



Unbridled coal extraction and concerns for livelihood: evidences from Odisha, India

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Abstract

Coal mining and its unfavourable consequences have generated global attention. It has further stimulated the paradoxical debate of development and desolation in the contemporary scenario. Since the coal resources are profusely available in India and it is comparatively less expensive, the country has been largely relying on it for its essential and non-essential consumption needs. Coal resources indirectly fulfil many of the modern requirements and comforts. Consequently, mining of minerals in general and coal in particular has become the prime focus. It helps to generate revenue, augment industrialisation and promote employment opportunities in India. Despite these progressive features, the opencast coal mining activities impose serious threats to the livelihood of the local communities. Based on critical review of the relevant literature, the article seeks to exhibit the mineral reserves and coal mining activities at global, national and regional context. The paper has incorporated a special focus on Odisha—a resource-rich state located in eastern part of India. Particularly, the two existing major coalfields—Talcher and Ib valley, situated in western part of the state—have been emphasised. The manifold adverse externalities of the coal mining practices on the livelihood pattern among the affected people have been assessed. Furthermore, the paper aims to examine the mining-induced threats on different livelihood capitals which has given rise to multiple risks and challenges.

Keywords Coal mining · Development · India · Livelihood · Odisha

JEL classification O13 · R11 · Q51 · Q39

Introduction

The rising environmental degradation in the contemporary time has evolved as one of the most complex and catastrophic dilemmas of modernity (Goldblatt 1996). Coal mining practices have further stimulated the paradoxical debate of development and destruction in the contemporary time. The post-globalisation era has given rise to escalating growth of development projects in the resource-rich regions of India (Choudhury and Choudhury 2020). Such areas with infinite ecology are inhabited by a large number of underprivileged people and now they are confronted with displacement,

disintegration and discontents at the altar of greater common good (Roy 1999). Mining of natural resources is one of the major economic activities in post-independent scenario (Mandishekwa 2020). Mining involves an act of excavation with the practice of applying engineering principles on the earth to extract minerals (Rao and Gouricharan 2016). Since the coal resources are profusely available in India and it is less expensive in nature, the country has been largely relying on it for its industrial, electricity and other essential and non-essential consumption needs (Lahiri-Dutt 2016). Consequently, mining of mineral resources in general and coal in particular has become the prime focus of Indian economy. Besides that, coal resource indirectly fulfils many of the modern needs and comforts of the contemporary time. The gross coal production in the world is expected to increase 10 billion tons by the year 2040 and India is expected to be one of the frontline coal-producing countries in the global platform (Prathap and Chakraborty 2019). India is not only the second largest populous country; globally, it is also the fourth largest consumer of electricity (World Coal Institute 2006). The total

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electricity consumption capacity of the country is expected to increase three times from 159 giga watts (GW) in 2014 to 450 GW in 2030 (Conservation action trust 2014). It reflects the possible dependency on coal resources in the coming days. Coal is one of the most crucial fuel resources in India and possibly the largest supplier to the industrial sectors (Uggupta and Singh 2017). In the current scenario, coal is one of the principal sources of revenue and employment generation in India.

Amidst all these progressive aspects, the dark side of it has not been given due importance (Carvalho 2017). Despite facilitating the economic growth, mining and the associated process are responsible for many adverse consequences like natural resource depletion and environmental degradation. Most importantly, it unfavourably affects the lives and livelihood of the individuals who stay in close proximity to the mining areas (Wamer and Jones 2019). Mostly the opencast coalmines produce serious threats to the human community (Hota and Behera 2016). The underprivileged and indigenous people like the tribal communities living in resource-rich areas become the worst affected victims of coal mining. Though they depend heavily on the ecosystem, their livelihood practices are mostly affected by mining practices (Paltasingh and Paliwal 2014; Mishra and Das 2017). It is argued that while the power-privileged people cherish all the benefits, the marginalised sections perish and bear all the brunts (Fernandes 2008). Corporate social responsibility (CSR) practices are undertaken without paying adequate attention to their cultural contexts (Satapathy and Paltasingh 2019). Hence, the time has come for serious contemplation. World Coal Institute (2006) has rightly observed, it is not use of coal, but how coal is used—must be the focus of action. Based on critical review of the relevant literature, the article seeks to exhibit the mineral reserves and coal mining activities at global, national and regional context. The paper has incorporated a special focus on Odisha—a resource-rich state located in eastern part of India. Particularly, the two existing major coalfields—Talcher and Ib valley, situated in western part of the state—have been emphasised. The manifold adverse externalities of the coal mining practices on the livelihood pattern among the affected people have been assessed. Furthermore, the paper aims to examine the mining-induced threats on different livelihood capitals which has given rise to multiple risks and challenges. The ensuing dilemma of development and desolation through debates and perspectives can facilitate a better understanding on the ground reality of mining and its consequences.

Mining, development and desolation: debates and discourses

In India, mining of coal offers a special context as coal is seen as a national icon rather than a mere fossil fuel. This is evident

from existence of a range of laws relating to coal resources and a devoted ministry on coal that is not found in any other country across the globe. Hence, extraction of coal draws considerable attention in India. Agamben (2005) has rightly called coal itself constitutes a ‘quintessential state of exception’. No doubt, coal mining produces enough economic benefits in the form of employment generation, augmentation of income, foreign exchange earnings and tax revenues, and ensures efficient use of energy and accumulation of capital; however, the ecological and social costs attached to it can never be undermined (Roy 2009). This unresolved question pertaining to development and desolation in mining context has been critically addressed by different thinkers and practitioners.

Mining and development: who lose the game?

Though coal mining affects large sections of people, it is the poor who lose the game. It is widely recognised that indigenous population live in geographically isolated forest and hilly areas where natural resources are abundantly available. In India, different tribal groups live in the lap of nature and have a special relationship with ecology so far as their livelihood is concerned (Choudhury 2013). From economic point of view, industries always prefer such resource-rich regions. Furthermore, the extractive industries have a tendency to damage the natural environments for their vested interests. As a result, the indigenous tribal communities residing in such areas or in close proximity depending on the natural capital become the victims of the so-called development (Harriss-White 2006). In fact, the privileged sections could able to cope with the development hazards to some extent by virtue of their access to resources and opportunities, but the less privileged people bear all the pain (Kothari 1996). Hence, the mining and the associated effects produce both winners and losers.

Mining, eviction and violation of human rights

Forceful eviction or involuntary displacement is known to be one of the most perceptible as well as painful consequences of development. The greed for acquiring ample amount of land resources caused massive displacement of people. The principle of ‘greater common good’ is deliberately invoked to justify this act of heartlessness (Roy 2009). Studies show that ethnic minorities like tribals constitute disproportionately large portion of those who experience development-induced displacement (Fernandes 2008). It is a well-known fact that the land owned by marginalised groups cannot be transferred or taken away from them. However, these are desecrated in the name of development (Lahiri-Dutt 2005). The state applies the principle of ‘eminent domain’ enshrined in the legislations like ‘Coal Bearing Areas (Acquisition and Development) Act (CBAA), 1957’ and ‘The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and

Resettlement Act, 2013' (Lahiri-Dutt 2016). The purpose is to demonstrate the ultimate form of authoritarian power to usurp any property of any citizen for coal extraction (Bennett and McDowell 2012). This is nothing but sheer violation of human rights. White et al. (2012) regard such kind of ruthless acquisition of land and abuse of land rights by state or corporate houses as 'new enclosures', while Zoomers (2010) calls it 'the foreignisation of space'. The rehabilitation policy fails to facilitate them to reconstruct their lost life support system and add on to their already marginalised position (Choudhury 2013). The involuntary eviction and resistance can be analysed from different perspectives.

Mining and conflict: individualistic and structural perspectives

Existing literature presents binary view about the resistance of people to the corporations or state to conquer their resource-rich territory. While first perspective gives importance to the individual actors, the other emphasises on the social structure. The local inhabitants being in a position of moral superiority resist the mining projects and feel aggrieved to the invasion by the state into their land marked by tranquillity and sustainability (Kumar 2013). This has been analysed by Lahiri-Dutt (2017) through her extensive research. She claims that in the mining areas of Jharkhand, the deprived and indigenous people exercise a moral claim over coal resources; hence, they mine it illegally. This is often called as informal mining, whereas indigenous groups of Meghalaya invoke the special status given to them in the Indian Constitution to mine coal by exerting a political claim over it. Scott (1985) points out that these actions signify a retaliation or revolt by the weaker sections against the powerful groups to keep their territory unacquired. On the other hand, scholars like Padel and Das (2010) have made attempt to uncover the existing structural factors which portray the ruthless mining companies as reincarnation of capitalism. Furthermore, these invasive coal miners are obsessed only with materialistic and economic benefits and attempt to grab the territory of local indigenous communities identified as tradition-bound, nature-loving, tied-to-the-land with depiction of homogeneity. Livelihood disruption of those communities is one of the vital consequences of mining.

Threat to sustainable livelihoods of marginalised groups

Marginalised groups especially the tribals live in resource-rich areas often regarded as eco-system people (Cernea 1999). Fernandes and Bharali (2014) have focused on the detrimental consequences of unbridled coal extraction on the sustainable pattern of livelihood based on agriculture

and natural resources. Land and forest resources provide them economic support round the year. Hence, loss of access to these resources is a primary cause of pauperisation and economic suffering of deprived sections (Meher 2009). Their woes also get heightened due to the loss of productive assets like livestock and Common Property Resources (CPRs). Consequently, they are forced to adopt industrial pattern of livelihood. Moreover, the self-sustaining and peace-loving communities confront with a range of hardships by losing their life support system. Roy-Burman (1994) highlights the plight of the tribal communities having communal ownership over the land and non-availability of proper record for the same. Consequently, during the initiation of development projects, their claim over the land is not considered (Mohanty 2001). Even the provision of customary ownership of land in Forest Rights Act of 2006 is not seriously implemented (Xaxa 2018). Besides economic practices, extractive industries also put the cultural identities of these communities at stake.

Impact on culture and breakdown of social ties

While analysing mining, its socio-cultural implications are never given due importance. Padel and Das (2010) regard the indiscriminate mining puts the socio-cultural practices of the indigenous communities at risk. They regard the deliberate denial or lack of opportunity for the sustenance of the cultural practices of the communities as 'cultural genocide'. Development interventions in the form of displacement, deforestation and formal-rational production system exterminate several human dimensions of life of which religion is one (Hamilton 1998). Tribal communities are culturally rich and they have a distinct identity with regard to religious practices (Githiria and Onifade 2020). Involuntary displacement dismantles their religious institutions having sacred and symbolic values. The rehabilitation policy designed by the state goes against their cultural world and fails to provide them culturally relevant opportunities to define their very purpose of life. In fact, Fenelon (1998) accuses the rehabilitation policy formulated by the state for 'detrribalising' the tribal communities. They are forcibly made to resettle within a new socio-cultural system. He also adds that their children are brought up within a new pattern of lifestyle where maintaining traditional customs and identity is punished—a process amounting to 'culturicide'. Mining-induced displacement also erodes the social capital, disperses and fragments communities and disturbs the pattern of social organisation, inter-personal ties and cohesion in family structures (Cernea 1999). Environmental deterioration due to mining is a rising concern in the contemporary time.

Environmental corrosion

One of the most visible consequences of mining is destruction of natural environment which gets worsened day by day, giving birth to multiple health and livelihood risks (Gadgil 2016). Environment acts as a prime catalyst of development behind the scene. The human capital formation and economic capital for ensuring welfare of the society largely depends upon natural capital. Hence, damage of natural capital disrupts the associated arenas of life (Costanza et al. 1997). Mining practices misuse the natural capital by considering it as free resources (Gadgil and Guha 1995). It makes perfect economic sense for the extractive industries to impair it rather than spending in technology to adequately treat and securely dispose its wastes. Poisonous emissions detriment the air, water and soil quality, and impose adverse impact upon the human society and also on the flora and fauna. In the contemporary time, sustainable mining practices have become a buzz word.

Sustainable mining: realistic or rhetoric?

The rhetoric of ‘sustainable mining’ is the central theme in the mining, minerals and sustainable development process, formed in a collaborative process by the world’s leading mining companies that prepared an influential report in 2002 entitled ‘Breaking new ground’ (Mining, Minerals and Sustainable Development (MMSD) 2002). Giving equal attention to socio-environmental concerns along with business practices is fundamental to sustainable mining. However, the ground reality provides a different picture as a large number of mining magnates never give adequate heed to it (Padel and Das 2010). The provision of Gram Sabha and prior informed consent of the people are either violated or misused to realise the capitalist agenda (Lahiri-Dutt 2017). As a result, discontents among the affected communities are in rise challenging the structures, discourses and institutions that drive and permit exploitation and dispossession (Harvey 2003).

Dialogues on the issues revolving around mining practices are difficult to be conclusive as the use and misuse of natural resources are debatable. Choosing a right direction between human concerns and economic gain is certainly difficult as both aspects need equal attention.

Coal as economic resources: global and local scenario

The dependency on the coal resources is widely noticed and not confined to any national boundaries. Coal extraction has received local as well as global attention. The developed as well as developing countries having the potential of coal resources have considered coal extraction as one of the viable options to ensure economic prosperity.

Global picture

Coal resources have gathered wide prominence across the globe. It is extracted in many countries beginning from China to the USA and from Russia to the UK and Australia. Mostly it is used as a staple source of energy in smelting of metal and electricity production across the globe. Currently, 37 per cent of the world’s electricity and over 70 per cent of the world’s steel are produced using coal (International Energy Agency 2017). With the growing realisation that mining of coal has significant social and environmental implications, developed countries are in search of clean/renewable energy production. However, most of the developing countries still rely heavily on coal-fired power plants for electricity requirements. As per the latest statistics, the top three coal-consuming countries are China, India and the USA which together account for around 70 per cent of world coal use. Demand for coal (hard coal, brown coal, lignite) has grown by 62 per cent over the past 30 years (Catherine et al. 2012). The International Energy Agency, in its reference scenario, expects coal demand to grow by another 53 per cent up to 2030. Total world coal production increased by 1.5 per cent in 2019, half the growth rate of the previous years (Department of Industry, Innovation and Science, Australia 2019). Asia has played a vanguard role in coal production as the demand for electricity has continued to grow. In 2020, COVID-19 has resulted into 2 per cent drop in total coal production. However, it is expected that the production will hit 8 billion tonnes in 2021 (Sahoo and Senapati 2021). Coal is the single biggest contributor to anthropogenic environmental degradation and climate change. The burning of coal is responsible for 46 per cent of carbon dioxide emissions worldwide (International Energy Agency 2017). As the production of coal is increasing, future days may be more catastrophic. The need for locating an alternative means of energy is increasingly felt. In fact, globally different movements challenging the coal industry’s expansion are taking momentum.

Indian scenario

India is known as one of the leading coal producers and consumers in the world and the country has a massive energy infrastructure of coal. In terms of world coal production, India is ranked as the fourth largest country. Coal India Limited (CIL) is the country’s largest coal company having eight affiliated coal-producing companies. The country continues to significantly rely on coal for power generation, and this abundant and affordable fossil fuel accounts for about 70 per cent of the country’s electricity output. Coal remains India’s most essential fuel and primarily used for electricity generation and industrial production. The share of the coal in power generation is projected to rise from 69 to 71 per cent by the year 2030 in India (Conservation action trust 2014). The

abundance of coal resources and less infrastructure facilities for alternative forms of energy are the prime factors for the increasing dependence of the country upon the black diamond. As per the state-wise inventory of geological resources of coal, India has 50 Gondwana coalfields and 18 tertiary coalfields (Mishra and Pujari 2008). Gondwana coalfields are located in the Eastern, Central and North Eastern regions of peninsular India. This kind of coal was formed about 250 million years ago. The tertiary coal is found in North Eastern India. This is relatively newer as it was formed 15 to 60 million years ago (Coal controller's organisation 2013).

Table 1 depicts the availability of coal reserves in select states of India. Jharkhand, Odisha and Chhattisgarh stand first, second and third respectively in terms of coal deposits in the country. They hold 84.506, 80.840 and 59.908 billion tonnes of coal resources respectively which is near to 70 per cent of the total reserves of the country.

Odisha: a resource-rich state

Odisha, a state located in eastern part of India as an economically developing state with its natural resources and huge mineral reserves, has always received global attention. The state is considered to be one of the fast-growing state economies in India. Now it is noticed as a transitional economy, as it is marching towards industry and service sectors from an agriculture-based economy. Odisha is one of the prominent states in terms of coal use and the largest three fold expansions of coal resources are expected in this state along with Jharkhand and Telangana (Conservation action trust 2014). The mining activities in Odisha have more prominently started during the post-independent period. In an effort to monitor the mining activities, Odisha Mining Corporation Limited (OMC) was established in 1956 as a Public Sector Unit. As per the Mines and Minerals (Development and Regulation) Act of 1957, the Schedule-I is to be administered by the Government of India and coal is listed in this Schedule. Hence, all the coal mines of Odisha are being managed by

the Mahanadi Coalfields Limited (MCL) a subsidiary of the Coal India Limited (CIL) (Mishra and Mishra 2014).

A total inventory of 315.148 billion tonnes of coal reserves is identified by the Geological Survey of India (2018). Out of such huge coal reserves, the amount of prime coking coal, semi-coking coal, non-coking coal and tertiary coal is 5.313, 29.219, 279.028 and 1.5888 billion tonnes, respectively. As per the Odisha Economic Survey Report 2018–2019, coal contributes 86.48 per cent, followed by iron ore (6.61 per cent) and bauxite (2.16 per cent) to the mineral reserves of the state. The share of mining in the state's own revenues has increased from 2.6 per cent in 1990–1991 to 16.9 per cent in 2017–2018. With regard to the contribution of the state to the mineral reserves of India, it possesses 25 per cent of coal. Odisha has two Gondwana coalfields, namely Talcher coalfield and Ib valley coalfield situated in the western part of the state. Opencast as well as underground mines are found in both the coalfields.

Figure 1 indicates the year-wise coal production by MCL in Odisha. During the year 2007–2008, the production of coal was 88.01 million tonnes and it has reached to 144.15 million tonnes in 2018–2019 and reduced slightly to 140.36 million tonnes in 2019–2020. Except during 2010–2011 and 2011–2012, the coal production rate has increased consistently. It demonstrates the increase of coal mining activities in Odisha and the possible huge extraction in the future.

Coal mines are basically found in the western part of the state especially at Angul, Jharasuguda, Sundergarh and Sambalpur districts (Ray and Saini 2011). MCL is spreading over two coalfields, i.e. Talcher and Ib valley. Talcher coalfield is having the pride of highest geological reserve of 51.220 billion tonnes in the country, whereas Ib valley coalfield has the third highest geological reserve of 29.620 billion tonnes (Planning and Convergence Department, Government of Odisha 2019). The total number of mining projects sanctioned to MCL till date is 53. The calculated production capacity of these sanctioned projects is 230.61 million tonnes per year. A total of 37 numbers of projects are already

Table 1 State-wise coal reserves in India (as on 01.04.2019)

Name of the state	Coal reserves (in billion tonnes)	Per cent of total reserves
Jharkhand	84.506	25.88
Odisha	80.840	24.76
Chhattisgarh	59.908	18.35
West Bengal	31.690	9.71
Madhya Pradesh	28.793	8.82
Telangana	21.839	6.69
Maharashtra	12.677	3.88
Others	6.242	1.91

Source: Mahanadi Coalfields Limited (MCL), Odisha

*Others – North Eastern States, Andhra Pradesh, Uttar Pradesh and Bihar (states located in India)

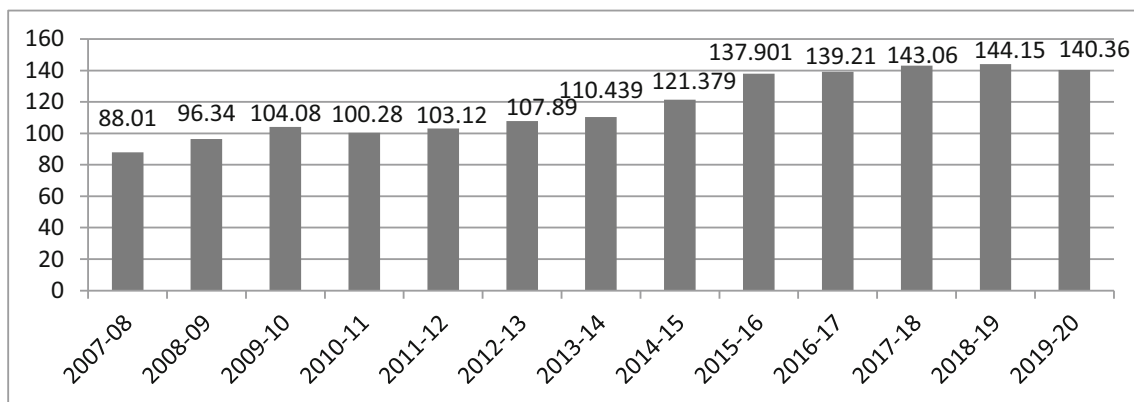


Fig. 1 Coal production by MCL in Odisha (in million tonnes). Source: Information obtained from MCL, Odisha

completed out of 53 projects. Currently, 16 projects are ongoing through Talcher and Ib valley coalfields having capacity of 156.83 million tonnes per year. It is argued that since the mining area of Western Odisha has dense forest resources and inhabited by socio-economically underprivileged people, the mining activity related to coal extraction has been responsible for many adverse consequences (Mishra 2009).

Talcher coalfields

Talcher coalfield is situated in Brahmani valley to the north of Mahanadi river in the Talcher block of Angul district, about 120 km away from Bhubaneswar, the capital of Odisha (Mishra and Das 2017). Currently, 10 mining projects with an area of 15,0966 square km are operating under this coalfield. The total project capacity of these projects is 61.83 million tonnes per year with Rs. 5323.37 crores of sanctioned outlay. Out of the 10 projects, 07 numbers (Ananta, Balaram, Bharatpur, Bhubaneswari, Hingula-II, Jagannath and Kaniha) are opencast projects while 03 (Jagannath, Natraj, Talcher) are underground projects. The projects have harmfully affected the environment and thousands of human lives. The figure is increasing with the expansion of mining activities (Mishra and Das 2017). As per the report by Central Pollution Control Board (2009), Talcher coalfield region has scored 82.09 points and ranked 7th in terms of critically polluted industrial cluster in India. It shows the amount of negative consequences confronted by the region and the possible catastrophes in the coming days. It is equally important to have a glance on the Ib valley coalfields.

Ib valley coalfields

Ib valley coalfield was discovered by Bengal-Nagpur Railway during the construction of a bridge through the Ib river. It has derived its name from this river, a branch of river Mahanadi. Ib valley is the 4th largest coalfields of India (Mishra and Das 2015) spreading over an area of 1375 square km. It is known as one of the store houses of huge thermal grade non-coking

coal which is favourable for power generation. Owing to this reason, its demand is immense. As per the information received from MCL, at present there are total 06 coal mining projects in operation and all are opencast mines. The total capacity of these projects is 95 million tonnes per year with Rs. 8907.89 crores of sanctioned budgets. Despite some developments in the local region through the mining activities, diverse environmental and human hardships are increasing (Mishra 2009). As per the latest report by Central Pollution Control Board (2009), Ib valley coalfield has scored 73.34 points and ranked 28th in terms of critically polluted industrial clusters in India which reflects the possible threats in the coming days. Coal resources and its extraction have substantial impact on the livelihood system of the residing people.

Livelihood implications of coal mining in Odisha

The coal mining and its impact cannot be viewed and analysed only from the perspective of economic development. There are many explicit and implicit consequences of coal mining with both short- and long-term impact. It has multiple consequences as it both directly and indirectly affects the livelihood of the people with a range of adversities (Gadgil and Guha 1995). In India, the total coal consumption is estimated to increase two to three times, i.e. from 660 million tonnes per year to 1800 million tonnes per year by 2030 (Conservation action trust 2014). It indicates the possible magnitude of pollution in the future days (Mulvihill 2020). In generic sense, livelihood involves means of gaining a living and securing the necessities of life (Chambers and Conway 1992). Livelihood system consists of five capitals: human, physical, natural, financial and social (Su et al. 2018). These five capitals produce capacity, and as a result livelihood outputs are ensured. Livelihood risk entails the chance of injury, damage or loss. Threat to the above said capitals produces various livelihood risks, i.e. health, environmental, financial and social which ends up into dispossession among the communities.

According to Giddens (1999), there are two kinds of risks: external and manufactured. External risks are caused due to natural occurrences like floods, plagues and famines and manufactured risks are human made in nature which are at present in the rising trend. Deforestation, global warming, ozone deterioration, ocean acidification, increasing air, water and soil pollution caused by rapid industrialisation are the examples of manufactured risks. This section makes a modest attempt in this direction and seeks to assess the livelihood implications of coal mining in Odisha. Particularly how the livelihood capitals have been threatened giving rise to multiple risks have been investigated.

Impact on human capital

Human capital involves the personal development ability of the individuals, including education, technical competence and health status. Threats to human capital produce health risks. As per an assessment, with the increasing demand of coal resources in India, the carbon dioxide emission may increase from 1590 million tonnes to 4320 million tonnes per year by 2030. The emission of nitrogen oxide and sulphur dioxide is expected to be almost double in the near future and the consequences would be extremely hazardous on human health (Conservation action trust 2014). Due to coal mining practices in Odisha, human capital has received severe blow. Coal mining activities have adversely affected the human health in the form of various water-borne diseases relating to skin and airborne diseases like respiratory issues, tuberculosis, cough and cold, gastric problems and eye problems in the mining areas (Hota and Behera 2015). As a result of contamination of ground water with fluoride, multiple health problems are noticed among people in the surrounding areas at Talcher coalfields (Nanda et al. 2011). The rising air pollution and climate change have made the habitants prone to hazardous diseases relating to the heart and kidney in both the coalfield regions of Western Odisha (Mishra 2015).

Displacement as an important consequence of coal mining mostly caused due to requirement of significant amount of land (Fernandes 2008). Though the concept of displacement involves physical uprooting from the place of habitation, it results into endless socio-cultural, psychological and economic difficulties (Cernea 1997). The displacement issue at the coal mining areas of Odisha is quite significant because the area is largely inhabited by underprivileged people. The major tribal groups living in the mining areas are *Kisan*, *Munda*, *Oraon*, *Kharia*, *Gond* and *Bhuyans* (Mishra and Das 2017). Both coalfields have displaced 7610 number of families. Within a new ecology and changing pattern of living, dissatisfactions among the people are noticed. It is detected that displacement has given rise to several health issues like cold, fever, some water-borne diseases and other health ailments (Ray and Saini 2011). Access to education has been

diminished significantly. In the previous place of habitation, some students were pursuing education; however, the displacement has added on to this educational backwardness in the resettlement area (Amnesty International India 2016). They lack opportunity to demonstrate their capability and express their choices. The infrastructures available in the new resettlement colony are inadequate which is a major cause of resentment (Mishra and Das 2015).

Impact on physical capital

Physical capital comprises the diverse assets used in economic production process. Adverse effects on physical capital generate financial risk. In the context of Odisha physical capital of the people have witnessed significant deterioration at both personal and public front. Agricultural land and CPRs are significant bases on which the livelihood of rural communities is built up. Damage or lack of access to it is the principal source of decapitalisation and marginalisation (Cernea 1999). Development projects especially the mines have the tendency of destructing both the vital sources of livelihood. Expansion of mining activities and massive extraction directly make the agricultural lands and CPRs infertile to produce economic benefits which leads to pauperisation. Due to large-scale mining and heavy layers of coal dust, agricultural lands in both the coalfield regions in Odisha have become unfertile and the farming activity is affected severely (Mishra and Pujari 2008). The access to the agricultural land of the displaced people is restricted. Soon after the displacement, the distance to the workplace of many people has increased. Many people in the post-displacement period have sold their instruments used in agricultural works as they are into new occupations presently. The physical assets used in petty informal works by men as well as women are jeopardised due to displacement and other complications. Most of the women who were doing some petty income generating works are seen to be only involved in the domestic and household work (Mishra 2009). Mining practices have endangered many CPRs consequently that have become unused (Ray and Saini 2011). Roads meant for public use are getting damaged due to increasing conveyance of coal loaded vehicles. In the local villages, the wells, tube wells, ponds and streams are getting polluted and dried up in a faster rate.

Impact on natural capital

Natural capital signifies elements of the natural environment which provides valuable goods and services to the people. Setback to the natural capital yields environmental risk. The coal mining activities result into the loss of forest cover and simultaneously affect biodiversity and animal resources in the forest areas (World Wide Fund for Nature (WWF) 2008). There are evidences of extinction of the endangered plants

with medicinal values and species due to deforestation (Paltasingh and Tyagi 2011). As per the information revealed by Ministry of Coal, Government of India (2014), nearly 60 per cent of coal minings are situated in the forest areas. A significant amount of coal blocks allotted over the last couple of years are located in and around the forest regions. Out of the total about 2,00,000 hectares of coal leases taken up by the CIL, 55,000 come under forest areas (International Energy Agency 2017).

As per the current work, most of the coal blocks operated by MCL are in adjoining forest areas. The mining activities have severely affected the peripheral environment and eroded the vegetation and topsoil. The forest cover is significantly reduced by 11 per cent between 1973 and 2015 because of the coal mining in Talcher region. Many of the residing tribal communities at Talcher and Ib valley region relying on the forest resources to maintain their livelihood have been marginalised. It is found that the extraction of coal in the opencast mining and the associated processes such as coal piles, supplying pipelines, communication roots like railway lines and public works have resulted into massive deforestation and erosion of plants having medicinal value adjacent to mining areas such as *Oroxylum indicum*, *Gloriosa superba*, *Rauvolfia serpentina*, *Andrographis paniculata*, *Calotropis procera*, *Scoparia dulcis*, *Wedelia chinensis*, *Leucas aspera*, *Uraria picta* and *Saraca asoca* (Mahalik and Satapathy 2016; Mishra and Das 2017). Floras having food and timber value like *Piasal* (*Pterocarpus trijuga*), *Sisso* (*Dalbergia*), *Gambhari* (*Gmelina*), *Kurum* (*Adina cordifolia*), *Aonla* (*Phyllonthus emblica*), *Mahua* (*Bassia latifolia*) and *Kendu* (*Diospyros*) are reducing in a fast rate in the mining areas (Mishra 2015). Animals like invertebrates, reptiles, pigeons, scabbling rodents and minor mammals are extincted in the mining region due to loss of forest resources. As a result, some hunting communities have been marginalised (Niti Aayog 2015).

Total Suspended Particulate Matter (TSP) and Respirable Particulate Matter (PM10) spawned from opencast coal mines are the major causes of air pollution which creates ecological imbalances and affects the health of living beings (Sinha and Banerjee 1997; Sharma et al. 2009). In the mining areas of Talcher coalfields, the affected and nearby villages suffer from severe airborne emissions due to mining (Mishra and Das 2017). The pollutions occur during every stage of the process, but mostly during extraction, transportation, piling and operational activities. The use of surface minor machine is limited and hence the manual process of mining through drilling, blasting and crushing is mostly found in both the coalfields (Guttikunda et al. 2014). Likewise, manual sweeping of dust is much visible than the use of dust collector machine. It is noticed that in both the mining areas the vehicles and even the trains remain uncovered during transportation of coals, which poses serious threats on human as well as natural resources (Nayak and Chowdhury 2018). In the train tracks, the local

villagers collect the fallen coals and use it for cooking purposes. When it burns it also adds into the fugitive dusts and pollution of the local environment. To escape from the mistakes, all the stakeholders are resorting to blame game. Efforts are not adequately taken by the industry as well as the state government to sort out the issue of uncovering transportation of coals which is the violation of the Environment (Protection) Act 1986 (Mishra and Mishra 2016). Lack of proper monitoring mechanisms might be the reason for the above mentioned cases. As per the report of State Pollution Control Board, Odisha (2010) pollution caused due to coal mining in Western Odisha; the nitrogen dioxide (NO₂) and sulphur dioxide (SO₂) levels in every mining area are within the limit but the suspended particulate matter (SPM) and dust levels in Talcher region is a matter of concern. All these create livelihood difficulties among the communities as the productive assets are destructed.

Water is an essential ingredient for all the living beings. Disposal of waste particles into the local water bodies is one of the prime reasons of water pollution (Mukherjee et al. 2003). The phenomenon of water pollution due to the coal mining in Odisha is a growing concern. Reza and Singh (2010) have observed that, in Angul district, the mining industries of MCL release loads of contaminated water into the river *Brahmani* and its tributaries which encompass poisonous elements like fluorides, phosphorus, ammonia, urea and acids. Consequently, the use of river water by the people has been decreased. In the Ib valley coalfield region, the flooded of fly ash spawned out of the mining process and the nearby ash ponds affect the adjacent water sources with the suspended, dissolved and heavy metals concentrations. The local villagers are facing innumerable difficulties as the wastes emanate from coal are getting penetrated with the nearby reservoirs and water sources which could not be used for domestic purpose (Hota and Behera 2015). Many of the local ponds have become unfit for common use. The water level is reduced drastically as every day due to the mining activities gallons of water are used to undertake its operation. Neither the industry nor the government is obeying the norms of water recycling.

Pollution of soil is a growing concern and it is polluted with the removal of solid wastes, contaminated water and acid mine drainage from the coal mines which results into deterioration of soil fertility (Ghose 2004; Raja et al. 2015). As per the statistics, every year in India a surface area of about 4 hectares is wasted due to million tonnes of coal extraction by opencast mining (Swain et al. 2011). It has direct impacts on the ecosystem, food chain and local water bodies (Singh and Singh 2004). The mining practices in Odisha have made huge damage to the soil resources. The available nitrogen is an important factor to increase the soil fertility. The nitrogen content at Ib valley coalfields region in the surface layer of depth 0–5 ft was found to be 2.845 kg ha⁻¹ (Mohapatra and Goswami 2012). The amount is too less as the standard value

of nitrogen must be between 272 and 544 kg ha⁻¹. This is one of the important factors behind the loss of vegetation of the region as nitrogen is known as a macronutrient of plants. The normal range of the availability of phosphorus in the soil is 22.5 to 56 kg ha⁻¹ (Gupta et al. 2006). As per another study at Angul-Talcher region (Singh et al. 2010), it has been found that the standard phosphorus content in the surface layer of depth 0–5 ft. was 1.110 kg ha⁻¹ which is substantially lesser in comparison to the normal value. The organic carbon composition is declined with increasing depth of soil in both the coalfield areas (Niti Aayog 2015). The potassium level in the surface soil (0–5 ft) of the Ib valley mining area is found 2.634 kg ha⁻¹ which is fairly negligible as the standard value is 136 to 337.5 kg ha⁻¹ (Mishra 2015). Existence of heavy layers of coal dust has practically made the practice of agriculture problematic and given rise to a wide range of complications around the mining regions (Mishra and Das 2015).

Climate change and increasing humidity due to coal mining are some of the rising phenomena of the contemporary time. Extraction and burning of coal resources produce enormous quantities of vapours which contains carbon dioxide (CO₂), carbon monoxide (CO), sulphur dioxide (SO₂), nitrous oxide (NO_x), methane (CH₄), hydrogen sulphide (H₂S), fugitive dusts and fumes which puts adverse impact on climate and temperature (Hamsa et al. 2011). As a result, difficulties are encountered in farming practices and adjustment of human (Goswami 2015). The phenomena of climate change and increasing humidity due to coal extraction in Odisha is alarming. During summer days, the temperature in Talcher goes high and remains between 42 and 48 degree Celsius and become unbearable (Nanda et al. 2011). Frequent mine fire in the coal mining areas like Lingaraj, Bharatpur and Ananta multiplies the situation. The mining activities under Angul-Talcher area have significantly added to the upsurge in temperature and heat waves, and as a result, the socio-economic activities of the people are getting affected (Nayak and Chowdhury 2018). Likewise, emissions from coal mining and thermal power plants of Ib valley coalfields at Jharsuguda region have resulted into significant rise in atmospheric temperature leading to acute difficulties (Mishra 2017). Since the coal dispatch process is not done properly, huge pile coals are gathered which often lead to combo stone, fire and smoke.

Impact on financial capital

Financial capital entails the money which is used for purchasing productive materials or consumer goods, including personal credit. Corrosion of the financial capital sprouts financial risk. In Odisha with the extraction of coal and consequent complication, people's financial capital has been devastated. During the post-displacement era, the self-reliant tribal people have become marginalised. Though they have received various resettlement benefits, most of it has been spent for various

requirements at the new resettlement area. It was found that none of the displaced families was issued *patta* (a legal document issued to owner of a particular plot of land) in the new resettlement area which is a major concern (Ray and Saini 2011). Their economic resources are exhausted and the productive assets like domestic animals, small shops and agricultural implements are either lost or sold. The surplus-making communities are now leading a 'hand to mouth' life. It is noticed that their income level in the new resettlement area has gone little higher in comparison to the previous life; however, with the new pattern of economy, the standard of living has become costlier which has produced multiple economic hardships among the displaced families (Amnesty International India 2016). Though tribals are not well verse with money economy, most of them are seen to be doing improper management of economic resources (Mishra and Das 2017). In fact, they have become sufferers of this culture. Lack of financial capital is also evident among the women. Previously, some of them were doing small petty jobs to generate some earning. However, in the resettlement colony, most of them are seen to be doing household jobs (Mishra 2009).

Impact on social capital

Social capital involves a network of relationship among people who live in a particular society. It is reflected in the mutual trust, cooperation and solidarity which acts as a vital factor to ensure common needs and purposes of life (Cerneia 1997). Threat to social capital ends up into social risk. Displacement is the prime cause of the breakdown of social capital. For the tribal community, social capital acts as a significant source of life support system (Roy-Burman 1994).

It is found that displacement due to coal mining activities in Odisha has brought enormous changes in the inter-personal relationship at individual and community level. Now a large portion of the villagers are engaged in non-agricultural jobs (Mishra and Mishra 2014). Most of them are spending time on their profession at the workplace and latter at home. Interaction and leisure activities have been a distant dream. Displacement, economic constraints and increasing dependency have led to the disintegration of the joint family. Collective values are replaced with individualism. Inclination for financial independence, building career, enjoying unbridled freedom and taking own decisions have become the new trend among young generation (Mishra 2009). Many of the joint families have become nuclear due to displacement in mining areas of Western Odisha (Das and Mishra 2015). Quarrel and competition among the family members for getting the resettlement benefit are rampant. With the dismantling of the joint family, the physical, emotional and psychological support for the members has disappeared (Mishra 2017). Social security for the women and children in the family has emerged as an important concern in the

nuclear family as the male members go to work in the mining industry for hours. The process of socialisation of the children is disturbed as families have become smaller. A handful of contractor and managerial class employees have become powerful by virtue of their close nexus with the MCL. As a result, fraction and group conflict are increasing among the villagers (Niti Aayog 2015). Prevalence of modern culture and money economy has given rise to heterogeneity among the people. Breakdown of community ties and family cohesion have affected negatively to the livelihood practices of the people.

Observation of religious and cultural festivals provides significant support to individual's life and communities are identified with such unique practices (Galek et al. 2015). Such celebrations indirectly strengthen the community ties or social capital. The coal mining in Odisha has affected the agricultural practices of the displaced people and consequently their religious and cultural practices are not retained. It was found that different rituals beginning from sowing to the ripening of crops and harvesting were celebrated in the villages. Those religious rituals aim to appease the deities and to get rid of the sinful effects caused by cyclic changes of nature (Hota and Behera 2015). Moreover, their religious practices were enabling them to get connected with the supreme deities as well as with the nature. Several rituals were celebrated to pacify the God *Indra* (rain God) who was supposed to create rain as they were mostly dependent upon monsoon. Local festivals like *Halasutra* (celebrated at the time of ploughing for the first time in the season), *Aghira-Purnami* (worship of moon God), *Akshya-Trutiya* (celebrated at the time of sowing of seeds), *Rajja* (worship of mother earth), *Dussehra* (worship of Goddess Durga for controlling evils), *Nua Khai* (festival for celebrating first harvest) and *Holi* (festival of colour) were observed with acute gaiety and enthusiasm (Niti Aayog 2015). However, after the initiation of coal mining activities, agriculture has hardly been practiced in the affected villages which have resulted into the extinction of the agro-based festivals (Mishra and Mishra 2014). Because of the advent of cash economy and new pattern of work, people are found to be busy round the year. Though some of these festivals are still celebrated, it is found that the festive spirit is lost and it is no more observed in the traditional way. Festivals like *Halasutra* and *Gahma Purnami* (worship of cattles) which were basically practiced at the time of ploughing and sowing the seeds are no more observed. Different farming accessories like bullock carts and ploughs have become redundant and as a result, the associated plough and cart songs are no more in practice (Mishra and Pujari 2008). The impact of such mining activities questions the continuation of handful of indigenous festivals in the coming days. Hence, non-celebration of festivals in the mining areas portrays the depth of adverse impact on the agriculture-based livelihood of the people.

Analysis of the livelihood disruption caused by coal mining in Odisha reveals the dark side of development in the state.

The issues raised above are limited and the process of mining has many more serious and even invisible ramifications. Economic growth in the name of development at the cost of livelihood of the people needs serious introspection at the policy level (Phillips et al. 1998). Coal mine may generate economic advantage but a close observation into the whole approach can discern how the process has myriad implications for the livelihood practices of the communities (Hossain et al. 2015). Mining and related activities cannot be totally withdrawn, but it can be monitored and controlled with appropriate policy measures which may reduce the detrimental consequences.

Conclusion and implications for policies

No doubt coal mining has produced significant economic benefits at national and international front. However, the socio-economic sphere of a developing state like Odisha is immensely influenced by the coal mining activities. However, production of coal has proved to be one of the principal factors of endangering the livelihood of the displaced as well as affected communities. In the pursuit of economic gain, extraction of coal in the state has jeopardised the socio-economic practices of the people. The livelihood capitals, human, physical, natural, financial and social, have received severe setback and resulted into health, financial, environmental and social risks among the communities. Consequently, people are unable to perform their previous livelihood practices and forced to adopt new industrial or unfamiliar jobs. Their sustainable pattern of livelihood has been derailed and they are leading a 'hand to mouth' life without any self-satisfaction and belongingness. Though mining cannot be entirely avoided, its negative consequences can be minimised and monitored carefully. There have to be sincere efforts to minimise the harms as development cannot succeed by marginalising a large segment of population.

Moreover, coal mining as a development strategy deserves serious reconsideration. Coal extractive industries in Odisha need to adopt sustainability as its core operational strategy in a vibrant manner. With the growing need and extensive use of coal resources, the concerns for environment as well as the social well-being cannot be ignored. Livelihood opportunities are to be extended to the displaced as well as affected people by considering them as one of the important stakeholders. As most of them belong to underprivileged sections, they need to be provided with culturally relevant development options and opportunities through CSR provisions. The government has to develop essential mechanisms to monitor the range of activities related to mining with stringent laws and adequate safety measures. Mining companies need to be ecologically sustainable as it has implications for both lives and livelihood. With the flow of time, people from different genres have become

increasingly cognizant about the development consequences in the post-globalisation scenario. An alternative approach is the need of the hour to bridge the dilemma between economic growth and livelihood challenges of the affected communities in mining context. Every development initiative must enable the individuals to lead a dignified and healthy life in a safe environment.

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References

- Niti Aayog (2015) Coal mining, displacement and rural livelihoods: a study in Mahanadi coalfield Odisha. <http://niti.gov.in/sites/default/files/2019-01/Report%20on%20Coal%20Mining%2C%20Displacement%20and%20Rural%20Livelihoods%20A%20Study%20in%20Mahanadi%20Coalfield%20Odisha.pdf>. Accessed on 29 November 2020
- Agamben G (2005) *State of exception*. University of Chicago Press, Chicago
- Amnesty International India (2016) When land is lost, do we eat coal? Coal mining and violations of adivasi rights in India. https://www.amnestyusa.org/files/report_final.pdf. Accessed on 28 November 2020
- Bennett O, McDowell C (2012) *Displaced: the human cost of development and resettlement*. Palgrave, New York
- Carvalho FP (2017) Mining industry and sustainable development: time for change. *Food Energy Secur* 6(2):61–77
- Catherine W, Shelef O, Gertler P (2012) How will energy demand develop in the developing world? *J Econ Perspect* 26(1):119–138
- Central Pollution Control Board (2009) Comprehensive environmental assessment of industrial clusters. http://www.indiaenvironmentportal.org.in/files/Industrial%20Clusters_env_assessment.pdf. Accessed on 01 December 2020
- Cernea MM (1997) The risk and reconstruction model for resettling displaced populations. *World Dev* 25(10):1569–1587
- Cernea MM (1999) Development’s painful social costs. In: *The development dilemma*. Institute of Social Studies, The Hague. Palgrave Macmillan, London. https://doi.org/10.1007/978-1-349-27248-8_1
- Chambers R, Conway GR (1992) Sustainable rural livelihoods: practical concepts for the 21st century. *IDS Discussion Paper* 296:127–130
- Choudhury C (2013) Adivasis and the New Land Acquisition Act. *Econ Polit Wkly* 48(41)
- Choudhury NB, Choudhury SRD (2020) Implications for planning of hydroelectric projects in Northeast India: an analysis of the impacts of the Tipaimukh project. *GeoJournal*. <https://doi.org/10.1007/s10708-020-10158-8>
- Coal Controller’s Organisation (2013) Coal directory of India-2011-12. https://coal.nic.in/sites/upload_files/coal/files/coalupload/coaldir11-12.pdf. Accessed on 02 December 2020
- Conservation Action Trust (2014) Coal kills: health impacts of air pollution from India’s coal power expansion. <http://www.indiaairquality.info/wp-content/uploads/docs/Air%20Pollution%20from%20India%20Coal%20TPPs%20-%20LowRes.pdf>. Accessed on 29 November 2020
- Costanza R, Dearge R, Groot RD, Farber S, Grasso M, Hannon B, Limburg KE, Naeem S, O’Neill RV (1997) The value of the world’s ecosystem services and natural capital. *Nature* 387(6630):253–260
- Das N, Mishra N (2015) Assessing the impact of coal mining on diversified sources of rural livelihoods: a case study in the Ib valley coalfield area of Western Odisha, India. *Int Res J Soc Sci* 4(6):83–88
- Department of Industry, Innovation and Science, Australia (2019) Coal in India-2019. <https://www.industry.gov.au/sites/default/files/2019-08/coal-in-india-2019-report.pdf>. Accessed on 12 November 2020
- Fenelon J (1998) *Culturicide, resistance and survival of the Lakota (Sioux Nation)*. Garland, New York
- Fernandes W (2008) Sixty years of development-induced displacement in India. In H.M. Mathur (ed.) *India: social development report 2008: development and displacement* (pp. 89–102) Oxford University Press, New Delhi
- Fernandes W, Bharali G (2014) Coal mining in Northeastern India in the age of globalisation. In: Lahiri-Dutt K (ed) *The coal nation: histories, ecologies and politics of coal in India*. Ashgate, Aldershot, p 183
- Gadgil M (2016) Today’s Environmentalism: time for constructive cooperative action. *Econ Polit Wkly* 51(46)
- Gadgil M, Guha R (1995) *Ecology and equity: the use and abuse of nature in contemporary India*. Penguin Books, New Delhi
- Galek K, Flannelly KJ, Ellison CG, Silton NR, Jankowski KRB (2015) Religion, meaning and purpose, and mental health. *Psychol Relig Spiritual* 7(1):1–12
- Geological Survey of India (2018) Indian coal and lignite resources-2018. <https://employee.gsi.gov.in/cs/groups/public/documents/document/b3zp/mjk1/~edisp/dcport1gsigovi295293.pdf>. Accessed on 22 November 2020
- Ghose MK (2004) Effect of opencast mining on soil fertility. *J Sci Ind Res* 63:1006–1009
- Giddens A (1999) *Runaway world*. Profile Books, London, UK
- Githiria JM, Onifade M (2020) The impact of mining on sustainable practices and the traditional culture of developing countries. *J Environ Stud Sci* 10:394–410. <https://doi.org/10.1007/s13412-020-00613-w>
- Goldblatt D (1996) *Social theory and the environment*. Polity Press, Cambridge
- Goswami S (2015) Impact of coal mining on environment. *Eur Res* 92(3): 185–196

- Gupta S, Mallick T, Datta JK, Saha RN (2006) Impact of opencast mining on the soil and plant communities of Sonepur-Bajari opencast coal mine area. West Bengal, India. Conference Proceedings Vistas in Geological Research (Conference Proceedings, UU Special Publication in Geology) 5:194–198
- Guttikunda SK, Goel R, Pant P (2014) Nature of air pollution, emission sources, and management in the Indian cities. *Atmos Environ* 95: 501–510. <https://doi.org/10.1016/j.atmosenv.2014.07.006>
- Hamilton MB (1998) *Sociology and the world's religions*. Palgrave Macmillan, London
- Hamsa AL, Jamal MA, Sultan Y (2011) Effects of change in the climate in India. *Asian J Environ Sci* 6(2):215–218
- Harriss-White B (2006) Poverty and capitalism. *Econ Polit Wkly* 41(13): 1242
- Harvey D (2003) *The new imperialism*. Oxford University Press, UK
- Hossain MN, Paul SK, Hasan MM (2015) Environmental impacts of coal mine and thermal power plant to the surroundings of Barapukuria, Dinajpur, Bangladesh. *Environ Monit Assess* 187:202. <https://doi.org/10.1007/s10661-015-4435-4>
- Hota P, Behera B (2015) Coal mining in Odisha: an analysis of impacts on agricultural production and human health. *Extr Ind Soc* 2(4): 683–693
- Hota P, Behera B (2016) Opencast coal mining and sustainable local livelihoods in Odisha, India. *Miner Econ* 29:1–13. <https://doi.org/10.1007/s13563-016-0082-7>
- International Energy Agency (2017) *World energy outlook 2017*. [https://www.eia.gov/outlooks/ieo/pdf/0484\(2017\).pdf](https://www.eia.gov/outlooks/ieo/pdf/0484(2017).pdf). Accessed on 12 November 2020
- Kothari S (1996) Whose nation? The displaced as victims of development. *Econ Polit Wkly* 27(34):128–136
- Kumar K (2013) The sacred mountain: confronting global capital at Niyamgiri. *Geoforum* 54:196–206
- Lahiri-Dutt K (2005) What quality of life in mining region? *Econ Polit Wkly* 40(9):907–908
- Lahiri-Dutt K (2016) *The coal nation: histories, ecologies and politics of coal in India*. Routledge, London
- Lahiri-Dutt K (2017) Resources and the politics of sovereignty: the moral and immoral economies of coal mining in India. *South Asia J South Asian Stud* 40:792–809. <https://doi.org/10.1080/00856401.2017.1370211>
- Mahalik G, Satapathy KB (2016) Environmental impacts of mining on biodiversity of Angul-Talcher open mining site, Odisha, India. *Scholars Acad J Biosci* 4(3A):224–227
- Mandishekwa R (2020) Rethinking mining as a development panacea: an analytical review. *Miner Econ* 34:151–162. <https://doi.org/10.1007/s13563-020-00243-2>
- Meher R (2009) Globalization, displacement and the livelihood issues of tribal and agriculture dependent poor people: the case of mineral-based industries in India. *J Dev Soc* 25(4):457–480
- Mining, Minerals and Sustainable Development (MMSD) (2002) *Breaking new ground: mining minerals and sustainable development*. Earthscan Publications, London
- Ministry of Coal, Government of India (2014) Coal resources. <http://www.coal.nic.in/welcome.html>. Accessed on 12 November 2020
- Mishra PP (2009) Coal mining and rural livelihoods: case of the Ib valley coalfield, Orissa. *Econ Polit Wkly* 44(44):117–123
- Mishra PP (2015) Mining and environmental problems in the Ib valley coalfield of Orissa, India. *Geol Soc* 250:141–147. <https://doi.org/10.1144/GSL.SP.2005.250.01.14>
- Mishra PK (2017) Socio-economic impacts of climate change in Odisha: issues, challenges and policy options. *J Clim Change* 3(1):93–107
- Mishra N, Das N (2015) Assessing the impact of coal mining on diversified sources of rural livelihoods: a case study in the Ib valley coalfield area of Western Odisha, India. *Int Res J Soc Sci* 4(6):83–88
- Mishra N, Das N (2017) Coal mining and local environment: a study in Talcher coalfield of India. *Air Soil Water Res* 10: 117862211772891. <https://doi.org/10.1177/1178622117728913>
- Mishra B, Mishra S (2014) Mining and industrialisation: dangerous portents. *Econ Polit Wkly* 49(14):56–65
- Mishra SK, Mishra P (2016) Do adverse ecological consequences cause resistance against land acquisition? The experience of mining regions in Odisha, India. *Extr Ind Soc* 4(1):140–150. <https://doi.org/10.1016/j.exis.2016.11.004>
- Mishra PP, Pujari AK (2008) Impact of mining on agricultural productivity: a case study of the Indian State of Odisha. *South Asia Econ J* 9(2):337–350
- Mohanty BB (2001) Land Distribution among scheduled castes and tribes. *Econ Polit Wkly* 36(40):3857–3868
- Mohapatra H, Goswami S (2012) Impact of coal mining on soil characteristics around Ib river coalfield, Orissa, India. *J Environ Biol* 33(4):751–756
- Mukherjee AK, Ravichandran B, Bhattacharya SK, Ahmed S, Roy SK, Thakur S, Roy CA, Saiyed HN (2003) Environmental pollution in rural areas of Orissa state due to industrial emission with special reference to fluoride. *Indian J Environ Health* 45(4):325–334
- Mulvihill PR (2020) The ambiguity of environmental disasters. *J Environ Stud Sci* 11:1–5. <https://doi.org/10.1007/s13412-020-00646-1>
- Nanda PM, Garnaik BK, Panda S (2011) Studies on fluoride pollution in ground water of Angul-Talcher industrial complex of Odisha, India. *Asian J Chem Environ Res* 4(1):13–16
- Nayak T, Chowdhury IR (2018) Health damages from air pollution: evidence from opencast coal mining region of Odisha, India. *Ecol Economy Soc INSEE J* 1(1):43–65. <https://doi.org/10.37773/ees.v1i1.9>
- Padel F, Das S (2010) Cultural genocide and the rhetoric of sustainable mining in East India, Contemporary South Asia. <https://doi.org/10.1080/09584935.2010.503871>, 18, 333, 341
- Paltasingh T, Paliwal G (2014) Tribal population in India: regional dimensions & imperatives. *Journal of Regional Development and Planning* 3(2):27–36
- Paltasingh T, Tyagi R (2011) Confronting environmental issues: challenges and perspectives. *Int J Environ Dev* 8(2):109–122
- Phillips D, Groenewegen P, Verhasselt Y (1998) Health, environment and development: issues in developing and transitional countries. *GeoJournal* 44:97–102. <https://doi.org/10.1023/A:1006823922100>
- Planning and Convergence Department, Government of Odisha (2019) *Odisha economic survey 2018-19*. https://pc.odisha.gov.in/Download/Economic_Survey_2018-19.pdf. Accessed on 15 November 2020
- Prathap A, Chakraborty S (2019) Assessment of surface water quality around opencast coal mines for sustainable utilization potentials: a case study in Jharkhand, India. *Environ Dev Sustain* 22:3179–3205. <https://doi.org/10.1007/s10668-019-00341-4>
- Raja R, Nayak AK, Shukla AK, Rao KS, Gautam P, Lal B, Tripathi R, Shahid M, Panda BB, Kumar A, Bhattacharyya P, Bardhan G, Gupta S, Patra DK (2015) Impairment of soil health due to fly ash-fugitive dust deposition from coal-fired thermal power plants. *Environ Monit Assess* 187:679. <https://doi.org/10.1007/s10661-015-4902-y>
- Rao DVS, Gouricharan T (2016) *Coal processing and utilization*. CRC Press, London
- Ray S, Saini S (2011) Development and displacement: the case of an opencast coal mining project in Orissa. *Soc Secur Bull* 60(1):45–64
- Reza R, Singh G (2010) Impact of industrial development on surface water resources in Angul region of Orissa. *Int J Environ Sci* 1(4): 514–522
- Roy A (1999) *The greater common good*. Outlook 8(14):54–72
- Roy A (2009) *Listening to grasshoppers: fieldnotes on democracy*. Hamish Hamilton, London
- Roy-Burman BK (1994) *Tribes in perspective*. Mittal Publications, Delhi

- Sahoo G, Senapati AK (2021) Are the households in coal mining regions more vulnerable? A study in Talcher Coalfield of India. *Mineral Economics* (Online first article). <https://doi.org/10.1007/s13563-021-00266-3>
- Satapathy J, Paltasingh T (2019) CSR in India: a journey from compassion to commitment. *Asian J Bus Ethics* 8(2):225–240
- Scott JC (1985) *Weapons of the weak: everyday forms of peasant resistance*. Yale University Press, New Haven
- Sharma YC, Aggarwal P, Singh TN (2009) Economic liabilities of environmental pollution by coalmining: Indian scenario. *Environ Dev Sustain* 11(3):589–599
- Singh V, Singh TN (2004) Environmental impact due to surface mining in India. *Minetech* 25(1):3–7
- Singh PK, Singh R, Singh G (2010) Impact of coal mining and industrial activities on land use pattern in Angul-Talcher region of Orissa, India. *Int J Eng Sci Technol* 2(12):7771–7784
- Sinha S, Banerjee SP (1997) Characterization of haul road dust in an Indian opencast iron ore mine. *Atmos Environ* 31(17):2809–2814
- Su F, Saikia U, Hay I (2018) Relationships between livelihood risks and livelihood capitals: a case study in Shiyang River Basin, China. *Sustainability* 10. <https://doi.org/10.3390/su10020509>
- Swain BK, Goswami S, Das M (2011) Impact of mining on soil quality: a case study from Hingula opencast coal mine, Angul district, Orissa. *Vistas in Geological Research* (Conference Proceedings, UU Special Publication in Geology) 10:77–81
- Uppgupta S, Singh PK (2017) Impacts of coal mining: a review of methods and parameters used in India. *Curr World Environ* 12(1):142–156
- Warner KJ, Jones GA (2019) The 21st century coal question: China, India, development, and climate change. *Atmosphere* 10(476):1–17
- White B, Jr SMB, Hall R, Scoones I, Wolford W (2012) The new enclosures: critical perspectives on corporate land deals. *J Peasant Stud* 39(3-4):619–647
- World Coal Institute (2006) Focus & activities of the World Coal Institute. https://www.unece.org/fileadmin/DAM/ie/se/pdfs/coal8/csd2feb06/Topic5/Copley_WCI.pdf. Accessed on 23 November 2020
- World Wide Fund for Nature (WWF) (2008) Living planet report-2008. https://wwf.awsassets.panda.org/downloads/lpr_living_planet_report_2008.pdf. Accessed on 18 June 2020
- Xaxa V (2018) Coercive ‘development’. *Econ Polit Wkly* 53(45):10–11
- Zoomers A (2010) Globalisation and the foreignisation of space: seven processes driving the current global land grab. *J Peasant Stud* 37(2):429–447

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