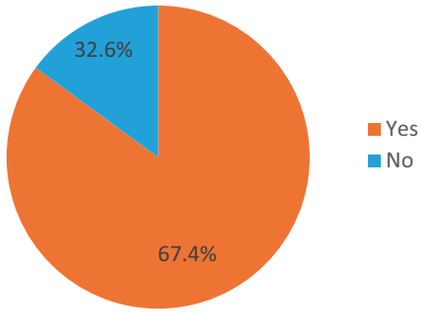


Figure 23: Land ownership in Chhattisgarh

The patterns of land ownership in Jharkhand, Odisha, and Chhattisgarh reveal significant disparities that influence the vulnerability of local communities to economic downturns following the closure of coal mines. Land ownership determines the cushion that the local community has against economic upheavals and other dimensions of its vulnerability to coal mine closure.

Image 6: Excessive open cast coal mining has led to land being degraded

In Jharkhand, the overwhelming majority of the population does not own land as shown in figue 21. This high level of landlessness exacerbates vulnerability in several ways—through economic dependency on the coal mono-economy, limited livelihood options, increased likelihood of migration, and housing insecurity. The reliance on coal mining for employment means that with mine closures, many residents lose their primary source of income. Without land to fall back on for agriculture or other forms of self-sustenance, they face increased economic insecurity. Landless individuals are also more dependent on wage labour or small-scale, informal work. The closure of mines reduces the availability of such jobs, pushing families further into poverty. With no land to cultivate, landless families are more likely to migrate in search of work. This can lead to disruption in family structures and additional challenges in new urban environments where they may lack social networks and access to services. Many landless people live in settlements on company land or unauthorized areas, making them more vulnerable to eviction and displacement once mining operations cease and companies withdraw support.

In Odisha, a significant portion of the population also does not own land, though the situation is somewhat less dire compared to Jharkhand (Figure 22). Those without land face similar vulnerabilities to economic changes, such as job loss and reduced income earning opportunities. Those who do own land may turn to agriculture, but land quality is often compromised by mining activities, reducing productivity and income potential. Land

ownership creates disparities within communities as landowners may have a buffer against economic downturns, while landless families face severe financial strain and instability—especially in agrarian communities in the rural hinterlands where sharecropping and agricultural labour is prevalent. The closure of mines may also force a shift from mining-related jobs to agriculture or informal sector jobs, which may not provide the same level of income or stability.

Chhattisgarh has the highest rate of land ownership among the three states, which influences the local community's response to mine closures (Figure 23). With a majority owning land, there is more potential for self-sustenance through agriculture or other land-based activities, providing a buffer against the loss of mining jobs. However, as discussed previously with regards to natural capital, the quality of agricultural activities is compromised. Landowners can potentially switch to agriculture or diversify into other land-based economic activities. However, the extent to which land remains fertile and productive despite mining activities can impact this transition.

The diversity of land ownership patterns shows that different regions would benefit from a localized, bottom-up approach to just transition planning that sees the convergence of central and state level welfare schemes and platforms for the realization of a just transition.

4.3.2. Access to water supply

- In Jharkhand, over half of the population relies on piped water, which could be disrupted by mine closures, especially if mining companies developed the water infrastructure.
- A significant portion of the population in Jharkhand (24.3%) and Odisha (22.4%) relies on hand pumps, exposing them to compromised groundwater quality.
- In Chhattisgarh, 71.1% of the population depends on hand pumps, highlighting a greater reliance on groundwater, which is impacted by coal mining activities, and even post-closure, mine pits often cause further degradation of groundwater sources.

Access to drinking water is a fundamental aspect of human well-being and is particularly critical in regions heavily dependent on natural resources, such as coal mining areas. In states like Jharkhand, Odisha, and Chhattisgarh, the availability and sources of drinking water vary significantly. This variation in water access can exacerbate the vulnerabilities local communities face, especially in the context of coal mine closures. The closure of coal mines can lead to significant socio-economic disruptions, and the existing disparities in water access can compound these challenges, affecting health, livelihoods, and overall community resilience.

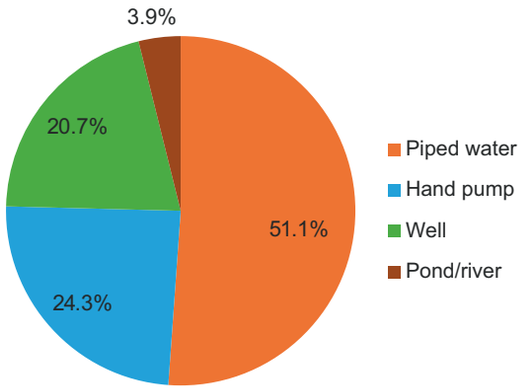


Figure 24: Drinking water access in Jharkhand

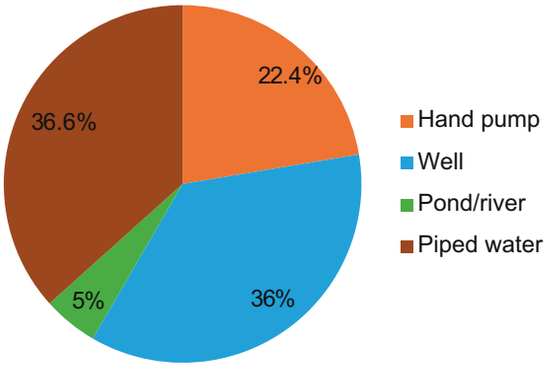


Figure 25: Drinking water access in Odisha

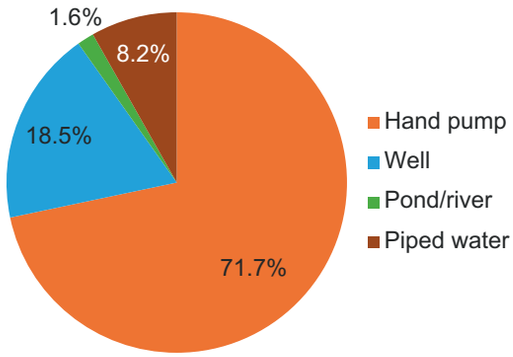


Figure 26: Drinking water access in Chhattisgarh

With over half of the study population relying on piped water in Jharkhand, the closure of coal mines may disrupt this supply if the mining companies have developed water distribution infrastructure or if the economic impact reduces the capacity of local governments to maintain these systems as observed from Figure 24. While in Odisha too, a smaller portion of the population (36.6%) relies on piped water with similar risks, a just transition plan should ideally consider improved water access for those dependent on groundwater given the impact of mining activities on this resource as illustrated in Figure 25.

A considerable proportion of the population in Jharkhand (24.3%) and Odisha (22.4%) depends on hand pumps, which is also an indication of exposure to contaminated/ compromised groundwater given water scarcity and decrease in aquifer levels is widely reported in these areas. High mineral content in water is a prevalent problem, and the significantly high reliance of Chhattisgarh's study sample (71.1%) from Figure 26 indicates a greater impact of coal mining-related impact on water for locals. This problem is not reversed by the cessation of mining activities either as mines are usually not backfilled and groundwater recedes and collects in the deep mine pits of both underground and open cast coal mines, affecting the local communities and their access to groundwater, which is their primary source of potable water.

Communities relying on surface water sources such as wells are particularly vulnerable to pollution from mining activities. Post-closure, if mines are not properly rehabilitated, the risk of water contamination remains high, affecting these populations significantly even though only the reports of using wells for drinking was low—3.9% in Jharkhand, 5% in Odisha, and 1.6% in Chhattisgarh.

4.3.3. Sanitation/Toilets

- Access to sanitation facilities in coal mining regions shows significant variation, with Jharkhand having the highest in-house toilet availability (71%) compared to Odisha (40.5%) and Chhattisgarh (11.9%).
- In Jharkhand, only 0.8% of the population practices open defaecation, highlighting better sanitation infrastructure, while Odisha (17.2%) and Chhattisgarh (28.7%) face higher rates of open defaecation, indicating serious public health challenges.

- The reliance on external toilets is more prominent in Chhattisgarh (53.2%) and Odisha (42.3%), which reduces sanitation quality, leading to greater public health risks and daily inconveniences, particularly affecting women and children.

Sanitation facilities, including clean water, waste disposal systems, and hygienic latrines, are fundamental for maintaining public health and ensuring quality of life. In coal mining regions, the significance of these facilities is heightened due to the unique environmental and health challenges these areas face. Coal mining activities often lead to environmental degradation, contaminating water sources with pollutants such as heavy metals and chemicals. This contamination exacerbates the need for robust sanitation infrastructure to provide communities with clean drinking water and safe waste disposal options. Without adequate sanitation, residents are at a higher risk of water-borne diseases and other health issues. This aspect has been examined on the basis of access to toilet facilities in the study area.

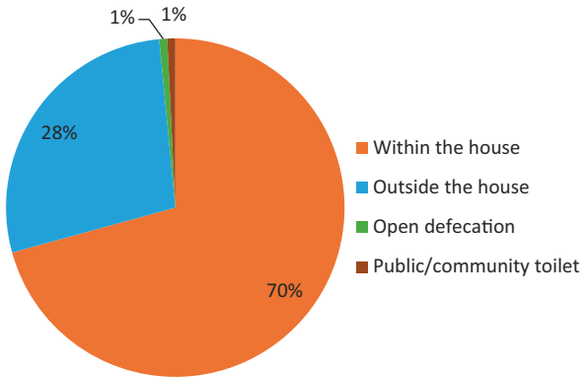


Figure 27: Toilet facilities in Jharkhand

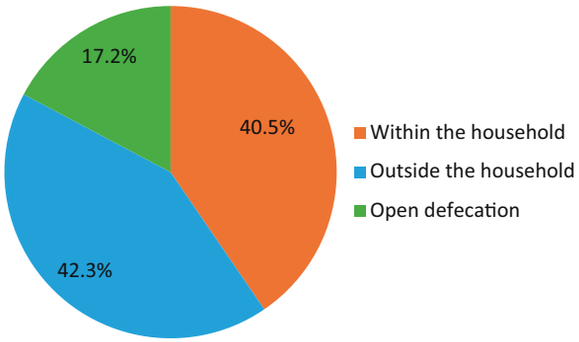


Figure 28: Toilet facilities in Odisha

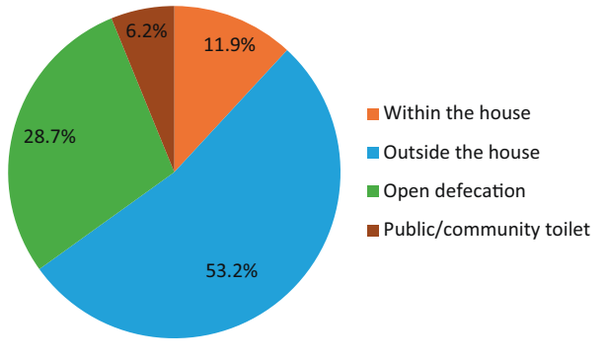


Figure 29: Toilet facilities in Chhattisgarh

The availability and accessibility of toilet facilities are crucial indicators of sanitation and public health, especially in coal mining regions where environmental and health challenges are pronounced. Data from Jharkhand, Odisha, and Chhattisgarh reveal varying scenarios concerning toilet facilities in these coal mining areas.

Jharkhand as seen in Figure 27 demonstrates relatively better access to sanitation facilities compared to the other two states. Only 0.8% of the population practices open defaecation, and the majority of households have access to toilets within their homes (71%). About 27.9% of households have toilets situated outside their houses, but the overall situation indicates a strong emphasis on in-house sanitation facilities, reflecting a higher standard of hygiene and privacy.

In contrast, Odisha as shown in Figure 28 faces more challenges in sanitation access. Open defaecation is notably higher at 17.2%, and only 40.5% of toilets are situated within the house. A significant portion (42.3%) of toilets are located outside the house, indicating a lower level of indoor sanitation compared to Jharkhand. This situation may contribute to greater public health risks and inconvenience, exacerbated by the environmental impact of coal mining.

Chhattisgarh as observed in Figure 29 reveals the most concerning scenario among the three states. A significant portion of the population (28.7%) still practices open defaecation, reflecting inadequate sanitation infrastructure. The majority of toilets are situated outside the house (53.2%), and only 11.9% have toilets within the house. Additionally, 6.2% of households rely on public or community toilets, further highlighting the insufficiency of personal sanitation facilities. The high rate of open defaecation and reliance on external facilities point to severe sanitation challenges that can impact health and well-being, particularly in areas affected by coal mining.

The availability of in-house toilets is a crucial factor in improving the quality of life. Jharkhand's higher rate of in-house toilets (71%) compared to Odisha (40.5%) and Chhattisgarh (11.9%) suggests better living conditions and privacy. In contrast, the reliance on external or community toilets, as seen in Chhattisgarh (53.2%) and Odisha (42.3%), can lead to inconvenience, lack of privacy, and exposure to unsanitary conditions. This impacts daily life, particularly for women and children, who may face additional challenges related to safety and access.

4.3.4. Access to healthcare facilities

- Access to healthcare in coal mining regions of Jharkhand, Odisha, and Chhattisgarh is uneven, with residents often facing inconsistent or inadequate services, forcing them to rely on costly private healthcare or travel long distances for treatment.
- In Jharkhand, while some communities have access to institutional healthcare, the quality is often lacking, with locals reporting inadequate care and expensive private healthcare, especially after the closure of BCCL hospitals.
- Odisha's coal mining areas show significant disparities in healthcare access, with marginalized communities, particularly in lower caste hamlets, struggling to afford or access institutional healthcare, often needing to travel long distances for serious medical issues.
- In Chhattisgarh, although respondents report access to institutional healthcare, field observations reveal a preference for private hospitals due to inadequate services at local government hospitals, and some areas lack essential healthcare workers, like ASHA workers, further limiting access.

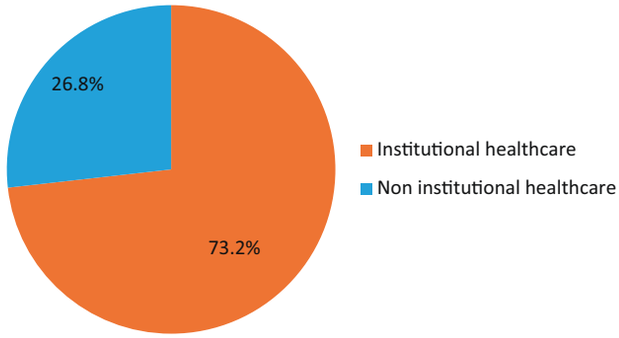


Figure 30: Access to institutional healthcare in Jharkhand

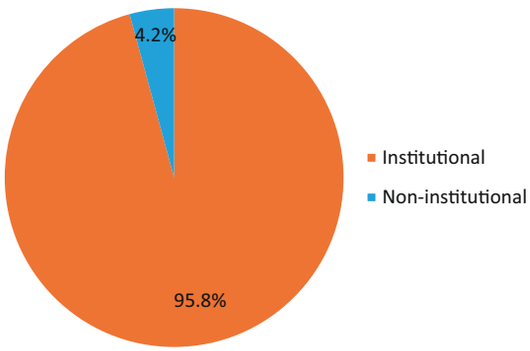


Figure 31: Access to institutional healthcare in Odisha

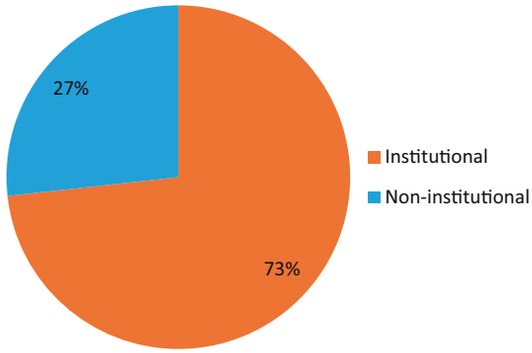


Figure 32: Access to institutional healthcare in Chhattisgarh

Access to healthcare is a crucial factor influencing the vulnerability of communities, particularly in the context of economic challenges such as those following the closure of coal mines. While institutional healthcare access is a significant indicator of community resilience, the quality of healthcare services and the reliance on non-institutional healthcare also play a vital role. The data from Jharkhand, Odisha, and Chhattisgarh highlight the disparities in healthcare access and the resulting implications for these communities.

In Jharkhand, a significant portion of the population has access to institutional healthcare, but FGDs with locals indicated that the quality of services is inconsistent (Figure 30). In the Ena Colliery area of Jharia, residents have access to a government hospital, but it allegedly provides the same medication for all issues according to the locals—implying a lack of sufficient care for the patients' individual needs. Private hospitals offer better care but at a higher cost and the high cost of private care limits accessibility. Limited and costly healthcare services increase residents' vulnerability, particularly in managing chronic health conditions and the effects of pollution. The Lodna area in Dhanbad used to have a BCCL hospital, but now residents rely on costly private doctors and hospitals for better services. ASHA didis provide regular help for minor health issues. The lack of affordable and accessible healthcare increases the vulnerability of residents, forcing residents to seek private care, which is costly. This contributes to economic strain and limits access to necessary medical treatments. Another community in Dhanbad reported having limited access to the nearby BCCL hospital where they could only avail basic OPD services but not medicines from the dispensary. Locals near the Simla Bahal underground mines in Jharia

(Dhanbad) reported a high level of employment and access to healthcare, but with the closure of coal mines, only 10% of the earlier number are still employed with the coal mines and this would also mean a significant reduction in access to healthcare provided by the mining company.

In the coal mining-affected communities of Odisha, access to healthcare varies significantly across different villages, reflecting a broader picture of challenges that necessitate attention in any just transition plan (Figure 31). In the Talcher town of Angul, local communities reported varying situations, for instance, residents of Chhendipada Gram Panchayat have relatively better access to healthcare, with a hospital located just 1 km away. However, for serious illnesses, they need to travel to Angul city. The loss of traditional medicine practitioners means there are no alternative healthcare options, leaving modern medical facilities as the only recourse. An Auxiliary Nurse Midwife (ANM) visits the village once a week, providing some basic regular healthcare services and advice. In contrast, a lower caste hamlet of the gram panchayat reported more severe healthcare challenges. The local Community Health Centre (CHC) was said to be inadequate for addressing serious health issues, forcing people to travel to Angul or Cuttack. This travel often required them taking loans from friends and family, adding financial burdens to health crises. Many residents also rely on pharmacies for minor ailments, visiting hospitals only when absolutely necessary. This shows a greater vulnerability of marginalized communities to transitions at scale.

In Tentuloi Gram Panchayat in Talcher dominated by the ST community, the nearest hospital is 7.5 km away, which is too far for emergencies. While there is an MCL hospital, it charges fees for basic check-ups which are subsidized on an employee card, adding another barrier to access for those who have lost their jobs or are not employed with the coal mining company. Residents often have to take informal loans to afford travel for medical care.

In Gothosahi, a general category dominated hamlet of Gobra Gram Panchayat in Angul, residents generally go to the MCL hospital 7–8 km away since they are dependents of MCL employees. Though a CHC exists in Balanda, it is not frequently used. Traditional medicine practitioners and local exorcists are also consulted and an ASHA worker and ANM provide some healthcare services. This is in contrast to the dire situation of healthcare access described by marginalized communities living in hamlets just a few kilometres away in the same gram panchayat such as Majhidipo-Sahi where residents mentioned that for serious illnesses they need to travel to Cuttack in spite of there being a MCL hospital less than 10 km away.

In the Rampur area of Brajrajnagar, Jharsuguda district in Odisha, residents avail the services of nearby CHCs, but for comprehensive care, residents travel to Jharsuguda which is far for the locals. Hypertension and diabetes are prevalent, possibly due to high-stress levels. People also resort to consulting local healers. In the coal mining areas of Sundargarh district of Odisha, residents who were contractually engaged in the coal mines reported buying their own medicines as their employee card did not allow them the benefits of the hospital chemist, and the local dispensary is far away. Gastric issues are common, and while there is a small hospital in Gopalpur, some women still give birth at home. Lack of access to institutional healthcare was also seen in this part of Odisha's coal mining regions. As for any gynaecological problems they need to travel to Sundargarh city which is over two hours drive away from where they are in Hemgir block. It was not uncommon for women

to give birth at home and 3–4 years back residents also reported the death of a woman during childbirth at home.

In Balinga Gram Panchayat, residents often travel to Hemgir hospital or further to Duduka and Sundargarh, more than 60 km away, with limited daily bus service. In Gopalpur gram panchayat—a community already bearing the brunt of having lost land to coal mining operations—residents said they could not avail the services of the nearest hospital that is the MCL Basundhara hospital and would go to Sundargarh city or even Jharsuguda for major ailments.

These field notes paint a picture of varied healthcare access and quality in Odisha's coal mining regions. Proximity to hospitals and regular visits from healthcare workers provide some support, but financial constraints and the necessity to travel long distances for serious medical care are significant challenges. Addressing these healthcare disparities is essential in developing a just transition plan for these communities.

While in Chhattisgarh too, like the other two study states, survey responses indicated that the respondents were able to avail the benefits of institutional healthcare, further probing in the field revealed otherwise (Figure 32). In Kapsara Gram Panchayat of Bhaiyathan block in district Surguja, locals reported that there is a PHC in the neighbouring panchayat area along with a government and private hospital fairly close by. They preferred the services of the private hospital indicating that the state of affairs at the local government hospitals was not up to the mark. In another hamlet of the same panchayat which was dominated by OBCs mentioned that the local Anganwadi had stopped functioning after the lady operating it passed away. They mentioned that the nearest SECL hospital is 6–7 km away but they cannot avail its services. In a Gond tribe dominated hamlet of Bansipur Gram Panchayat of Surguja district, residents reported that they had never heard of an ASHA worker and that for every small issue they need to travel to Bhatgaon which is an hour's journey for them. In the neighbouring district of Surajpur, discussions with residents of Govindpur Gram Panchayat revealed that there were no government hospitals nearby. The nearest healthcare facility for this panchayat is the SECL hospital where they only get medicine prescriptions. For checkups, the locals visited a private practitioner who charged ₹200–350 per visit and this together with the price of the medicine would cost them ₹1000.

4.3.5. Access to electricity

- Jharkhand's high grid connection rate (97.7%) is undermined by the erratic nature of the supply, with nearly all households (99.6%) experiencing daily load shedding or seasonal blackouts.
- In Chhattisgarh, 70.1% of households are connected to the grid, but 46.1% face unreliable supply.
- Odisha shows a split in grid reliability, with 87% of households connected but only half experiencing consistent electricity.

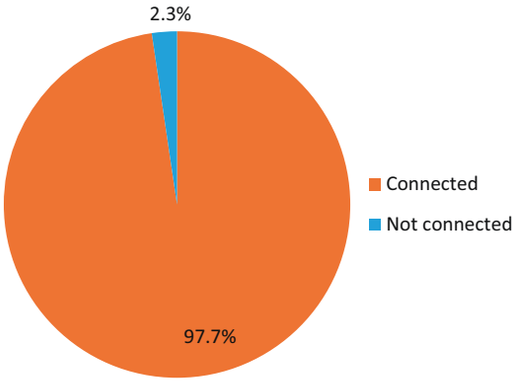


Figure 33: Electricity access in Jharkhand

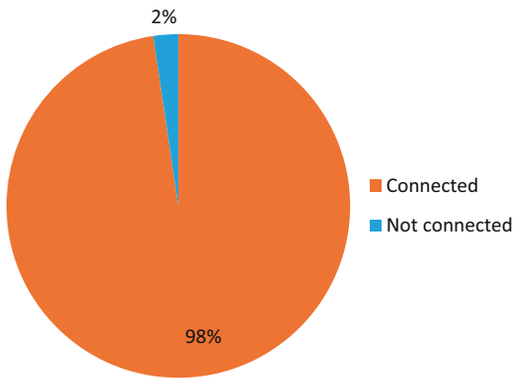


Figure 34: Quality of electricity supply in Jharkhand

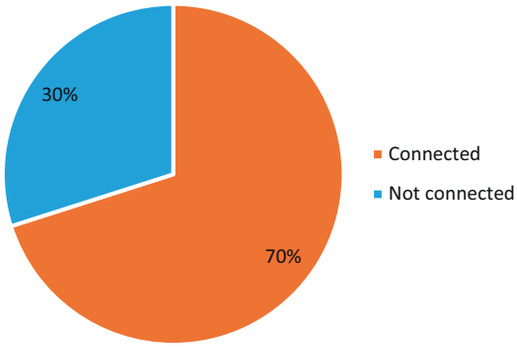


Figure 35: Electricity access in Chhattisgarh

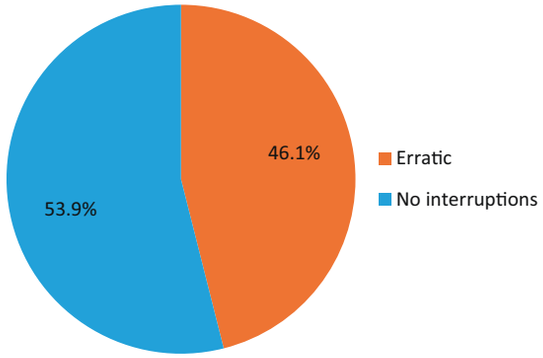


Figure 36: Quality of electricity supply in Chhattisgarh

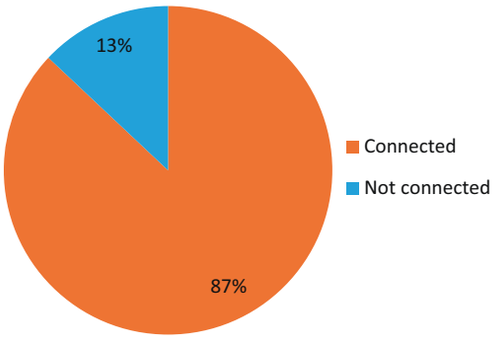


Figure 37: Electricity access in Odisha

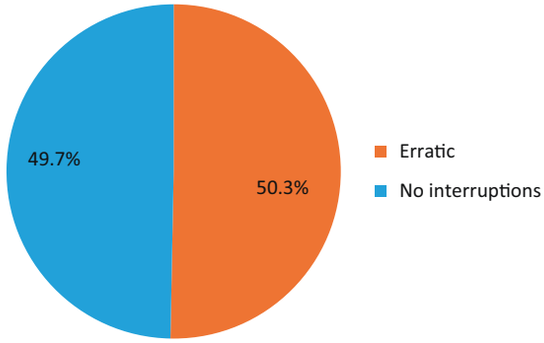


Figure 38: Quality of electricity and electricity supply in Odisha

Jharkhand's high rate of grid connection (97.7%) is undermined by the erratic nature of the supply, with 99.6% of connected households experiencing interruptions in the form of either daily load shedding or seasonal blackouts (Figure 33). Such unreliable supply affects daily life, limiting the use of electrical appliances, hindering children's education due to inconsistent lighting, and impacting healthcare delivery, particularly in the use of medical equipment. Economic activities, especially those reliant on electricity, are disrupted, impeding local businesses and agricultural productivity. Unreliable electricity supply exacerbates the challenges faced by residents, including poor economic conditions and limited opportunities for stable employment from illustrated by Figure 34. Erratic power also

affects the functioning of local businesses and healthcare facilities, further increasing the vulnerability of the community.

These findings are also validated by the field interactions in the Lodna No. 7 mine area, Burnpur North Railway, West Birsinghpur, Mahtadih, where electricity is supplied by BCCL and is provided free of charge to the residents. The supply was reported to be erratic, with frequent power outages and unreliable access to electricity with residents of West Birsinghpur gram panchayat claiming that they had blackouts every 2–3 hours. In Mahtadih Gram Panchayat, residents mentioned that their connection is provided by ECL as part of their initiative to provide free electricity in 10 km radius of their operations, but they do not have supply.

Chhattisgarh presents a mixed scenario with 70.1% of households connected to the grid. Among these, 53.9% enjoy a reliable supply, which positively impacts their quality of life. However, the 29.9% without any connection and the 46.1% with erratic supply still face significant challenges. The lack of connection in almost one-third of the surveyed households points to acute energy poverty, with the potential to affect basic needs such as lighting and communications. The communities with erratic supply struggle with similar issues as those in Jharkhand, albeit to a slightly lesser extent. In Govindpur Gram Panchayat of Surajpur district, the mostly OBC residents managed to procure their own electricity connections, indicating the need for public authorities to take positive action towards increasing reliable access to electricity among the local population. The electricity supply is frequently interrupted, and households receive high electricity bills, averaging ₹3000–4000. Despite this financial burden, they prioritize payment to ensure their children's education is not disrupted. Voltage fluctuations are also a common problem, likely affecting the functioning of electrical appliances and potentially causing damage. Puhputra Gram Panchayat's OBC, SC, and ST hamlets also reported similar problems. Residents of Kasalgiri's Gram Panchayat, either OBC or ST, rely on borewells for water, which function only when there is electricity creating a dual dependency, where water access is directly tied to the reliability of electricity supply. While all households have electricity connections, the supply remains irregular, undermining the benefits of universal access (Figure 36).

In Odisha, 87% of households are connected to the grid, with a balanced split between those with reliable and erratic supply (Figure 37). The 13% without any connection face substantial barriers to improving their living standards. The equal division between reliable and erratic supply among the connected highlights a significant quality gap that affects half of the population. This inconsistency impedes progress in healthcare, education, and economic activities, similar to the issues observed in Jharkhand and Chhattisgarh.

In the coal mining areas of Odisha, access to electricity is marred by frequent and prolonged power cuts. The reliability of electricity supply varies by region, but interruptions are a common theme, impacting the daily lives and well-being of residents (Figure 38). In Chhendipada Gram Panchayat of Angul district, residents experience frequent power cuts after midnight, disrupting their sleep and potentially affecting their health and productivity. In the same district, the community receives electricity but endures power cuts for 1–2 hours each day. The duration of these outages increases during the summer, coinciding with peak demand periods when cooling needs are highest. Similar outages were also reported in Rampur Colliery, Brajrajnagar in Jharsuguda where the community faces electricity outages for 2 hours every morning. In Sundargarh's Tiklipara gram panchayat, electricity

supply is available, but residents face 1–2 hour outages daily. During the rainy season, power cuts extend up to 5 hours and can last for 2–3 days at a stretch. This seasonal variability highlights the vulnerability of the electricity infrastructure to weather conditions, exacerbating the challenges during monsoons when reliable electricity is critical for pumping water and other essential activities.

4.3.6. Household cooking fuel

- Jharkhand has a high reliance on coal for cooking (51.9%), reflecting its proximity to coal mines, while adoption of LPG (12.1%) and electricity (6.7%) is low.
- In Chhattisgarh, the use of wood for cooking (75.8%) exposes households to indoor air pollution and health risks, with low use of LPG (8.4%) and electricity (7.0%) highlighting gaps in cleaner fuel availability.
- Odisha shows better LPG adoption (31.5%) compared to Jharkhand and Chhattisgarh, but coal (24.7%) and wood (42.6%) are still widely used.

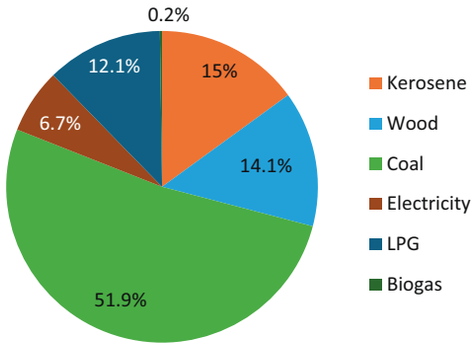


Figure 39: Type of household cooking fuels in Jharkhand

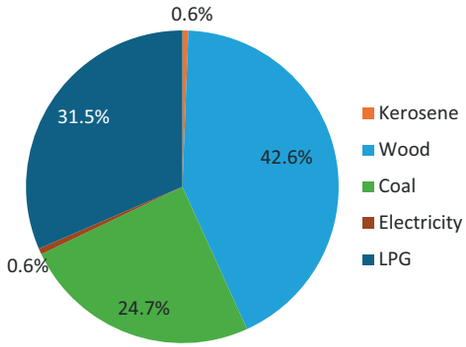


Figure 40: Type of household cooking fuels in Odisha

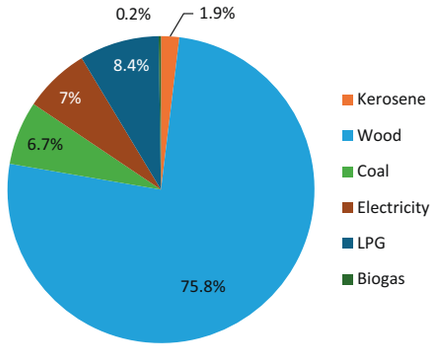


Figure 41: Type of cooking fuels in Chhattisgarh

Jharkhand has an alarmingly high percentage (51.9%) of households using coal as their primary cooking fuel. This is indicative of the proximity to coal mining operations, making coal a readily available but highly polluting option. The use of kerosene (15%) and wood (14.1%) further underscores the lack of access to cleaner cooking fuels. The relatively low

adoption of LPG (12.1%) and electricity (6.7%) for cooking suggests that significant segments of the population remain reliant on traditional and polluting fuels (Figure 39).

Image 7: Women use coal from coal mines as cooking fuels, which cause a lot of smoke

In Chhattisgarh, a striking 75.8% of households use wood for cooking. This high reliance on wood reflects both the accessibility of biomass and the limited reach of cleaner alternatives. The low use of coal (6.7%) contrasts sharply with Jharkhand, but the use of LPG (8.4%) and electricity (7.0%) remains low, pointing to a significant gap in access to modern cooking fuels. The predominance of wood indicates exposure to indoor air pollution and associated health risks (Figure 40).

In Odisha, the use of coal (24.7%) for cooking, while lower than in Jharkhand, still reflects significant health and environmental concerns typical of coal mining regions. A large portion of households (42.6%) depend on wood, further indicating the challenges in accessing cleaner cooking fuels. The relatively high percentage of households using LPG (31.5%) suggests better penetration of cleaner cooking technology compared to Jharkhand and Chhattisgarh. However, the minimal use of kerosene (0.6%) and electricity (0.6%) for cooking reflects limited diversity in fuel sources (Figure 41).

The relatively lower use of LPG in Jharkhand (12.1%) and Chhattisgarh (8.4%) compared to Odisha (31.5%) indicates disparities in access to cleaner cooking technologies. This may be due to economic barriers, inadequate distribution networks, or lack of awareness. The reliance on traditional fuels like wood and coal reflects a state of energy poverty, where communities lack access to affordable, reliable, and clean energy. This hampers overall development, affecting health, education, and economic productivity.

The heavy reliance on coal and wood for cooking in coal mining regions of Jharkhand, Chhattisgarh, and Odisha underscores the urgent need for interventions to promote clean cooking solutions. Ensuring access to cleaner fuels is essential for mitigating health risks, protecting the environment, and supporting a just transition for these vulnerable communities. By prioritizing energy access and sustainability, these regions can move towards a more equitable and healthier future.

4.4. Social Capital

- The closure of coal mines has severely impacted social capital in coal mining regions, leading to increased alcoholism, domestic violence, and a reported breakdown of community relationships, particularly in Jharkhand, Odisha, and Chhattisgarh.
- In Chhattisgarh, mine closures have resulted in heightened uncertainty (30.8%) and indebtedness (29.4%) for many families, along with increased in-migration (19.4%) and rising crime.
- In Odisha, the effects of mine closures include widespread job losses (39.6%), food shortages (37.1%), and a marked increase in alcoholism (5.7%), with domestic violence becoming a significant issue in many communities, especially in Chhendipada and Brajrajnagar.
- Alcohol consumption has escalated in all three states, leading to financial strain, domestic violence, and social breakdown. In regions like Rampur Colliery and Kumbhar Sahi, alcoholism is deeply entrenched, with limited local efforts to curb the problem.

Social capital, the networks and relationships within a community, is crucial in coal mining regions for resilience and adaptation to changes. It encompasses trust, cooperation, and connections that enable communities to mobilize resources and support each other during economic and environmental challenges, such as mine closures and environmental degradation.

High social capital strengthens a community's capacity to address risks and access external support, while low social capital increases vulnerability. As coal mines shut down, strong social capital helps communities navigate transitions more effectively, making it a vital component of a just and equitable transition.

In Chhattisgarh, the closure of coal mines has had significant impacts on both families and local communities. Quantitative data reveals that 3% of respondents reported an increase in alcoholism, while 18.7% noted that their children's education suffered, resulting in increased school or college dropouts. Family feuds affected 4% of respondents, and 9.7% experienced food shortages. A striking 30.8% felt an increase in uncertainty about their future, and 29.4% reported higher levels of indebtedness. Health-wise, 4.3% noted an increase in illnesses within their families.

The local community in Chhattisgarh also faced considerable challenges. Job losses were reported by 23.6% of respondents, and 9.9% noted frequent fights and conflicts. Drinking

among men and youth increased according to 12.1% of respondents. The community saw a rise in in-migration (19.4%) and out-migration (7.5%), both of which affected the social fabric. Local businesses suffered, as reported by 20.4% of respondents, and 7.3% noted an increase in thefts, snatchings, and property-related crimes.

In Odisha, the impact of mine closures on families was equally severe. Alcoholism increased for 5.7% of respondents, while a significant 18.4% reported adverse effects on children's education. Food shortages were noted by 37.1% of respondents, with 40% experiencing increased uncertainty. Although no respondents reported increased indebtedness, 5.7% noted more illnesses within their families.

For the local community in Odisha, job losses were a major issue, with 39.6% of respondents affected. Frequent fights and conflicts increased, as reported by 10.4% of respondents and 16.7% observed a rise in drinking among men and youth. In-migration was less of a problem, affecting only 2.1%, while out-migration impacted 4.2% of respondents. Local businesses were impacted for 4.2% of respondents, and 22.9% noted an increase in thefts and property-related crimes.

Qualitative data from Odisha provides a deeper understanding of these issues. In Kumbhar Sahi, Chhendipada, men typically earn between ₹300 and ₹500 daily but spend much of it on alcohol. This habit remained even after the reduction in income post-coal mining, leading to financial strain on households. Women in Harijan-sahi, Chhendipada, reported that 90% of men drink, leading to domestic violence and further financial issues as men sell household items and supplies to fund their drinking. Similar patterns were observed in Bantabori Sahi, Chhendipada, where illicit liquor consumption has severely affected the youth, causing several deaths.

In Majhi Sahi, Tentuloi GP, as well, alcoholism is a major problem, leading to a sense of insecurity in households. However, in Gothosahi, Gobra GP, a general category dominated village, reported no issues with alcoholism. In contrast, Majhidipo-sahi, Gobra GP, has seen an increase in alcoholism since the start of coal mining, leading to significant domestic violence. Cultural factors play a role, as there is a local saying that a man who doesn't drink isn't considered a man.

Rampur Colliery Brajrajnagar was particularly hard hit, with unemployment leading to increased domestic violence and substance abuse. Women reported that "Rampur is drowning in alcohol and ganja," with domestic violence being the biggest problem in the village. Local authorities have been ineffective in addressing these issues, with reports of councillors encouraging alcoholism.

In Chhattisgarh, similar issues were noted. In Jhilmil-para, Kapsara gram panchayat, alcoholism is a significant problem, with men engaging in domestic violence. Sarna Pada, Old Kumda Basti, saw men drinking regularly but not engaging in domestic violence unless they could afford alcohol. However, in Khakhurpada, Puhputra Village, alcoholism and domestic violence are prevalent. In Teendhari Pada, Piparkhar GP, women reported sexual exploitation following alcohol consumption, although they did not attribute this to coal mining. In Pandrapara, Puhputra gram panchayat, in-migration increased crime, gambling, alcoholism, and cigarette consumption. In Devalapara, Kasalgiri GP, alcoholism was reported to have increased following mine closures, with many women making and selling mahua liquor. This has led to domestic violence and worsening social conditions.

Residents here also mentioned in-migration to the village when coal mining work started—and when the mines closed there was an increase in local crime as people lost employment. In Baraudhi Khas, Baraudhi Gram Panchayat, half the village makes alcohol, and half the village drinks, with 90% of village problems and conflicts attributed to alcohol.

In Jharkhand, the closure of coal mines has severely impacted social capital, contributing to widespread issues with alcoholism and domestic violence. In Lodna No. 7 mines area, the community continues to struggle with significant levels of alcohol consumption, leading to frequent domestic violence incidents. This pattern is echoed in West Birsingpur GP, where alcoholism is pervasive, and domestic violence has left women particularly shaken by its horrors.

In the vicinity of Lodna No. 7 mines, closure of coal mines and the subsequent economic downturn was evidenced by significant outmigration as residents sought alternative employment opportunities. Many individuals turned to work as labourers or drivers, earning modest daily wages. Migration to bigger towns is common due to lack of local employment, leading to additional expenses and minimal remittances back home. Some own vehicles they drive for commercial purposes, while others aspire to be drivers or cricketers, inspired by the renowned former Indian cricketer Mahendra Singh Dhoni. The closure of mines has impacted the local economy, resulting in a decline in business opportunities and a shift in the employment landscape.

In Mahtadih Gram Panchayat, the problem is compounded by the presence of alcohol shops set up by people who migrated from other states, such as Bihar. These individuals remained in Jharkhand after the mines closed, finding a lucrative business in selling alcohol. Women in Mahtadih are particularly distressed, noting that children are exposed to alcohol consumption early on and internalize these behaviours as they grow up. Despite protests and processions by the women, no effective help has come to address the issue.

At Ena Colliery, Jharia, the situation is similarly dire. Alcoholism is rampant, and domestic violence is a common outcome. Women in the area also consume tobacco, with men spending as much or more than they earn on alcohol. Women spend approximately ₹10 daily on tobacco, illustrating a cycle of substance abuse that affects both genders.

These findings underscore the severe social impacts of coal mine closures, highlighting the need for a just energy transition that addresses the economic and social vulnerabilities of these communities. Ensuring stable employment, access to education, and effective social support systems are critical to mitigating the adverse effects of mine closures and fostering resilience in affected communities.

4.5. Financial Capital

- Financial capital in coal mining regions is often limited.
- The heavy reliance on the coal mono-economy in regions like Jharkhand, Odisha, and Chhattisgarh further exacerbates financial insecurity.

Financial capital refers to the monetary resources individuals, households, or communities have access to, including income, savings, credit, and assets. In coal mining regions,

financial capital plays a crucial role in determining resilience and adaptability, particularly in the face of economic shifts like mine closures. Communities with higher financial capital have greater capacity to diversify their income sources, invest in new livelihoods, and absorb shocks, while those with limited access face heightened vulnerability. Assessing financial capital is essential for understanding the economic stability of coal-dependent regions and for planning effective interventions during transitions.

Coal mining regions in India are often characterized by a high degree of economic dependency on the coal mono-industry. The livelihoods of workers, the economic stability of local businesses, and the financial health of households are intricately tied to coal mining activities.

4.5.1. Investments and savings

- In Jharkhand, 68.7% of households save in banks, reflecting relatively higher financial inclusion, but 16.9% still rely on cash savings at home, while 14.4% invest in riskier local schemes or chit funds.
- Chhattisgarh sees a substantial 42.4% of households saving cash at home, revealing economic vulnerability and limited access to formal banking, although 56.7% do engage with banks.
- The heavy reliance on informal financial mechanisms in Odisha and the cash-saving practices in Chhattisgarh point to significant economic insecurity.

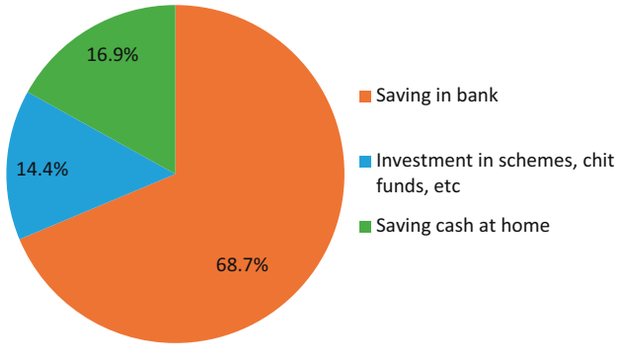


Figure 42: Means of financial investments/saving in Jharkhand

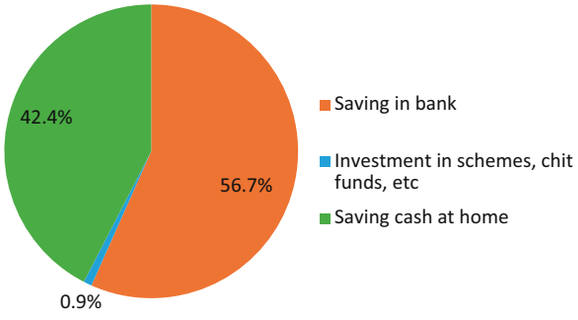


Figure 43: Means of financial investments/saving in Chhattisgarh

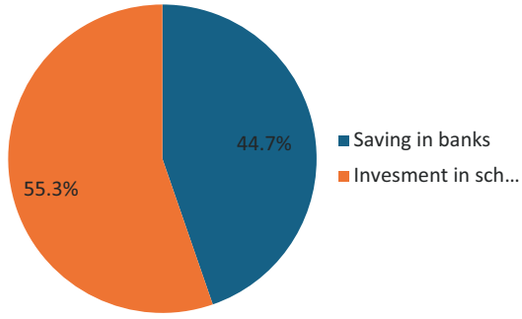


Figure 44: Means of financial investments/ saving in Odisha

In the coal mining regions of Jharkhand, Chhattisgarh, and Odisha, the means of financial investments and savings vary significantly, reflecting the differing levels of financial inclusion and economic strategies among households in these areas. These practices are crucial indicators of the economic resilience and vulnerability of these communities, particularly in the context of coal mine closures and the transition to a just energy future.

In Jharkhand, a majority of the population (68.7%) prefers saving in banks, which suggests a relatively higher level of financial inclusion and trust in formal banking systems. This is indicative of a community that, despite the economic challenges posed by coal mining and its associated health and environmental issues, has managed to engage with formal financial institutions. However, a significant portion (16.9%) still relies on saving cash at home, reflecting a level of mistrust in formal systems or possibly issues of accessibility. Additionally, 14.4% invest in local schemes or chit funds, which are informal financial instruments that can offer higher returns but also carry greater risks (Figure 42).

In Chhattisgarh, the financial landscape is markedly different. A substantial 42.4% of households prefer saving cash at home, highlighting a potential lack of access to or trust in formal financial services. This high reliance on cash savings can expose households to risks such as theft or loss and indicates economic vulnerability. Only 0.9% of the population invests in local schemes or chit funds, suggesting limited engagement with informal financial systems. Nevertheless, a significant 56.7% save in banks, which shows a considerable degree of financial inclusion but still lower compared to Jharkhand (Figure 43).

In Odisha, the financial strategies are heavily skewed towards informal investments, with 55.3% of households participating in local schemes or chit funds. This high reliance on informal financial mechanisms could be due to higher returns or better accessibility compared to formal banking services. However, it also indicates a significant risk of financial instability, as these schemes are often less regulated and can collapse. On the other hand, 44.7% of households save in banks, which reflects a balanced approach between informal and formal financial practices (Figure 44).

These varying financial practices in the coal mining regions underscore the economic challenges and adaptive strategies of these communities. In Jharkhand, the higher engagement with formal banking services may offer more stability and protection for savings, but the significant minority relying on cash savings and chit funds points to underlying vulnerabilities. Chhattisgarh's high rate of cash savings highlights significant economic insecurity and potential barriers to financial inclusion. Odisha's heavy reliance on chit funds suggests a search for higher returns or accessible investment options but also exposes households to greater financial risks.

Understanding these financial behaviours is crucial for designing effective interventions aimed at promoting economic resilience and stability in these regions. Efforts to enhance financial literacy, improve access to formal banking services, and regulate informal financial systems could play a significant role in supporting these communities, particularly as they navigate the challenges of transitioning away from coal-dependent economies.

4.5.2. Loans

- In Odisha, the majority of households (54%) repay small loans under ₹500, indicating a high reliance on short-term borrowing to meet immediate needs, reflecting financial instability and economic vulnerability.
- Chhattisgarh has a significant portion of households (32.3%) repaying larger loans between ₹20,000 and ₹30,000, suggesting higher financial burdens and a greater reliance on larger credit, which may strain household finances.
- Jharkhand shows overwhelming reliance on very small loans, with 82.9% of households repaying loans under ₹500, indicating extreme economic fragility and a need for frequent short-term borrowing to cover basic needs.
- The high prevalence of small loans in Jharkhand and Odisha points to limited financial capacity and access to credit, while the larger loan burdens in Chhattisgarh suggest a different financial dynamic, with greater access to credit but increased debt pressure.
- Addressing these financial vulnerabilities by improving access to affordable credit, enhancing financial literacy, and supporting income-generating activities will be crucial for building economic resilience in these coal mining regions during the transition away from coal dependency.

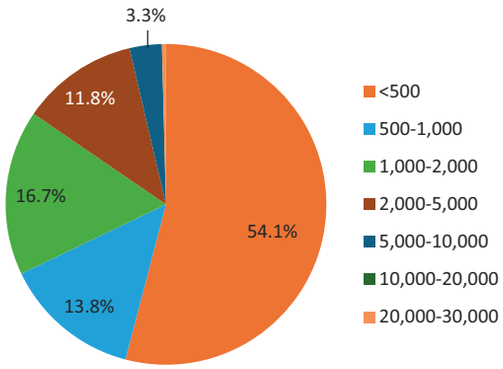


Figure 45: Annual loan repayment in Odisha

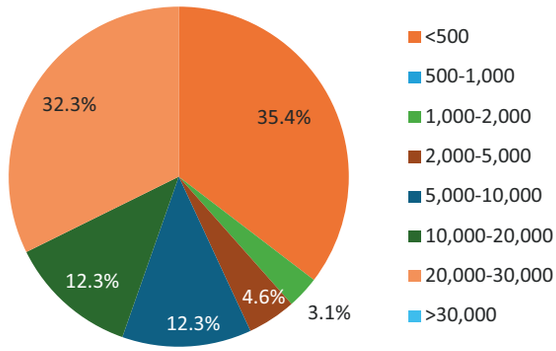


Figure 46: Annual loan repayment in Chhattisgarh

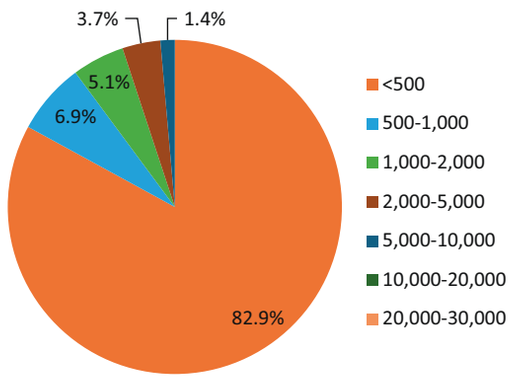


Figure 47: Annual loan repayment in Jharkhand

In the coal mining regions of Odisha, Chhattisgarh, and Jharkhand, the patterns of loan repayment reveal significant differences in the financial burdens and economic resilience of households. These patterns are indicative of the broader economic circumstances and the challenges faced by these communities, particularly as they deal with the impacts of coal mine closures and the need for a just transition.

In Odisha, the majority of households (54%) repay loans amounting to less than ₹500, suggesting that small, short-term loans are common. This reflects a high reliance on borrowing for immediate needs and indicates financial instability as shown in Figure 45. The next largest group, 16.7%, repays loans between ₹1,000 and ₹2,000, followed by 13.8% in the ₹500 to ₹1,000 range. Loans larger than ₹5,000 are relatively rare, with only 3.3% repaying loans between ₹5,000 and ₹10,000 and a mere 1% repaying loans between ₹20,000 and ₹30,000. This distribution suggests that while small loans are common, larger financial commitments are less prevalent, possibly due to limited access to credit or reluctance to incur significant debt. The predominance of small loan repayments indicates economic vulnerability and a reliance on short-term borrowing to meet basic needs.

In Chhattisgarh, the loan repayment landscape is quite different. Only 35.4% of households repay loans of less than ₹500, indicating that small loans are less common compared to Odisha as shown in Figure 46. A significant portion of households (32.3%) are repaying loans in the ₹20,000 to ₹30,000 range, highlighting a substantial financial burden. Additionally, 12.3% of households repay loans between ₹5,000 and ₹10,000 and another 12.3% between ₹10,000 and ₹20,000. This pattern suggests that households in Chhattisgarh are more likely to take on larger loans, which could be indicative of higher financial needs or better access to credit. However, the high repayment amounts also suggest a significant debt burden, which can strain household finances and contribute to economic instability.

In Jharkhand, the overwhelming majority of households (82.9%) repay loans of less than ₹500, indicating a high reliance on very small loans as depicted in Figure 47. This is a clear sign of economic fragility and suggests that households are frequently borrowing small amounts to meet their immediate needs. The next largest group, 6.9%, repays loans between ₹500 and ₹1,000, with very few households repaying loans larger than ₹1,000. This distribution underscores the limited financial capacity of households and their heavy dependence on small, short-term credit. The lack of larger loans suggests restricted access to credit or an aversion to incurring significant debt, further highlighting the precarious financial situation of these communities.

The loan repayment patterns across these regions paint a picture of economic vulnerability and the heavy reliance on short-term borrowing to meet daily needs. In Odisha, the dominance of small loan repayments suggests limited financial stability and frequent borrowing to cover basic expenses. In Chhattisgarh, the presence of larger loan repayments indicates a significant debt burden and the potential for financial strain, despite better access to credit. In Jharkhand, the overwhelming reliance on very small loans underscores the precarious economic situation and the immediate financial needs of households.

Understanding these loan repayment patterns is crucial for designing interventions aimed at improving financial stability and resilience in these communities. Efforts to enhance access to affordable credit, improve financial literacy, and support income-generating activities can help reduce the reliance on short-term borrowing and build a more secure economic future. As these regions transition away from coal-dependent economies,

addressing the financial vulnerabilities of households will be key to ensuring a just and sustainable transition.

4.5.3. Purpose and nature of loans

- In Jharkhand and Odisha, a significant portion of loans are taken for non-productive purposes such as marriage and repaying older debts, trapping households in a cycle of debt without contributing to income generation or asset building, leaving them financially vulnerable.
- Chhattisgarh shows lower levels of productive loans for agriculture, education, and health, limiting opportunities for communities to invest in skills or alternative livelihoods, reducing their ability to adapt to economic changes like mine closures.
- The reliance on non-productive loans in these coal mining regions reflects limited access to formal credit for economic improvement, with many households turning to informal lenders for immediate social needs, deepening financial instability.
- As coal mines close, households already trapped in non-productive debt are hit hardest, lacking savings, alternative income sources, or investments in education, which severely limits their recovery from job losses.
- Addressing this cycle of non-productive debt requires promoting access to productive loans and enhancing financial literacy to encourage investments that build assets and diversify income sources, making these communities more resilient in the face of economic transitions.

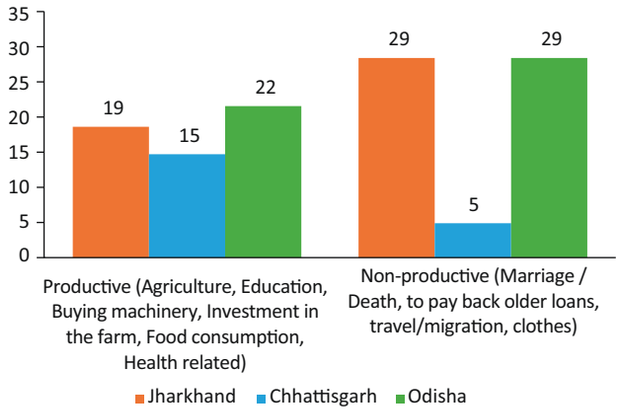


Figure 48: Purpose of loans in coal mining regions

An analysis of the purpose of loans taken shows that the high prevalence of non-productive loans in Jharkhand and Odisha, where more loans are directed towards social obligations or repaying existing debts rather than contributing to income generation or asset building.

The graph illustrates the purpose of loans taken by individuals in coal mining regions across three states—Jharkhand, Chhattisgarh, and Odisha. The data categorizes loan purposes into two main types: productive (for agriculture, education, machinery, farm investment,

food consumption, and health-related expenses) and non-productive (for marriage, death, repaying older loans, travel, migration, and clothing).

In regions such as Jharkhand and Odisha, a large proportion of loans are for non-productive purposes such as marriage and repaying existing loans. This trend points to a cycle of debt where households are forced to take loans for social obligations or to cover previous debts. Such borrowing offers little to no financial return, leading to a continuous dependence on credit without improving economic resilience. Communities are left financially fragile, with no savings or assets to cushion against economic shocks, particularly when coal mines close and primary livelihoods are lost.

Productive loans—intended for agriculture, education, or health—are generally more beneficial in improving the economic standing of households. However, the lower level of such loans, especially in Chhattisgarh, suggests that these communities may not have sufficient access to credit for improving their livelihoods through investment in skills, education, or farming. This underinvestment in productive areas reduces their ability to diversify income sources or adapt to changes in the labour market, such as the closure of coal mines.

The data suggests that financial inclusion in these regions is skewed towards loans for non-essential or non-productive purposes, indicating that access to formal credit for economic improvement is limited. Households may rely on informal money lenders or microfinance institutions that offer loans for immediate social needs but fail to support long-term economic stability. This limitation further deepens the vulnerability of coal mining communities who are already at risk due to the volatility of the coal industry.

As coal mines close or reduce operations, communities that are already trapped in cycles of non-productive debt are hit hardest. With little investment in education or alternative livelihoods, they are less likely to recover from job losses. The reliance on loans for consumption, marriage, and social functions reveals a lack of savings and economic planning, meaning that the closure of coal mines leaves these households without a safety net or an alternative source of income.

Loan-taking behaviour in coal mining regions exacerbates the vulnerabilities of the communities by perpetuating a cycle of non-productive debt. The emphasis on loans for social and non-productive purposes highlights the economic fragility of households, leaving them ill-prepared for the financial shocks that accompany coal mine closures. To mitigate these vulnerabilities, there is a critical need to promote access to productive loans and financial literacy programmes that focus on building assets and diversifying income sources in these regions.

4.5.4. Income

- In Odisha, coal mining had a mixed impact, with 30.1% of respondents reporting increased income, but 39.8% seeing no change, and 30.1% experiencing a decrease. Following mine closures, 41.9% reported a decrease in income, highlighting the reliance on coal for livelihoods.

- In Chhattisgarh, 36.6% of respondents saw increased income during coal mining activities, while 35.7% experienced a decline. After mine closures, 45.3% reported a drop in income, indicating substantial economic challenges for a significant portion of the population.
- Jharkhand experienced the most severe impact from coal mine closures, with 97.4% of respondents reporting decreased income, showcasing the region's extreme dependence on coal mining for economic survival.
- The overall data reveals that while some communities benefited economically from coal mining, a significant number either saw no change or experienced income declines, especially after mine closures, with Jharkhand facing the worst impact.
- These findings highlight the urgent need for a just energy transition that focuses on sustainable economic diversification, re-skilling programmes, and social safety nets to mitigate the economic distress caused by the closure of coal mines.

Odisha

The impact of coal mining activities and subsequent coal mine closures on the income of local communities in Odisha, Chhattisgarh, and Jharkhand reveals a complex and multifaceted economic landscape. These regions, heavily dependent on coal mining for livelihoods, experience significant fluctuations in income based on the operational status of the mines.

In Odisha, coal mining activities had a mixed impact on local incomes. Approximately 30.1% of the respondents reported an increase in income due to coal mining activities. However, for a larger segment of the population (39.8%), income levels remained unchanged, indicating that the benefits of coal mining were not universally experienced. Another 30.1% of respondents saw their incomes decrease, highlighting the economic disparities and potential negative impacts on certain community segments.

The closure of coal mines in Odisha presented a different picture. A substantial 41.9% of respondents reported a decrease in income following mine closures, underlining the heavy reliance on coal mining for their livelihoods. Only 10.4% saw an increase in income, while for 47.7% of the population, income levels remained the same, suggesting either stability in alternative income sources or insufficient impact from the mine closures.

Chhattisgarh

Chhattisgarh's experience with coal mining activities also demonstrated varied economic outcomes. A significant 36.6% of respondents experienced increased income from coal mining activities, reflecting substantial economic benefits for a portion of the community. However, 27.7% of respondents saw no change in their income, while 35.7% experienced a decline, indicating that the economic benefits of coal mining were not evenly distributed.

The closure of coal mines in Chhattisgarh had a pronounced negative impact on incomes. A notable 45.3% of respondents reported a decrease in income post-closure, reflecting the economic challenges posed by the loss of coal-related employment. Only 6% of respondents experienced an increase in income, while 48.7% reported no change, indicating that for nearly half the population, the economic impact of mine closures was neutralized by other factors.

Jharkhand

Jharkhand presents the most dramatic case regarding the impact of coal mine closures on income. An overwhelming 97.4% of respondents reported a decrease in income following the closure of coal mines, highlighting the extreme dependency on coal mining for their livelihoods. A negligible 1.1% saw an increase in income, and only 1.6% experienced no change, underscoring the severe economic distress caused by the cessation of mining activities.

The data across these three states paints a stark picture of the economic volatility faced by communities dependent on coal mining. During active mining periods, there were instances of increased income, but these benefits were not uniformly felt, with significant portions of the population either seeing no change or a decrease in income.

The closure of coal mines exacerbates economic vulnerabilities, with a majority of respondents across all states reporting decreased income. This trend is most severe in Jharkhand, where almost the entire population felt the adverse economic impacts. Chhattisgarh and Odisha also show significant portions of their populations experiencing income decreases post-closure, though with some variance in the extent of impact.

This data underscores the critical need for a just energy transition that considers the economic dependencies of these communities. Policies must address the immediate loss of income and focus on sustainable economic diversification, social safety nets, and re-skilling programmes to ensure that the transition away from coal does not leave these communities in economic despair. The goal should be to create resilient local economies that can withstand the closure of coal mines and provide stable and equitable income opportunities for all residents.

5. Conclusion and Way Forward

Coal mining offers opportunities to many upstream and downstream sectors but it also brings ensuing human and environmental risks. This needs the adoption of a fair transition paradigm that addresses climate change mitigation while also assuring the protection of workers, communities, and businesses, as well as economic advantages.

The fundamental question that crops up here whether 'transition away from coal and switching to a cleaner choice' is a utopia or is it a plausible construct that may be translated into a reality in a phased manner. It indeed calls for a sustained policy push, simultaneous and multi-pronged approaches towards a balanced socio-economic growth and scaling of tested solutions across larger geographies. It looks like a tall order; however, a concerted effort towards converting a vicious cycle to a virtuous one is the path ahead. This may be achieved by recognizing basic issues of reluctance to change, lack of local and political will, inadequate preparedness and ability to leverage resources, etc., which would perhaps provide the necessary impetus to adapt to the changing context, eventually ensure a sustainable and a resilient future.

Recommendations and plausible solutions at the local level are as follows -

5.1. Human Capital

» Training and capacity building of district and coal officials: Capacity building efforts should be enhanced by utilizing insights from the Coal Census to sensitize district and coal officials in understanding the ecosystem around coal mining areas. These officials should be equipped to address issues related to contractual workers' profiles, skills, and vulnerabilities while planning for transition strategies that mitigate risks for affected communities.

» Awareness building among affected communities: Educational access and integration into the formal economy should be part of the broader awareness-building campaign. Tailored career guidance and job placement services for local youth, especially girls, backward segments, and those with disabilities, can create equitable opportunities. Vocational training aligned with market needs will also help prepare communities for new job opportunities outside the coal sector.

» Dealing with the consequences of informality: It is crucial to formally integrate a large informal workforce of the coal mining region into the local economy by re-skilling them and offering access to jobs and income opportunities in non-coal sectors. Career guidance and livelihood diversification strategies, including the promotion of ITIs and vocational training, will reduce dependency on coal jobs and increase economic resilience.

» Alternative livelihood creation (re-skilling): The creation of alternative livelihoods should focus on new job opportunities for informal and temporary workers. Re-skilling initiatives should include market-oriented training in association with educational institutions. Promoting entrepreneurship through vocational training, financial literacy, and creating sustainable income opportunities for women and marginalized groups will help mitigate the socio-economic impacts of the transition.

» Gender Sensitive Budgeting for Just transition: Initiatives should ensure gender-sensitive approaches, including targeted re-skilling and women-centric enterprises, and backward

segments. Promoting women-centric business models through micro-enterprises and Joint Liability Groups (JLGs) can significantly impact their economic independence and social capital growth.

5.2. Natural Capital

» Promotion of clean energy infrastructure: Encouraging renewable energy infrastructure, such as solar-based systems, clean cooking solutions, and distributed renewable energy (DRE), should be a priority. Incorporating sustainable water management practices, like water harvesting and groundwater recharging, into state action plans for just transition will improve environmental conditions, ensuring cleaner water and air in coal-affected regions.

» Land reclamation, repurposing, and redevelopment: Repurposing the land available with abandoned or closed coal mines for sustainable agriculture and the promotion of farmer producer organizations (FPOs) should be part of land reclamation strategies. Reviving a land-based economy through sustainable practices can provide long-term income sources for local communities. Additionally, initiatives to promote NTFPs and strengthen supply chains for forest-based products can offer viable livelihood alternatives.

» Containing environmental risks: To address environmental risks, efforts must be made to restore degraded lands and ensure that communities are provided with safe water and sanitation facilities. Further, engagement of scientific research institutes can help coal-dependent regions adopt sustainable environmental management practices, ensuring a smoother transition towards a post-coal future.

5.3. Physical Capital

» Enhancement of social infrastructure: Improving access to basic infrastructure like low-cost housing, sanitation, and healthcare will be critical for the well-being of transitioning communities. Leveraging government schemes, such as the PM Awas Yojana, for low-cost housing solutions in coal belts can help address the needs of landless and informal workers. Mobile healthcare services can also be introduced to enhance community health and prevent disease outbreaks.

5.4. Social Capital

» Leveraging participatory governance mechanisms: Mobilizing local collectives, such as Self-Help Groups (SHGs), farmer cooperatives, and Community Resource Persons (CRPs), to engage in participatory governance mechanisms can foster better local governance. By imparting technical, financial, and entrepreneurial skills, these collectives can actively participate in the decision-making process, ensuring that transition strategies reflect the needs and aspirations of local communities.

» Gender-sensitive development: Campaigning against substance abuse, particularly alcoholism and tobacco use, and providing access to support services like detoxification and counselling should be a part of community enhancement efforts. Empowering women's and youth groups through the formation of cooperatives and imparting leadership skills will further strengthen social cohesion and foster resilience.

5.5. Financial Capital

» Financial Access for Alternative livelihood creation: SHG funds must be tapped apart

from leveraging other avenues such as forming Joint Liability Groups (JLGs) which helps in easier capital uptake. Microenterprises can then be set up through financial literacy, vocational skilling, and entrepreneurship.

» Linkages with financial institutions and market: Collateral-free seed capitals may be made available by the local banks, or the impact investors and CSR fund may be tapped for establishing backward and forward linkages, creating sustainable supply chain, value addition, capacity building, etc.

» Promotion of product-based clusters through Joint Liability Groups: Women-centric business models can also be piloted and scaled through formation of Joint Liability Groups (JLGs) as promoted by NABARD and product-based clusters may be promoted for sustainable livelihoods and impact creation.

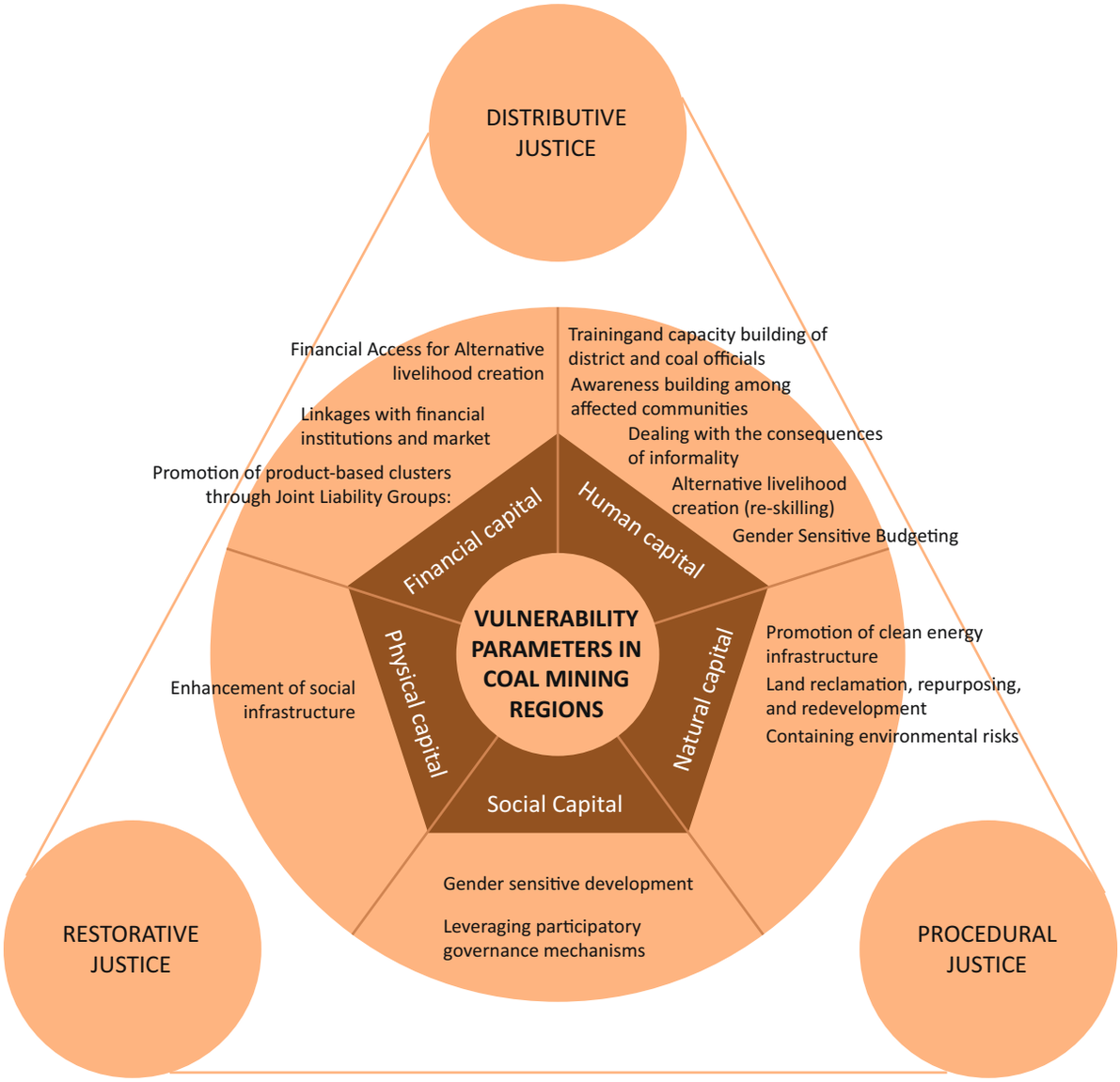


Figure 49: Reversing vulnerabilities and solutions for a sustainable future in India's coal mining regions

The recommendations outlined above directly tie into the Just Transition Framework for a Sustainable Future in India's Coal Mining Regions, particularly the functional aspect of the framework. This aspect addresses key areas of concern identified through the study in coal-producing states like Odisha, Chhattisgarh, and Jharkhand. The recommendations, categorized by human, natural, physical, social, and financial capitals, provide actionable steps that align with the framework's focus on procedural justice, distributive justice, and restorative justice. For instance, the strategies for alternative livelihood creation and addressing informality reflect the socio-economic transformation necessary for distributive justice, ensuring that vulnerable communities have equitable access to new economic opportunities. Efforts around clean energy infrastructure and environmental restoration resonate with the goal of green development for restorative justice, aiming to repair ecological damage while fostering sustainable growth.

This alignment of actionable recommendations with the broader framework ensures a well-rounded and holistic transition, where local-level policy and governance transformations are matched with practical, community-centred interventions. In essence, the recommendations provide a roadmap for tackling immediate concerns while supporting the long-term goals of a just transition as envisioned in the framework.

References

1. Abraham, J. (2017). Just transitions for the miners: Labor environmentalism in the Ruhr and Appalachian coalfields. New Political Science, 39 (2), 218–240.
2. Healy, N., & Barry, J. (2017). Politicizing energy justice and energy system transitions: Fossil fuel divestment and a "just transition". Energy policy, 108, 451–459.
3. United Nations Framework Convention on Climate Change. (1992). United Nations Framework Convention on Climate Change.
4. Henry, M. S., Bazilian, M. D., & Markuson, C. (2020). Just transitions: Histories and futures in a post-COVID world. Energy Research & Social Science, 68, 101668.
5. United Nations. (2015). Transforming our world: The 2030 Agenda for Sustainable Development. United Nations.
6. International Labour Organization. (2015). World employment and social outlook: Trends 2015. International Labour Office.
7. United Nations Framework Convention on Climate Change. (2023). Summary for policymakers: Global stocktake report for COP28. UNFCCC.
8. Ministry of External Affairs. (2023). G20 New Delhi leaders' declaration. Government of India.
9. Johnstone, P., & Hielscher, S. (2017). Phasing out coal, sustaining coal communities? Living with technological decline in sustainability pathways. The Extractive Industries and Society, 4 (3), 457–461.
10. Weller, L., & Schmid, S. (2023, September). Navigating the Transition to a Green Economy: The Crucial Role of Skills for Regional and Local Labour Markets. In Pathways of Greening Labour Markets (pp. 309–320). Nomos Verlagsgesellschaft mbH & Co. KG.
11. McCauley, D., & Heffron, R. (2018). Just transition: Integrating climate, energy and environmental justice. Energy policy, 119, 1–7.
12. Ministry of Coal. (n.d.). Production and supplies. Government of India. Retrieved September 27, 2024,
13. Ministry of Coal. (2022, June 14). All India coal production target for the year 2022–23. Government of India.
14. International Forum for Environment, Sustainability & Technology. (2022, November). Informal coal workers: Discussion paper.
15. Eco-Business. (2022, September 7). India's growing informal coal workforce complicates energy transition.
16. Institute for Energy Economics and Financial Analysis. (n.d.). Coal: A heavy burden for Indian Railways.

17. International Energy Agency. (2021). Coal in net zero transitions: Strategies for rapid, secure and people-centred change.
18. Ministry of Coal. (2024). Economic significance of the coal sector: Extends beyond energy production. Government of India.
19. Press Information Bureau. (2022, August 3). Cabinet approves India's updated nationally determined contribution to be communicated to the United Nations Framework Convention on Climate Change. Government of India.
20. Menon, M. (2024, April). India's long road to net zero. The Diplomat.
21. NITI Aayog. (2023). India Climate and Energy Dashboard: Sector-wise coal consumption. ICED NITI Aayog. https://iced.niti.gov.in/energy/fuel-sources/coal/consumption

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