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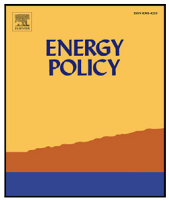

The spatial and economic footprint of the coal industry on rural livelihoods in Jharkhand, India

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ABSTRACT

The socio-economic dimensions of coal mining in India form a complex picture of inter-linked livelihoods and economic dependencies. In this article, we contribute to sharpening this understanding through an analysis of household reliance on coal-related livelihoods. Through a telephone survey of 2000 households, stratified by proximity to active coal mines (within 5 km, 5–10 km, and 10–20 km), we provide new evidence of the spatial nature of formal and informal coal-related employment. Our findings indicate a pronounced concentration of coal-related livelihoods within a 5 km radius of active mines, whereas approximately half of the households in each distance stratum are reliant on casual labour incomes. This work sheds light on the concentrated spatial footprint of extractive industries and broader challenges of employment informality relevant to necessary just transition and rural development policies in India.

1. Introduction

While international climate goals require a sharp decline in coal-mining and use, recent studies describe the continued dependence on thermal power generation infrastructure in India (Oskarsson et al., 2021). Beyond concerns around national energy security, the narrative of the coal industry as an important provider of rural livelihoods and state revenues prevails (Lahiri-Dutt, 2016). In this article, we provide new empirical evidence describing household reliance on coal mining and alternative livelihoods in rural Jharkhand, India.

The existing literature on just transitions in coal mining districts in India has primarily focused on workers within the coal sector, as well as issues of equality and justice in working conditions (see e.g., Pai et al., 2020; Hota and Behera, 2016). In recent years, however, research has broadened to explore the dependence of communities on coal mining, the substitution of traditional livelihoods and practices, and the social and economic changes that arise, acknowledging the varied effects of coal mining on livelihoods in these districts (Reddy et al., 2016; Sahoo and Senapati, 2021; Lahiri-Dutt, 2016; Hota and Behera, 2016; Banerjee, 2022; Bhushan et al., 2020). Despite these advancements, a gap persists in the availability of data concerning the spatial concentration of coal dependence and the perceived significance of the coal industry.

We contribute to addressing this gap by conducting and analysing primary household surveys in rural Jharkhand, one of India's largest coal-producing states. Jharkhand faces many socio-economic and environmental challenges, including high poverty rates, low literacy levels, governance challenges, and high vulnerability to climate change (Jewitt, 2008; Banerjee, 2022). The large informal economy and concentrated coal production in specific districts poses severe challenges in the context of a just transition away from coal (Banerjee, 2022). Labour market frictions such as congestions (many workers potentially looking for new jobs) make an orderly transition to a low-carbon economy difficult and slow (Petrongolo and Pissarides, 2001; Pai et al., 2020; Lim et al., 2023). This highlights why understanding the degree to which local economies depend on coal is important.

We address two related research questions. Firstly, what sources of livelihoods are relied upon in rural villages proximate to coal mines in Jharkhand? Secondly, how does coal-related livelihood dependence manifest at different distances from these coal mines? To answer these

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questions, we use primary data from a telephone survey of 2000 households within distances of 5 km, 5–10 km, and 10–20 km from the nearest mine, conducted during the COVID pandemic. Our findings reveal a livelihood landscape heavily influenced by proximity to coal mines. Agriculture emerges as the primary income source for nearly half of the households in the 10–20 km strata, a prevalence that diminishes closer to the mines where day labour becomes more dominant. Interestingly, retail and trade employment remains relatively uniform. Across all strata, casual (informal) work is the most common employment type, with self-employment being next in prevalence but decreasing closer to the mines. Formal salaried jobs, although less common overall, show an increase nearer to the mines. Coal-related livelihoods are predominantly found within a 5 km radius of active mines, accounting for the primary incomes of at least 11% of households in this area.

The spatial distribution of livelihoods we identify here can inform policies aimed at balancing rural development and just transition strategies in the region. Our research suggests that targeted initiatives offering job training and government-led job investments in areas proximate to coal mines would be welcome interventions. Additionally, policies aimed at casual labourers across rural areas of the state will be necessary. This dual strategy would be an important component of broader rural development efforts, supporting a smoother transition to resilient and decent livelihoods in the state.

2. Literature review

Recent literature increasingly recognizes the need for a just transition away from coal that expands beyond formally employed coal workers (Healy and Barry, 2017; Pai et al., 2020). This is particularly pertinent in rural India, where shifts to community dependency on coal have been forced, replacing traditional livelihoods and leaving lasting detrimental effects on local populations (Reddy et al., 2016; Sahoo and Senapati, 2021). Structural changes caused by coal mining have required communities to develop new livelihood strategies (Reddy et al., 2016; Lahiri-Dutt, 2016; Hota and Behera, 2016; Levien, 2015; Lahiri-Dutt, 2017), altering their occupations and social dynamics (Lahiri-Dutt, 2016; Hota and Behera, 2016). This forced dependency also manifests in various socio-economic and political ways, impacting community decision-making and worker conditions (Pai, 2021; Hota and Behera, 2016). Lahiri-Dutt (2014a) succinctly captures this dismal situation, describing the 'decay in forest-based livelihoods; crumbling social order, declining farming and the shift of peasantry away from farm-based livelihoods; to say nothing of physical displacement by mining' (Chapter 2 Lahiri-Dutt, 2014a, Page 47).

Jharkhand's coal districts are particularly characterized by high rates of informal coal-related livelihood dependencies (Banerjee, 2022). This includes both 'illegal' mining, marketing and distribution of coal due to regulatory limitations on individual entrepreneurship, as well as the informal sector, work and economy, each with various subcategories (Lahiri-Dutt, 2016; Banerjee, 2022). Casual workers make up another tranche of the local coal-reliant population, typically hired through private contractors and enduring low wages with little to no job security. In contrast to most skilled 'formal' coal workers recruited from outside the mining areas, casual and informal workers are often from communities displaced during the course of land acquisition for the coal mines (Lahiri-Dutt, 2016; Hota and Behera, 2016; Reddy et al., 2016). Lahiri-Dutt (2016) calls the relevance of coal from these 'numerable, dispersed producers' as a means to provide livelihoods for the rural poor, 'subsistence coal'. The complex nature of these interdependencies underlines the need for further research to adequately plan a just transition that addresses injustices or at the very least avoids exacerbating them in the process (Lahiri-Dutt, 2014b; Banerjee, 2022).

To address these challenges, new policy interventions are needed to support sustainable and decent livelihoods, reduce inequalities, and diversify economies, particularly in and near coal mining areas (Hota and Behera, 2016; Lahiri-Dutt, 2016; Choithani et al., 2021; Oskarsson and Lahiri-Dutt, 2019; Sahoo and Senapati, 2021). Existing rural livelihood improvement policies, such as MGNREGA and FRA, have not fully mitigated local impacts (Bhushan et al., 2020; Sahoo and Senapati, 2021; Reddy et al., 2016). Furthermore, the effectiveness of efforts by Coal India Limited (CIL) through Corporate Social Responsibility (CSR) activities are contested, underlining the need for better planning, targeting and evaluation (Hota and Behera, 2016).

Spatial analysis has emerged as a critical tool in informing policy interventions in the context of energy transitions. Lim et al. (2023) and Sharma and Banerjee (2021) highlight the importance of geographic factors and frictions in labour market adaptation to green transitions, indicating the need for region-specific policy measures. Pai and Zerriffi (2021) explore possible solutions by evaluating the spatial suitability of solar versus wind energy industries in replacing concentrated extractive industry employment. Weller (2018) adds a critical dimension by examining policy interventions in Australia's coal-dependent Latrobe Valley, emphasizing the potential pitfalls in neglecting the local socio-economic context in spatially oriented policies. The inclusion of spatial economics insights more broadly enriches the understanding of economic activities' geographical dependencies (Rosenthal and Strange, 2004; Anderson, 2011).

The literature collectively emphasizes the need for spatially informed policy interventions tailored to the unique socio-economic landscapes of different regions. Recent work has called for more detailed examinations of the structural change process in coal mining districts and the dependence of livelihoods on coal mining to guide policy interventions in India (Pai and Zerriffi, 2021; Rai et al., 2017). Our research details the spatial concentration of coal-related livelihood reliance in Jharkhand's mining districts, including data on alternative livelihoods and the perceived importance of coal mining and other sectors for local community livelihoods at different distances from active coal mines.

3. Research design

We design a spatially stratified self-weighted sample of 2000 rural households at different distances from currently operating coal mines. Based on data from Pai and Zerriffi (2021) we know that median coal production was approximately 0.3 mega-tonnes (MT) in 2019–20 across $N = 114$ operating mines. 60% of mines produced less than 0.5 MT where as 5% of mines produced greater than 5 MT over this period. Combining this spatial data with the 2011 census, we find that approximately 25% of rural villages in Jharkhand are within 20 km of active coal mines, 9% are within 10 km and 3% are within 5 km. In terms of the rural population in Jharkhand, approximately 28% live within 20 km of active coal mines, 12% are within 10 km and 5% are within 5 km. We use this preliminary analysis to define three strata and our self-weighted sampling design. First, we split the desired sample of 2000 households into equally sized distance strata: within 5 km, between 5 km & 10 km, and between 10 km & 20 km. This gives a sample of 670 households from 67 villages per distance strata. The sample frame from which these villages are selected is shown in Fig. 1.

Villages in each distance strata are then proportionally (sub-)stratified by proximate production, where this is defined as the total coal production from all mines within each strata distance band. The proximate production sub-strata are defined as villages with ≥5MT proximate production and those with <5MT proximate production. The skewed distribution of mine production described earlier in this section motivates this analytical decision. The intention being to ensure that a population-weighted sample does not over-represent either small or very large mines if they are systematically associated with population density. We select villages to be sampled using a probability proportionate to size (PPS) sampling approach (weighted by village population in the 2011 census, the best available administrative data) within each strata, respecting the proportions of proximate production within each sub-strata. This is clearer in the Table 1, which describes the share of

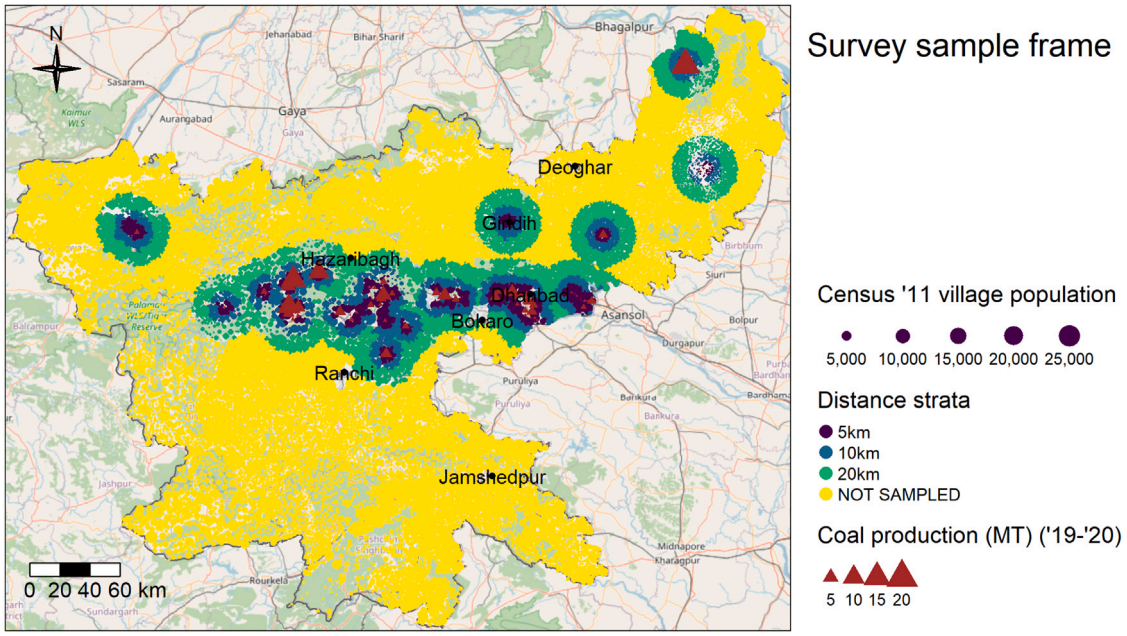

Fig. 1. Overview of the sample frame, describing the location and production (2019–20) of coal mines and the location and populations of rural villages. Urban areas are not sampled, nor shown, barring the identification of cities for orientation purposes. Coal mine data is sourced from Pai and Zerriffi (2021). Rural village data is sourced from the 2011 Indian Census. Basemaps are provided by OpenStreetMap.

Table 1
Overview of the sampling design describing three distinct village strata - 5 km, 10 km and 20 km from a coal mine.

Distance strata	Production sub-strata	Villages	Households	Village share	Household share	Sampled villages
5 km	5MT	222	48 519	0.25	0.22	15
5 km	any	659	171 743	0.75	0.78	52
10 km	5MT	406	84 653	0.25	0.25	17
10 km	any	1194	256 987	0.75	0.75	50
20 km	5MT	1422	283 679	0.33	0.37	25
20 km	any	2897	482 383	0.67	0.63	42

households in each sub-strata and determines how the 67 villages in each strata are split proportionally by proximate coal production sub-strata. Finally, 10 households are selected to be interviewed in each village. The sample of villages is visualized in Figure A1 in Appendix Section A1, highlighting the proportional self-weighted sampling by strata and proximate production.

The surveys were conducted over the phone due to the COVID-19 pandemic. The questionnaire used is available[1] and covered aspects of employment, subjective assessments of the importance of various sectors, trust and preferences with respect to the coal sector and the state government, and household socio-economic and demographic characteristics. The final selection of households to be surveyed was based on voter registration lists in the sampled villages. The enumeration team at Morsel India Ltd. obtained the voter registration lists from the Election Commission of India and then created a random sample of subjects to approach as per standard survey protocols. Permission to conduct these surveys was secured through a local Institutional Review Board (IRB) provided by Morsel India Ltd. and linked to an IRB at Johns Hopkins University (HIRB00013714) to ensure that our study meets best ethical practices. The households' phone numbers were obtained by contacting the local village committee, which helped the team reach the households. This was done with the intent of keeping respondents and enumerators safe given the public health situation. While the survey was conducted by phone, all the usual ethical guidelines were followed as if in person (e.g., informing respondents of their right to stop the survey any time, etc.). Despite our transparently communicated research design, there are a number of potential avenues through which bias can enter such surveys. For example, one bias may be that marginalized households could not be reached because they did not have an active telephone number. Our subsequent discussion of the characteristics of our sample goes some way to alleviating these concerns, however due to our specific sampling strategy, our sample aggregates are not directly comparable to Jharkhand-wide survey aggregates, making comparative assessments challenging. We nevertheless briefly describe these here to contextualize our work. According to the World Bank, the share of people below the poverty line in Jharkhand was 37% in 2012, whereas this aggregate is 75% in our sample (World Bank, 2016). The 2011 census also reveals that about 66% of the population is literate, whereas this is 84% among our sample (GoI, 2011). More recent data was collected by NITI Aayog, who find in 2021 (p.121) that only 5.6% of the state's population lacks electricity, approximately 4% in our sample, and that about 69% use solid cooking fuels, approximately 84% in our sample despite an LPG access rate of 71% (NITI Ayog, 2023). While these aggregates help contextualize our sample, we note that our work is intended to provide evidence specific to coal-mine proximate rural communities and does not reflect the wider sentiment of the population across Jharkhand, not least the urban areas proximate to coal mines.

4. Results and analysis

Table 2 provides an overview of the socio-economic characteristics of the households surveyed. Of note is the share of below-poverty-line (BPL) households, reflecting almost three quarters of the entire sample. Furthermore, historically marginalized scheduled caste and scheduled tribe (SC/ST) households comprise just over a third of the sample. High

[1] https://doi.org/10.7910/DVN/VXVKGU.

Table 2
Summary statistics of the sampled respondents. Expenditures are provided in 2021 INR (November).

Variable	Mean	SD	Min	Max	Median	Missing
Female	0.08	0.28	0	1	0	0
Age	37.19	13.02	18	80	35	0
Literate (Native Language)	0.57	0.5	0	1	1	0
Literate (Hindi)	0.84	0.37	0	1	1	0
Education 10th+	0.37	0.48	0	1	0	0
SC/ST	0.36	0.48	0	1	0	0
BPL	0.73	0.44	0	1	1	0
Adults in household	4.27	2.1	1	22	4	0
One member of trade union	0.02	0.14	0	1	0	0
Working toilet	0.73	0.45	0	1	1	0
Piped water	0.19	0.39	0	1	0	0
Grid connection	0.96	0.19	0	1	1	0
LPG connection	0.71	0.46	0	1	1	0
Owns land	0.82	0.38	0	1	1	0
Rooms in home	3.38	1.83	1	15	3	0
Monthly expenditures	7323.26	4672.79	1000	50 000	6000	2

levels of access to electricity and LPG reflect recent government efforts to roll out energy infrastructure across India, whereas access to piped water remains low. The sample population is largely literate but only a third of respondents reported completing 10th grade. The majority of households own some land, whether for agriculture or domestic purposes. Notably, we find very low rates of reported membership of any household member with any trade union (coal or non-coal related). Summary statistics by sample strata are included in Appendix Section A1.

Fig. 2 describes reported primary household income type and sector within each sample distance strata. Panel A indicates a large informal labour sector across all strata, with almost half of all respondents relying on casual livelihoods. Self-employment follows as the second most common employment type and appears more concentrated in areas proximate to coal mines. Formal salaried employment also grows more common in areas proximate to active coal mines. Panel B shows similarly that the majority of households rely primarily on livelihoods earned through casual labour/day labouring.[2] Agricultural incomes are the most common source of livelihoods in regions furthest from active coal mines, and are increasingly substituted by other sectors in regions proximate to mines. The retail and trades sectors appear consistent by distance strata. In contrast, approximately 11% of surveyed households within 5 km of an active coal mine state that their primary income is derived directly from the coal sector, which reduces to approximately 2% within 5–10 km and less than 1% within 10–20 km.

Reported direct coal dependence in areas proximate to active mines appears lower than expected, however the evidence of widespread informal employment suggests that this may manifest in larger numbers among those informally employed. To explore this vulnerability in measurement, we consider the perceived composition of village economies at different distances from active coal mines. Panel A in Fig. 3 indicates that approximately 72% of all respondents within 5 km of an active coal mine perceive coal to be an important sector for village livelihoods, and Panel B shows that just under half of those *not reporting to work in the coal sector* believe the coal sector is important for their household livelihoods (without revealing how this importance is derived). One could infer that casual 'other' livelihoods reported in Fig. 2 are indeed masking coal sector informality. Respondents might be hesitant to report this due to concerns about potential repercussions or simply because they have multiple sources of livelihood. This would partially explain the disconnect found in Panel C in terms of perceived loss of income of the main income earner (in most cases the respondent), who may not willingly admit that their own income is directly drawn from the coal sector and would be affected by coal mine closures for the reasons mentioned above.

[2] Households reporting 'other' were asked to clarify in their own words what this referred to. The overwhelming majority stated casual labour/day labour.

The results in Figs. 2 and 3 are arguably somewhat endogenous to increasing rates of remoteness associated with further distance from coal mines in Jharkhand. Nonetheless, it is notable that the coal sector exhibits the largest shift in perceived importance across all sectors, dropping from approximately 72% (in stratum <5 km) to just over 23% (in stratum 10–20 km), which is indeed even larger than shifts in the agricultural sector. Aligning with the results in Fig. 2, trades/manufacturing and retail exhibit the least shifts in perceived importance. It would appear that coal sector dependence, while challenging to measure due to high rates of informality, nevertheless exhibits high spatial concentration in close proximity (<5 km) to active mines.

We now turn to household perceptions of the coal industry and preferences for policies addressing job loss in case of nearby mine closer. Panel A in Fig. 4 indicates the perceived performance of the coal company (a colloquial term for Coal India Limited) in improving key community services appears concentrated around water and electricity supply, although the consensus is broadly of little improvement across the services we explored. Panel B shows that corresponding trust in the coal company to improve local livelihoods is far lower than the state government. Trust in the coal sector to improve local livelihoods appears to grow somewhat in proximity to coal mines, while trust in the state is far higher and broadly consistent across distance strata. Although the coal mining sector is often linked to local development and livelihoods in rural areas, it would appear that this is limited to areas proximate to active mines (<5 km). Even among this proximate population, it is a minority perception that any real benefit to basic community services or trust in future livelihood improvements can be attributed to the coal sector.

Fig. 5 reports household preferences for policies addressing job loss due to hypothetical nearby coal mine closure. Panel A indicates that both job guarantees (100 days unskilled manual labour) and free job/trade training are broadly attractive policies in case of mine closure. Panel B shows that there is a clear preference for new job investments (considered important by approximately 80% of households sampled) to occur in nearby villages rather than the state capital. While we see quite uniform aggregates across the distance strata, it is important to recognize that these are subjective preferences among a specific subset of households proximate to active mines in rural Jharkhand (approximately 28% of the state population). These preferences exist in a context of severe livelihood informality and high rates of poverty, and were captured in the midst of the global COVID-19 pandemic. Thus, while not informative for broader long-term efforts to pursue a just transition in a state with large coal sector revenues, these findings do provide bottom-up evidence of the immediate desire for government investments in training, job-guarantees and industrial development in poorer rural areas proximate to active coal mines in Jharkhand.

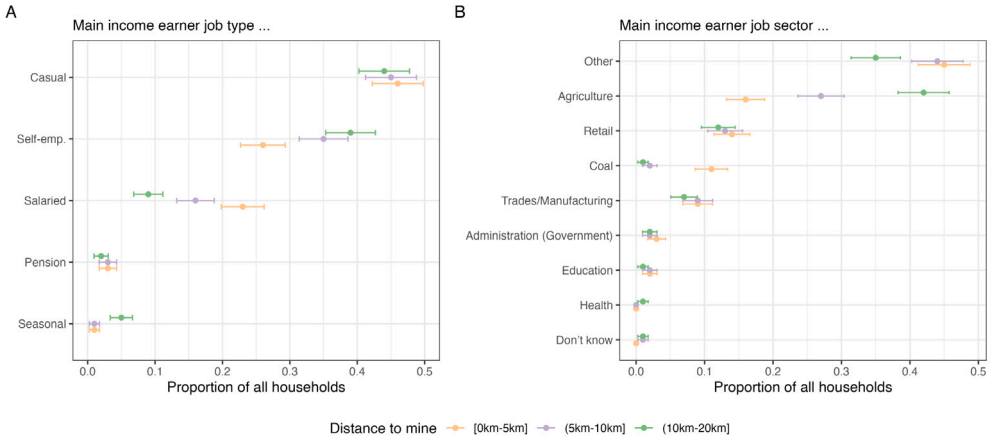

Fig. 2. Reported direct dependence on the coal industry for primary household incomes. Panel A: type of employment for the main income earner. Panel B: rate of employment in each sector for the main income earner. Aggregates are stratified by distance to coal mine. Error bars indicate the 95% confidence interval around the sample proportion.

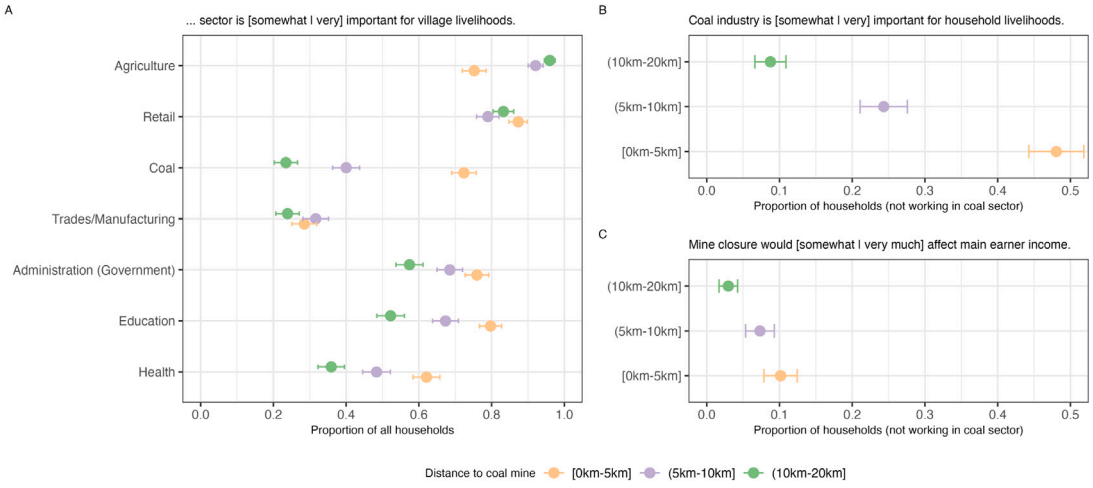

Fig. 3. Village livelihoods and the perceived importance of the coal industry. Panel A: perceived importance of different sectors for all households. Panel B & C: perceived importance of coal and real sensitivity to coal mine closures from the perspective of households not directly depending on the coal industry for livelihoods. Aggregates are stratified by distance to coal mine. Error bars indicate the 95% confidence interval around the sample proportion.

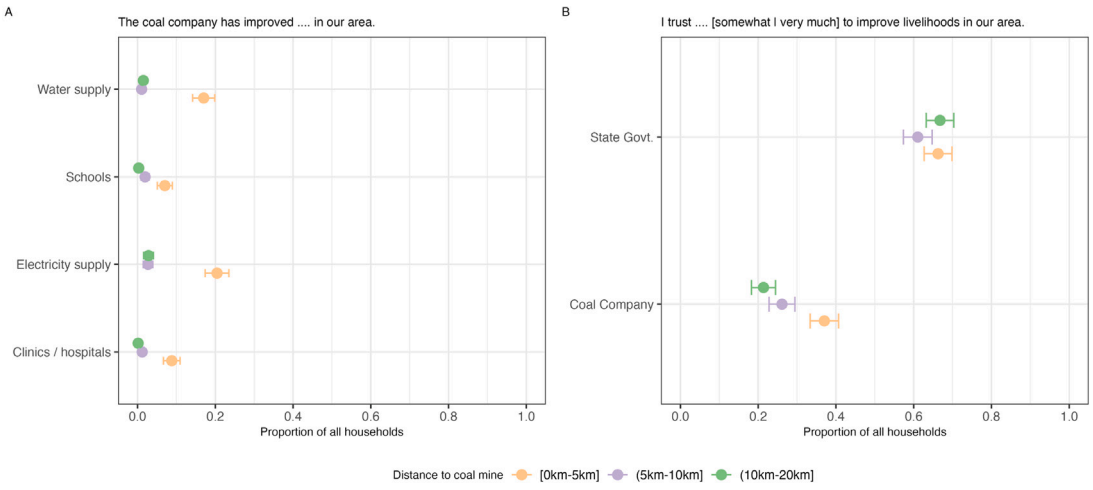

Fig. 4. Perceived improvements to community services and trust in the coal industry. Panel A: reported rate of community service improvements by the coal company. Panel B: perceived trust in the coal company to improve local livelihoods. Panel C: perceived trust in the state government to improve local livelihoods. Aggregates are stratified by distance to coal mine. Error bars indicate the 95% confidence interval around the sample proportion.

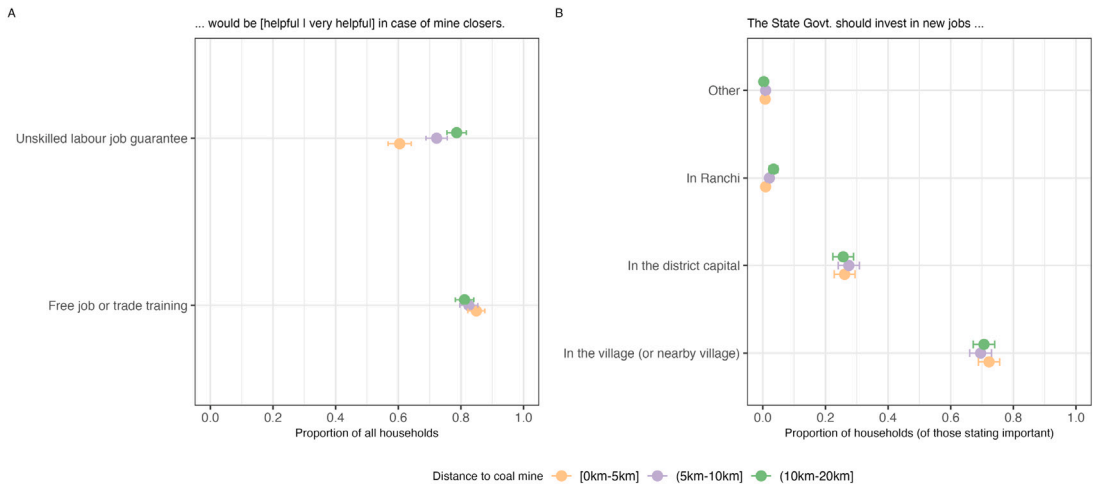

Fig. 5. Preferences on policies addressing job loss in case of nearby mine closer and preferred location of investments in non-coal jobs. Panel A: preferences on policies addressing job loss in case of nearby mine closure. Panel B: preference for location of new job investments by the State Govt. among households who perceive this as important (>80% of respondents indicated this to be important or very important). Aggregates are stratified by distance to coal mine. Error bars indicate the 95% confidence interval around the sample proportion.

5. Conclusion and policy implications

In this article we present the results of a targeted telephonic survey of coal mine proximate households in rural Jharkhand, India. We explore two related research questions. Firstly, what sources of livelihoods are relied upon in rural villages proximate to coal mines in Jharkhand? Secondly, how does coal-related livelihood dependence manifest at different distances from these coal mines? In answering these research questions we rely on descriptive aggregates across different distance strata from active coal mines.

Our findings reveal a distinct spatial relationship between coal extraction and the prevalence of different livelihood sources and types in rural Jharkhand. Agricultural livelihoods decline while day labour and coal sector livelihoods increase closer to active mines, particularly in areas within 5 km of active mines. Retail and trades sectors are smaller but remain mostly consistent across all three distance strata. Coal sector reliance is concentrated in areas close to active mines (less than 5 km of active mines), however, only 10% of surveyed households indicated that the coal sector was their primary source of livelihoods within this stratum. Further analysis of perceived sectoral importance at the household and village level suggests that informal coal sector dependence is likely under-reported. Nevertheless, we argue that even after considering these measurement challenges, our principal finding – that household coal sector dependence rapidly diminishes beyond 5 km from active mines – still holds. We find that past efforts by the coal sector to improve local community services have fallen short and that there is little trust in improvements to local livelihoods through this sector. Rather, respondents place greater trust in the State, with 80% believing that investments in new jobs should occur now and be concentrated in nearby villages and district capitals. Furthermore, respondents confirmed that free job and trade training coupled with an unskilled job guarantee (particularly in regions further from active mines) are helpful policy interventions in case of mine closures.

We develop three policy recommendations based on these findings. Firstly, policy interventions toward a just transition in Jharkhand must consider the spatial concentrations of skills and future employment deficits across the state. Specific just transition interventions and policies addressing formal and informal coal employment must be targeted sharply around active coal mines (<5 km). This includes transition policies and job-related assistance, as well as economic diversification, such as education and retraining opportunities, early retirement programmes, rehabilitation packages (Green and Gambhir, 2020; Choithani et al., 2021). Such policies will likely require an emphasis on the particularly vulnerable informal economy. We also note that while our analysis provides evidence of dependence in terms of household livelihoods, the ecological and socio-cultural impact of coal mining need to be considered in developing local transition policies (e.g. restoring water quality, education) (Dutta Dey and Singh, 2021).

Second, in terms of the use of the district mineral fund (DMF), greater emphasis must be placed on basic service delivery, the use of local resources and indigenous skills and knowledge, and cross-sectoral investment (Shalya, 2020). The DMF and related efforts under corporate social responsibility (CSR) have the potential to enhance local livelihoods, but reforms and critical reflections are needed (Hota and Behera, 2016; Dutta Dey and Singh, 2021; Shalya, 2020). Identified hindering aspects of the implementation of the DMF are short-sightedness, poor planning, and ad-hoc investments. The functioning of the DMF could be improved by committing to long-term planning, review processes, improvements in transparency, and inclusion of affected people in the decision-making to built up trust and balance power (Shalya, 2020). This has important implications given that despite the poor performance to date, Coal India Limited is arguable well-placed to be involved in designing and implementing spatially-concentrated just transition interventions.

Lastly, our results also show that approximately half of all households in each distance strata rely primarily on casual labour incomes. As we note above, while this likely masks coal informality proximate to active coal mines (<5 km), the vast dependence on informal livelihoods across all distance strata must be taken into consideration in the formulation of just transition programmes. While we make the case for spatial targeting above, we also argue that broader policies targeting casual labour are necessary to ensure those most vulnerable are not left behind by energy system transitions that may have wake effects on secondary and tertiary industries. These policies and interventions will necessarily differ given differences in skill-sets and spatial distribution of this population, drawing most likely from the lessons of MGNREGA and other labour-related rural development policies.

In conclusion, our findings emphasize the importance of recognizing the spatial footprint of the coal industry and the corresponding employment deficits when considering rural economic diversification to compensate for mine closures. This is particularly evident for households in close proximity (i.e., within approximately 5 km) of active coal mines. Additionally, the large informal sector necessitates broader policies targeting casual labour to ensure those most vulnerable are not left behind by energy system transitions that may have ripple effects in secondary and tertiary sectors.

CRediT authorship contribution statement

Setu Pelz: Formal analysis, Investigation, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing, Data curation. **Alexandra Krumm:** Writing – original draft, Writing – review & editing. **Michaël Aklin:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Vagisha Nandan:** Data curation, Investigation. **Johannes Urpelainen:** Conceptualization, Funding acquisition, Methodology, Resources, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Setu Pelz reports financial support was provided by Initiative for Sustainable Energy Policy at Johns Hopkins SAIS.

Data availability

A replication archive including the data necessary for the analysis is available here: https://doi.org/10.7910/DVN/VXVKGU.

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Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.enpol.2023.113973.

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