Revisiting coal cycles in Eastern India: Report of 2012 survey

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Abstract

This report builds on a previous study (Lahiri-Dutt and Williams, 2005) of the delivery of coal by cycle around the eastern Indian coalfields of Jharkhand and West Bengal. It surveys the informal mining in this region as well as the socio-economic characteristics of those involved in this coal distribution network (mostly in the form of coke) and provides an updated estimate of the amount of coal supplied in this manner throughout

It is estimated that, in 2012, about 3.7 Mtonnes of coal was transported by cycle in the study region. The coal was mined in small village-run underground mines or scavenged from the disused pits remaining from large scale mining operations. The mining and coking was often carried out by family groups, many of whom had been doing this several years. The cycle-wallahs, who may not be part of the mining/coking families, provide the transportation of this fuel to small and medium sized end-users. According to our survey, they can earn about INR 5000 (~ $100) per month, otherwise they might earn from farming, maybe, INR1500 pm. Hours can be long, maybe starting at 2am to get the coal to market A separate survey carried out in two villages highly involved in coal cutting indicated they earned about INR7000 pm. One village seemed to fairly recently lost land to the Parej project, whilst the other appeared to have lost land a generation earlier.

Poverty and lack of alternative opportunities were the major driving factors for these people.

Keywords: *coal, illegal, mining, poverty, cycle, supply, village, Eastern India*

Introduction

India is the third largest coal miner after China and the USA, currently producing around 620Mtonnes pa (USEIA); this about 100 Mtonnes short of demand which is met by imported coal. The bulk of the coal is used to generate electricity from conventional thermal power stations. The rapid industrialization of India has necessitated a similar increase in the rate of coal extraction particularly in the coal bearing area of the North Karanpura valley in Jharkand and also in Chattisgarh. Previously, much of India's coal was extracted from the Eastern coalfields (Jharia and Raniganj) in Jharkhand and West Bengal. The Raniganj-Jharia coalfields are still significant, producing about 25 Mtonnes pa. Until the advent of open cut (cast) mining, much of the coal came from relatively shallow underground mines, extracted using board and pillar technology. Today, large scale open cut mining provides about two-thirds of India's coal production.

Alongside the largely government-operated formal mines, informal non-conventional mining has flourished that is often seen as illegal. This type of coal mining is carried out by villagers, digging in small patches or from older abandoned mines in these coal-bearing areas or scavenging from spoil piles. The mining is illegal because in India, as in many other developing countries, mineral resources under the ground belong to the state. Coal is considered to be a 'major' mineral and hence only licensed collieries can legally mine the coal following various norms set by the government. This informal mining began about 7-8 years after nationalisation and the raising of coal prices, but instead of staying hidden as they used to be before, in recent years, it has become more visible and has diversified. One of visual characteristics of this activity are bicycles traveling along the highways and other roads in the area carrying sacks of coal; the bike being used as an inanimate packhorse with men pushing them instead of pedalling. These cycles are indicative of the illegal coal economy, possibly the tip of the iceberg, although all the coal transported on them is not necessarily mined illegally. Therefore, we make a distinction between illegal mining and illegal trading of coal on cycles, and remind the readers that the amount of coal that is illegally carried on cycles is much smaller than the amounts carried by large trucks where it becomes nearly impossible to detect the origin of the coal.

Figure 1. The coal resources of India (adapted from IEA, 2002)

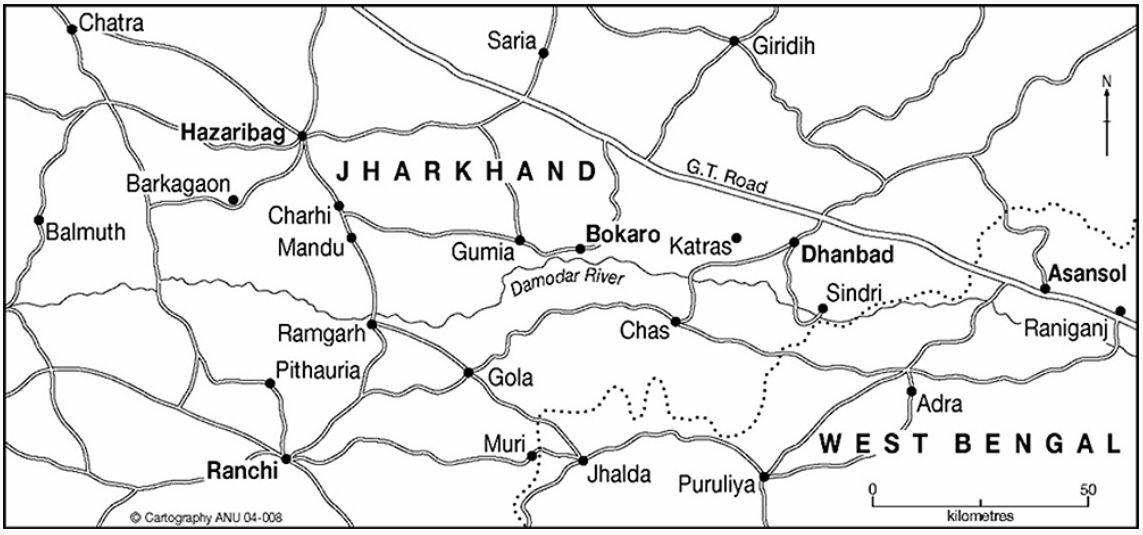

Figure 2. The study area

In 2003, two of the authors (KLD and DJW) carried out the first survey to find out who are these coal cycle wallahs, how much coal they carry, where does the coal come from, where it goes to and gave an overview of the economics (Lahiri-Dutt and Williams, 2005). The survey, which was carried out around Hazaribagh in Jharkhand, counted the number of rickshaws entering the town and estimated the weight of coal or coke they were carrying. Assuming the demand was population driven both in terms of household or shop use and small scale industries, and with considerations for seasonality in production/transportation activity, and then extrapolating the supply with the populations to other major towns/cities around the coal producing regions, it was estimated that about 2.5 Mtonnes passed along this supply chain every year. This is not an insignificant amount equivalent to the production of a medium sized coal mine.

In 2012, we decided to revisit the scene. This is because coal production (and demand) has increased by more than 50% from nearly 400 Mtonnes in 2005 and because steps have been suggested to constrain the coal cycle phenomenon; also questions are being asked concerning the role of the informal economy. For example, Sood (2012) has recommended that evaluation of informal sector activities needs more attention at local micro-level than a top-down approach. This recommendation followed from a Delhi High Court 2010 decision that the current restrictive and punitive regulations concerning cycle rickshaws were unreasonable given the rapid expansion of Delhi. Consequently, we carried out a more detailed, survey of supply of informal coal carriers (as well as mining) in the Hazaribagh region in order to update the estimate of the amount of coal traded and delivered in this manner. This report focuses on the supply chain aspects rather than illegal coal mining itself: an analysis of the economics of the supply chain and the ethics of regulating this activity through a top-down police process. To start with, we outline the sources of illegal coal, then describe the processing of the coal, and trace the origins and socio-economic characteristics of the cycle-wallahs, and offer an estimation of the entire economy and potential greenhouse effects.

Sources of coal

Coal, or rather mostly coke, carried by bicycle to nearby towns comes from three main sources:

1) small shallow underground or open cut mines located in villages;

2) mining on abandoned or orphaned government mines; and

3) coal from official operating mines, that 'fell off the back of truck' or was otherwise scavenged from sale dumps.

1) Village mines

The land on which these mines are dug may be privately owned, but often, in Jharkhand, the land is village commons or gair majurwa. Whilst to the east in the more densely populated West Bengal where there is little gair majurwa remaining, the mines are generally on private land. The mines are dug into seams located near outcrops exposed at the sides of steep hills or rivers. The coal may be extracted through a series of small open cut holes which may extend underground a little way. Alternatively, they may be shallow underground operations, entered via a drift or a shaft to a depth of about 10m-15m, and which can extend for up to 200m horizontally.

Figure 3. Carrying coal out of a village mine

An example is shown in Figure 3 with loaders/carriers bringing the coal to the surface, whilst Figure 4 shows two of the authors (DJW and JI) descending into another village mine. A site of many families engaged in informal mining is shown in Figure 5. This depicts a female readying a cycle load of coke – the coal is heap coked on the surface. Here there are a number of small underground drifts.

There are many of these mines; indeed it is estimated there are may be 250 such excavations in the Giridih region alone.

Figure 4 . Two of the authors descending into a village mine

Figure 5. Loading a cycle

The coal is removed by pick-axe by the coal cutter, after which loaders (bojharis) put the pickings into metal dishes or wicker baskets that are carried out on the head, ~25 kg at a time. Often, the cutters get paid by the loaders, but sometimes a family may excavate one of the chambers in the mine as is the case in Figure 4.

Some of these mines can operate most of the year; others can become unworkable during the monsoons. Also in the rainy season, those who have land need to spend time in the field, but some families mine full-time throughout the year.

2) Abandoned mines

The Eastern coalfields have a 200 year-long history of mining that is not well documented. The region is dotted with small abandoned mines, some of them orphaned by mining companies owned by individuals. Since the collieries were brought under state ownership, no one has any responsibility for the remains of such old mines. Moreover, the nationalized company often neglects to entirely refill voids with sand. Villagers have ready access to any coal that is left. For example, coal from orphaned mines around Jarangdih to the southeast of Hazaribagh supports at least 25,000 people, the coal remaining for use within the village rather than being carried further afield. An example of coal excavation from the abandoned section of Parej East open cut mine is shown in Figure 3, the long excavation slits can be seen in the centre.

3) Scavenging

Another source of coal is scavenging of coal dumped in overburden stockpiles. Often there are coal seams which are uneconomic to collect in large-scale open cut excavation, also some coal from the top of the target seam may get scraped up and disposed along with the overburden. Such sources are also to be found in Jharia, although the amount of gair mahurwa land decreases towards the east. The lack of safety equipment and geotechnical knowledge means that accidents can and do happen. These accidents tend to attract a lot more media attention than the cyclists. However, the attention has a flip side as, in the case of fatalities, family members are unwilling to identify their members because of the stigma of illegality and the potential ensuing harassment from police.

Figure 6. Loading a cycle

In Badam village, we found in 2005 that a local, better-off villager had provided the investment (~US$400) to cut the entrance way or drift down to the coal. Then contractors from the village cut the coal and carried it out to the surface. The bojharis bought the coal from the cutter (who gets about ~US$3 per day) and then sold it to the cycle wallahs for about US$1 per 150-200 kg (a cycle load). They, in turn, retailed their load for about~US$3. The mine 'financier' receives about US$3 per day, which is a reasonably good return on his investment. The extra money that a family may get from mining coal is about the same that they get from traditional agriculture but provides the critical extra cash in seasons when agriculture is impossible or other wage work are unavailable. One might remember the value of this additional income; for example, cash that enables a poor family to send the children to school.

4) Official mines

This report does not deal in any detail with this source of coal. There is poor security at many Indian coal mines and plenty of opportunity for pilfering. In underground mines, this happens from the coal loading area - coal is loaded by head baskets into awaiting 10 tonne trucks, and there may be some degree of co-operation from certain mine staff. This activity is probably more directed to larger scale fraud involving the so-called 'coal mafia'. Coal India also delivers coal to both local sale dumps located near the mines and big dumps on major highways for long-distance trucks to load and carry interstate. Again small scale pilfering would not be difficult from these dumps. Some coal also 'falls off the backs of trucks'.

A recent article in the West Bengal Telegraph (26 Oct 2012) reported on the murder of a coal mafia boss, Sheikh Selim, in Durgapur. He was out on bail since 2008 for murdering two CPM leaders for opposing coal smuggling. Some further discussion of the coal mafia can be found in Workers Education (2011).

Coke-making

Most, but not all, of the fuel that is delivered by cycle to neighbouring towns is crudely coked. This is because it is cooking fuel that is most in demand, and removal of the volatiles by coking prevents tainting of the food being cooked. The coking is largely carried out on the surface near to the mine entrance. Each carrier out of the mine heaps coal from eight dishes into a shallow depression (or khudi) to form one pile, which yields about one bicycle load. A number of such piles can be seen in Figure 5. These piles are then ignited by the firers (who may also be the bojharis) and allowed to burn for awhile. When judged hot enough, it is covered with slack (fine coal) to prevent too much ingress of air. The coke is ready by early morning but may need to cool down and be ready for the next day. Some bicyclists carry raw coal to their homes and heap coke the coal there, which saves small sums of money. Examples are shown in Figures 7 and 8.

Figure 7. Coking coal away from the mine

Once the coal is coked it is packed into bags; once these were largely jute containing up to 50kg but now mainly somewhat smaller plastic bags holding perhaps 25 kg. A stack of bags ready for the cycle-wallahs to load on to their bike is shown in Figure 8, probably enough for 3 cycles.

Many heaps are burning at any one time and one of the consequences is that visibility in these areas, once very good, is often very poor - perhaps only 1 km on calm mornings and maybe 2-3 km in the afternoon. This implies atmospheric particle loadings can exceed 200 micrograms per m3 which can be contrasted with the fact that modern cities are setting particle limits of 25-50 micrograms per m3 averaged over 24 h. Haze, however, also results from other activities, particularly those carried out at coal-based power plants, domestic use of biomass as fuel, and particle emissions from brick kilns; however, areas to the south of Hazaribagh, which prior to the advent of coal mining experienced good visibility but not now, coke making would be a major contributor.

Figure 8. Stacks of coke awaiting collection

Figure 9. Coking coal on village commons.

The coal cycle

Coal cycles have been a common sight on main roads and highways around the coal mining regions for at least two decades, the expansion of coal mining in India driving demand and opportunity for this activity to develop. In Raniganj, which has an older tradition of informal mining, other means of transport have traditionally been used, including the cycle van, and bullock carts, but now it is mostly by the two-wheeled pack-horse.

The coal cycle wallahs

A stream of these cycle-wallahs pushing their loads up a hill reminds one of a line of ants struggling with food seemingly too big to be practical. They provide a fascinating subject of enquiry to the curious person. In most cases, the cyclists are friendly and open to chatting, particularly if caught during one of their rest breaks in an uphill push. However, they are often guarded in their responses when asked where the coal comes from. Locals such as jeep/trekker (a form of open large jeep used commonly for transporting passengers) drivers or even local police may stop to help them if a curious interviewer causes suspicion to be aroused.

The loads are pushed by the cycle wallahs 15-25 km sometimes up reasonably steep hills and the return journey may take as long as eight hours. Here, in Figure 10, an initial hard slog as they leave the mining/coking site. In some instances they may pay a motor cyclist to help tow the loaded cycles.

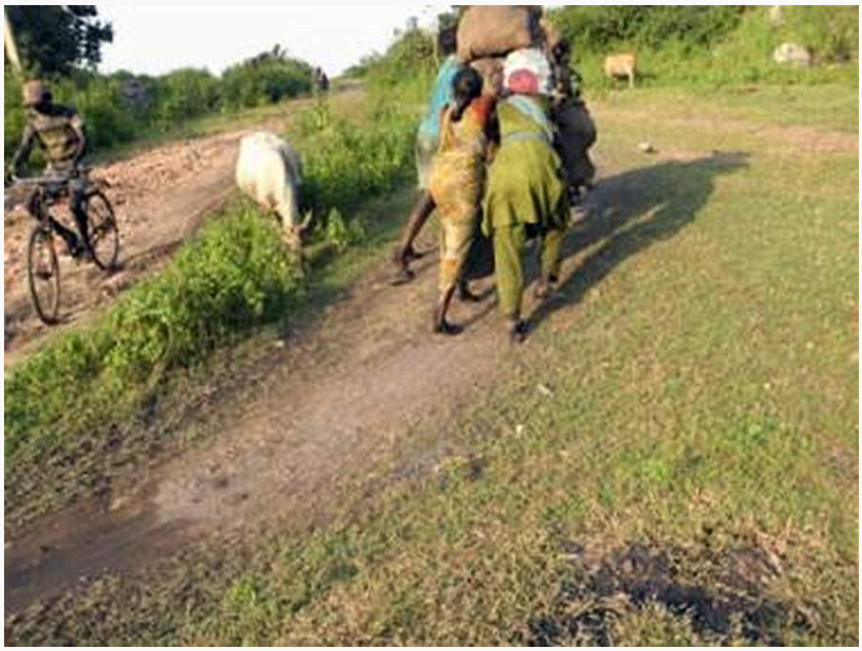

Figure 10. Pushing coke uphill

When pushing the coal up steep inclines out on the roads they may stay in groups of 4 to 8 in order to help each other. On flat roads, individual cycle-wallahs can be observed. For one destination, Ranchi (the capital of Jharkhand), the cycle-wallahs undertake a two day journey of ~60 km, the extra time taken being compensated by a higher price for the coal. The stamina needed to undertake this long trip means

they only do this twice a week, and return by local trekkers with their cycles on top. Those who take only one day for their trip often do it every day.

Some of the cycle-wallahs can also be involved in cutting coal, particularly if they are operating as part of a family unit.

The daily cycle

An earlier survey in 2005 found that around Hazaribagh, cycle-wallahs arrive from about 6am onwards, having arrived at the village mine-site at around 4 am onwards to load up their cycles with raw coal or, more often, newly formed coke - this can take up to an hour. There maybe makeshift tea stalls located on site to cater to their primary needs. The peak arrival time in 2005 was around 7 am then tapering off gradually in afternoon hours. If the mines have only limited amounts of coal to sell then the procession tapers off earlier. After selling their fuel, the cycle-wallahs reinstall the chain and ride the bikes back home.

The bicycle

The cycle used for delivering coal is a basically a standard cycle but strengthened in some ways. All have stouter wheels, such as are found in cycle rickshaws; the spokes are twice the diameter of normal bikes and the hubs are stronger. An elite view of these cycles is that they are 'given' to the local villagers by the coal mafia who control the delivery systems. Based on our surveys, however, we feel that this does not apply to small scale delivery to nearby towns. Some cycles, but not all, have stronger frames through welding reinforcing metal plates to the major part of the frame.

The coal or coke is packed into used plastic or jute bags. The load may range from 8-10 x 20-25kg bags to one 150-200 kg bag roped onto the bike through the frame. The chain is disconnected but carried with them as the bikes are often ridden back.

In the Raniganj area, the bicycles tend to be standard issue rather than special strengthened for the purpose with the result that the individual loads are somewhat lighter. In addition to the bicycles, three-wheeler goods rickshaws are also deployed to carry the coal. The overall organisation of this coal supply network is rather intricate and can engage entire village communities in digging up coal from local, privately owned land. This is because being more densely settled with a longer history of coal mining, the amount of gair majurwa is much smaller towards the east. However, even in the Raniganj region, mines have come up on the surface in the last decade and have left a devastating impact on the environmental resources that these communities have traditionally survived on. An example of the overall organisation of this coal supply network is diagrammed in Figure 11 involving coal dug up by villagers on local private land.

The social characteristics of cycle-wallahs

The effort involved in cutting coal, coking it then transporting it to the point of sale is very dirty and arduous; so who are these cycle-wallahs and why do they do it? To provide some insight into this aspect we surveyed, in this second study, 65 cycle-wallahs operating to the SE and SW of Hazaribagh. Of the 65 respondents, 5 were female. The average age was 38 years, the youngest was 16 and the oldest 65, whilst the women's average age was 49 ranging from 35 to 60. In terms of education, 70% were illiterate,

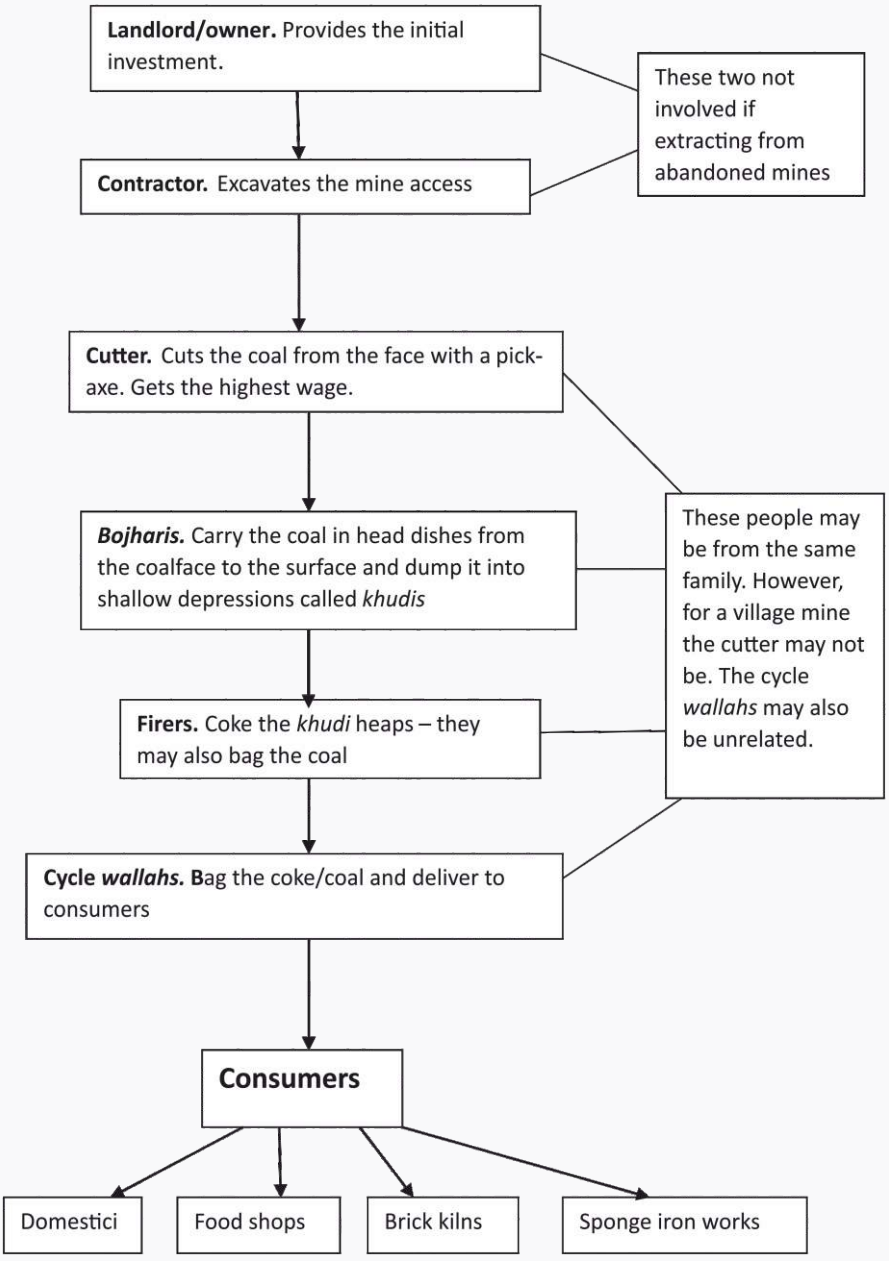

Figure 11. Informal coal supply chain

21% had attended primary school and the remainder had entered secondary school; all the females were illiterate. On average, there were just over 2 children per family, with the minimum being 0 and the maximum 5. About half of the cycle-wallahs stated they had no assets, the other half owned a mobile phone.

With regard to religion, 21 were Animists, 32 Hindu, 9 Muslim and 3 Christian. The breakdown by social group is listed in the Table below; the Muslims and Christians being self identified with their religion and. SC and ST dominate the remainder.

Social group	Nos
Muslim	9
Christian	3
Scheduled Caste	29
Scheduled Tribe	16
Other Backward Castes	8
Total	65

Table 1. Social composition of cycle-wallahs

Two-thirds of the respondents live in huts, with less than 5% residing in pucca houses (made of bricks, cement, steel), a similar proportion in semi-pucca and 9% in kuccha (basically a straw/mud hut). Only two of the 65 had private toilets, the remainder used the fields. Two-thirds of the cyclists were landless, those that did have any land averaged at 0.14 ha, the largest landowner having 0.8 ha. Half of the respondents used wood as fuel the other half coal. One third belonged to a self-help group – these met regularly and had access to banks.

Now we delve more into the background of these people to learn why they do what they do.

Prior occupation	Nos
Self employed	5
Farmer	19
Farmer + Wage labourer	6
Wage Labourer	32
Student	2

Table 2. Prior occupation of cycle-wallahs

This is reasonably consistent with the degree of landlessness as the majority are not farmers. If we ask about their parents' or grandparents' occupation then 90% or more are described as farmers. There is not enough information from the survey to assess whether the land had been divided into units too small to sustain the family but only 5 fathers of the 65 respondents had lost land.

On average the interviewees had spent 10 years coal cutting/carrying, with a minimum of 5 and a

maximum of 25 years. 18 stated that their spouses were housewives, the remainder helping with the coal coking, packing etc. However, another question revealed that only about 10 were 'just housewives', the others helping out in the informal coal business. The length of time they spend per month averages out at 23 days with a minimum of 8 days and a maximum of 30 days. This is hard dirty work and all respondents would prefer to do something else and wouldn't want their children to do this work; but our field observations show that some of the kids do indeed help out in this type of work. Of the 65 surveyed, 46 sold their coal in Hazaribagh, 19 to Ranchi the remainder to other smaller villages, brick kilns and even the CCL staff colony.

It's perhaps not surprising that 63 of the 65 interviewed stated that they were below the poverty line (BPL), the remaining 2 being BPL + greencard-holders. The definition of poverty has a degree of subjectivity and relativity, the latter reflecting that one may be at the bottom of the socioeconomic rankings but well above basic sustenance or survival levels as is the case in wealthy nations.

These values are close to US$1.25 and $0.65 per day respectively at current exchange rates; the former is a commonly used value by many institutions for estimating poverty. In purchasing power parity terms the values are about US$2 and $1.05 respectively.

If we look at the estimates of the earnings of these people from informal coal supply we find that they averaged at INR 6395 per month with the lowest being INR2000 and the highest INR7000. These earnings are informal and therefore tax-free. This money is substantially above the rural poverty line of ~ INR1000 pm, even for the lowest earner, who incidentally was the youngest of the carriers and who only worked 8 days per month. Further details of the working week can be found below.

Other factors that go to make up poverty may have helped push these people into the informal coal supply business; they were asked to comment on the issues listed in Table 3, and the responses on the right-hand side column are typical.

1. Unemployment/Lack of alternatives	There is no alternate source of employment in villages. In one village, for example, there are 200 families dependant on selling coal for livelihood
2. Low agricultural productivity	There is no irrigation facility, so the farms are not as productive as elsewhere.
3.Education	There is no system of education up to a high level. Poor incomes mean that villagers are unable to afford to educate their children up to the college level
4. Health	There is no dispensary or health centre in village, so they have to go to private doctors and buy expensive medicines
5. Assistance from the government	There is no government scheme to help the poor and the officials and political leaders swindle off the money for developmental schemes.

Table 3. Reasons for entering this activity

Extent of supply by the coal cycle

Our approach to quantifying the supply of coal or coke by bicycle has been to observe how many coal cycles come to a particular town, Hazaribagh in Jharkhand, and assuming, the demand is population driven, extrapolating over the towns within a certain distance of the collieries. Surveys of the roads on which coal cycles have been observed define the area across which the extrapolation is made. Anecdotal evidence has also been used.

Delivery to Hazaribagh

Coal cycles enter Hazaribagh by two routes viz. the Ramgarh road from the south-east and the Barkagaon road from the south-west. The cycles start to arrive at about 4 a.m. in winter or summer months from both roads. Those from the south-east can still be seen arriving at 4 p.m., whilst those from the south-west seem to cease at about 2pm. The reason for this difference may be due to the amount of coal that is available for delivery from the sources that use these roads. The latter fuel from the south-west comes from small village-dug mines with limited production rates, whilst the former comes from around the official mines, east of Charhi. The rates of cycles, observed by traveling along the road in question or by counting at a particular point on the road, are listed in Table 4 in round figures.

Time	Cycles per 2 hour
From south-west (Barkagaon valley) sightings	
4:00 – 6:00 (2 hrs)	50 (Dhingura)
6:00 – 8:00 (2 hrs)	150 (Dhingura)
8:00 -10:00 (2 hrs)	100 (Khapriawa)
10:00 -12:00 (2 hrs)	100 (Fatha)
12:00 – 14:00	100 (St. Columbas Hospital mord)
From south-east (Charhi Coalfields of C.C.L) sightings	
4:00 – 6:00 (2 hrs)	100 (Hathiari mord)
6:00 – 8:00 (2 hrs)	200 (Demotand)
8:00 -10:00 (2 hrs)	150 (Masipiri)
10:00 -12:00 (2 hrs)	100 (Herangunj)
12:00 – 14:00 (2 hrs)	50 (St. Columbas college mord)

Table 4. Rate of coal cycles proceeding into Hazaribagh town

Total numbers of cycle coal carriers entering Hazaribagh from south-west illegal coal mines of Barkagaon valley via the Barkagaon ghati daily between 6 am to 2 pm (9 hours) is approximately 500 cycles, each carrying about 250 kg of coke. Those entering Hazaribagh from south-east Charhi coalfields via the Charhi ghati daily between 6 am to 2 pm (9 hours) total approximately 600 cycles.

The cyclists still keep arriving, albeit at a diminished rate, after the end of counting. In the previous study (Lahiri-Dutt and Williams, 2005) a plausible distribution curve was fitted to the data based on anecdotal evidence of the time period that coal carriers arrive. Taking a similar approach, we would estimate that perhaps 1250 cycle arrive daily in Hazaribagh carrying a total of about 300,000 kg coke roughly equivalent to 450,000 kg coal.

The population of Hazaribagh was about 153,000 in 2011 according to the Census of India; thus, the market for this sort of fuel is equivalent to ~ 2 kg per capita per day of coke. The previous estimate was 1.5 kg per capita per day; whether there has been an increase in demand or the estimates are within the bounds of uncertainty is a moot point. Nevertheless, we will use this value to estimate the overall market for the coal cycle in the coalfield region defined by the area in Figure 2.

Delivery of coal by coal cycle

Delivery of coal/coke by bicycle to towns up to ~30 km away and return can be accomplished by the cycle-wallahs in one day. In some instances, they travel for two days (e.g. Ranchi) but probably only to large towns/cities where higher sale coal price makes it worthwhile. Towns, to which it is known the coal cycles go, are listed in Table 2, along with their population taken from the 2001 census and the estimated weight of fuel that the coal-wallahs deliver.

India has a large rural population, so although the population of Hazaribagh municipality is only 153,000, the population of Hazaribagh district (area ~4400 sq km) is about 1.7 million. We have used the urban population as the demand driver for coal by bicycle, as rural families often use local fuel wood for

Table 5. Annual demand for cycle coal based on population

Town	Population (000s) 2011	Amount of coke (thousands tpy)
Hazaribagh *	153	111
Ramgarh *	132	92
Dhanbad *	1195	838
Ranchi *	1126	789
Bokaro Steel City *	498	346
Chas	97	68
Chatra	63	44
Simdega	43	30
Asansol UA	1243	872
Durgapur	581	407
Faridpur	140	112
Total	5,294	3709

* Populations refer to urban area conglomerates as per Census, 2011

domestic consumption. The list of towns and their population as per 2011 Census are shown in Table 5. The total amount of coke carried by coal cycle is estimated to be 3.7 million tonnes annually, which is equivalent to about 5.5 million tonnes coal. In terms of the amount of coal, In the case of Ranchi, the state capital of Jharkhand and a bigger urban centre, it involves a two day trip for the coal cycle-wallahs twice a week, the rate of coal carrying could be lower than that to other towns that only involve a one day for the round trip. We have, however, used the same specific demand factor for Ranchi as used for the other towns.

A typical working month

As part of this study, we asked 65 cycle-wallahs to respond to a questionnaire from which thefollowing information was ascertained. A summary of their responses is provided in Appendix 1

Supplying Hazaribagh

The cycle coal carriers from the villages of Harli, Rudhi, Babupara near Badam in the Barkagaon valley to the south-west of Hazaribagh, carry coal on cycles 4 days/week or 16 days every month. They typically leave home about 2 am in the morning carrying coal on the cycles via the ghati (mountain road) to reach Hazaribagh by 6 am, taking breakfast under the shade of a Mahuwa tree in Dhingura village near Hazaribagh. Then they go about selling the coal returning home by 2 pm. Hence they work almost 12 hours on the day when they are carrying coal. When not carrying coal, they are collecting, coking, packing and loading coal onto the cycles, working almost every day of the month.

Those coming from Nano, Parbar near Charhi Coalfields to the south-east, carry coal 3 days a week and thus make 12 trips to Hazaribagh per month, One day is spent collecting, packing and loading coal on to the cycle, so he works typically 24 days a month. They start from their village at 2 am in the morning to reach Hazaribagh by 6 am in the morning, cycling for 5 hours.

Informal miners at Agaria tola near Parej coal mine in Charhi in south Hazaribagh district collect, coke and pack coal about 8 days a month, then on another 8 days they carry the coal on cycle to sell at the road side. Some, however, do this for 24 days a month. Similarly nearby coal miners at Durukasmar, cut,collect, coke and pack coal three times a week, that is 12 days a month, while during another 12 days they carry the coal on cycle to the road side where customers in vehicles buy it from them. Note that the amount of coal delivered this way is outside or in addition to estimates made of delivery to centres of population.

Because the daily number of cycle-wallahs entering Hazaribagh is fairly constant then at least twice that number are working in this coal supply business as they only carry coal about 12 days per week.

Supplying Ranchi

The cycle carriers of Giddhi, Urimari, Bhurkunda Coalfields (North-west Ramgarh district) who carry coke via Patratu to Ranchi take three days to sell their cycle load of coal. Day 1 - coal collection, Day 2 - transporting coal on bicycle via Patratu to Ranchi with a night halt, and Day 3 - selling coal from door to door in Ranchi town and returning home by mid-day. They deliver coal once a week making 4 /trips a month. Those from the Rajrappa Coalfields (East Ramgarh district) who carry coal via Chatupallu ghati have a similar pattern except they manage two trips per week to Ranchi whereas carriers from Kujju (North Ramgarh) do 8 trips to Ranchi via Ramgarh and the Chatupallu ghati to Ranchi.

The cycle coal carriers of Birsa and Patel nagar in Bhurkunda (West Ramgarh district) start moving their cycle loads from their village at 3 am and by 7 am arrive at the brick kilns in Ghutwa, Barkakhana and C.C.L. staff colony quarters where they also sell the coal. Those from Bhurkunda, Sirka, Saunda

Coalfields (West Ramgarh) who sell coal to households and brick-kilns in Ghutwa, Barkakhanna west of Ramgarh have a different schedule, delivering coal 16 times a month, other days being spent collecting and packing.

Rewards

The responses to the survey questionnaire provided details of overall earnings of cycle-wallahs; more details were revealed in various interviews with other cycle-wallahs, particularly those getting coal from around Ramgarh and selling it to Ranchi. Those working in the Bhurkunda coalfields (East Ramgarh district) pay Rs.120/- to the coal cutter at the coal mine, and the land owner (where the illegal coal is mined) for a bike load of fuel and sell it for Rs 200-300 earning around Rs. 5000/- (monthly).

Those carrying coal to Ranchi from Kundru, near Rajrappa coalfields (East Ramgarh district) sell their cycle load of coal for Rs.400/- to Rs.500/- . As they usually undertake 8 such trips per month, their earnings range from 3200- to Rs.4000/- per month. The cycle-wallahs working at Hundru khurd, near Rajrappa coalfields (West Ramgarh district) buy the coal for Rs.200/- to Rs.300 per load and sell it in Ranchi at Rs.700/- to Rs.800/- thus earning around Rs.4000/- per month. Those getting coal around the Kujju Coalfields (North Ramgarh district) pay Rs 300 at the mine head or from other villagers who mine and coke the coal and sell the cycle load of coal for Rs.1000/- in Ranchi. They do this 8 times a month earning RsRs. 5,600/- per month.

The cyclists from Torpa near Kujju Coalfields (North Ramgarh district) carry 6 small sacks plus one big sack of coal in the centre of the cycle frame twice a week or 8 times a month, selling it for Rs.1200/- to Rs.1300/- in Ranchi from door to door. They pay at the mine-head Rs.200/- to Rs.300/ earning up to Rs. 7000/- per month which is sufficient tto meet family needs.

The cycle coal carriers of Sirka Coalfields (North Ramgarh district) buy the coal at Rs.120/- per big sack at the mine-head and they carry and sell the coal either to households, tea-shops or merchants who further market the coal in Ranch. They do this twice a week or 8 trips a month and they earn up to Rs.550/- to Rs.600/- per trip or Rs. 4,800/- per month. The cycle coal carriers of Saunda Coalfields (North Ramgarh district) sells the coal from door to door or brick-klins in Barkakhana, Ramgarh for Rs.300/- per trip, 4 days a week x 4 weeks = Rs.4,800/- per month.

The cycle-wallahs of Giddhi Coalfields (North-west Ramgarh district) start at 4 am and carries coal on cycle via Patratu to reach Ranchi in the evening a distance of 70 km. They get Rs.1200/- to Rs.1300/- per cycle load of coal, once a week x 4 weeks = Rs.5,200/- per month. Similarly, the cycle coal carrier of Urimari Coalfields (North-west Ramgarh district) buys the cycle load of coal Rs.500/- to Rs.600/and after travelling- over 70 km to Ranchi sells for Rs.1400/- to Rs.1500/-, He does four such trips a month, earning Rs.3,200/- net per month.

Those who get coal from around the Lapanga, Bhurkunda Coalfields (North-west Ramgarh district) pay Rs 400 to buy 400-450 kg coked coal packed in 21 sacks at the minehead, another Rs 150 to motorcycle carriers for pulling his cycle laden with coal up the Jilabee ghat and hafta (bribe to police, etc. en-route) of Rs 250 He sells his load for Rs.1400/- to Rs.1500, which he does once a week thus earning 2,800/- net monthly.

The cycle coal carriers of Patratu Coalfields (North-west Ramgarh district) carries 20-22 sacks of coal on his cycle which he sells in Ranchi for Rs.1300/- to Rs.1400/- per load four times a month. He pays Rs.500/- for the coal and expense in the ghati for motor cycle assistance, so he makes about Rs.2,800/- per month.

Two migrant cycle-wallahs (originally from Murni east of Ranchi), who get coal from Urimari Coalfields

(north-west Ramgarh district), have rented a room at Rs.300/- and hired a cycle for Rs.600/-per month for Rs.200/-per load carried in about 20-22 sacks of coal which they sell for Rs.50 to Rs.55/- each sack, in total one cycle trip is sold for Rs.1200/- or Rs.1300/-. They have additional expense in the ghati to pull the cycle by motorcycle at Rs.300/- per trip.. Their net earnings are about Rs. 2,300/- per month each.

Coal stockists and merchants of Mandu (north Ramgarh district) (village middlemen really) buy their coal from cycle coal carriers operating around the Mandu Coalfields who sell it for Rs.50 to Rs.55/- per bag Rs.400/- to Rs.450/- per load. This is on-sold at the road side to customers traveling from Ranchi to Hazaribagh who buy it for Rs.70/- per sack. The road-side sellers can make Rs.150/- to Rs.160 or 4500 per month. This has been happening for the past twenty years.

Similarly, at the Hesagada near Kujju Coalfields (North Ramgarh district) people spend three days a week at the mine collecting, coking, and packing coal in gunny sacks which are sold at Rs.20/- each x 15 sacks per day or Rs.3,600/- per month to road-side resellers on the Hazaribagh-Ranchi road The stockists sells the coal at Rs.50 to Rs.60/- per sack.

There are over a dozen Brick kilns at Dulmi block under Rajrappa thana (East Ramgarh district) which are using illegal coal supplied by cycle coal carriers from illegal coal mines on the Damodar river and transported by tractors after 9 pm. The cycle coal carriers use the route via Nayamord to Chotkipana and Marang marcha via Sikni village to reach the Dulmi block.

This information is summarized in the Table 6. The cost of buying coal varies from site to site and the net monthly income depends on the number of trips they make each month.

Village	outgoings per cycle load (INR)	income per load (INR)	monthly net income (INR)
Bhurkumda	120	250	5000
Kundru			3600
Hundru khurd	350	750	4000
Kujju	300	1000	5600
Torpa	250	1250	7000
Sirka	120	600	4800
Saunda		300	4800
Giddhi		1250	5200
Urimari	550	1450	3200
Lapanga	550	1450	2800
Patratu	500	1350	2800
migrants Urimari	650	1250	2300
roadside sellers	55	150	4500

Table 6. Monthly incomes

Village survey

In order to investigate the contribution of informally mined coal to local livelihoods, we also carried out a survey loosely based on the livelihoods framework to see if any further insights could be obtained from the 'source' end of the coal carriers. This survey was undertaken in two villages that have in recent years been both impacted by large-scale coal mining leading to a marked switch in the primary subsistence of their populations who are now heavily involved in the supply of informal coal. One village, namely Duruskumar, is situated to the southeast of Hazaribagh, near Parej East open cut project, and the other, namely Bapupara/Rudhi, is located to the southwest, in the Barkagaon district where a number of mining leases have been granted.

Responses from 20 households in each village were obtained by going from door to door by interviewers. All respondents but one were male and were of similar age distribution, averaging 40 years and all were married. They were predominantly animist in religion with 2 or 3 Hindu in each sample. However, there were some distinct differences in regard to other parameters. The majority of those interviewed in Duruskumar was illiterate while some in Bapupara/Rudhi had reached secondary school; but those in Duruskumar had, on average, nearly four time as much land. Part of the reason for poor educational standards in Duruskumar may be the lack of near-by schools noted by the villagers; as against this all children in the two villages were attending school.

We tried to understand the social changes in response to the expansion of coal mining in the area, and the key questions pertained to the occupation of the father and that of the grand-father. The difference in land holdings is further reflected by the fact that the fathers of the Bapupara/Rudhi respondents were mostly wage labourers whereas those from the Durukasmar village located in the southeast were mostly farmers. However, all the Duruskumar respondents said that either they or their fathers had lost land, the amount typically being 1 ha, to the Parej coal mine project. They had also received monetary compensation averaging at INR 140,000 (1.4 lakhs); the money mostly being used to build or repair a house. Going back a further generation the grandfathers in both villages were nearly all farmers. One can only speculate about the reasons for these circumstances, but it would seem that the grandfather of the Bapupara/Rudhi villagers had either lost land or it had been subdivided amongst inheritors to the point where farming was no longer an economically viable livelihood option.

Education	Duruskumar	Bapupara/Rudhi
illiterate	11	2
literate	7	3
primary	1	4
secondary	1	11
Ownership of Land		
average (ha)	1.36	0.37
Max	2.8	2.13
Min	0.62	0.05
landless	3	

Table 7. Differences in education and land ownership

To understand choice in livelihood, we inquired about their preferences. The answers to these questions show marked difference between the two villages: the villagers from Duruskumar who had bigger lands and have been more directly affected by coal mining would all prefer to be farming rather than cutting coal, whilst all but 4 were accepting of their coal work. However, no respondent in either of the villages wanted their children to work in the cycle coal trade.

Economically, five Duruskumar respondents indicated they had a red card with the remainder being BPL as were all those in the other village. The monthly earnings were very similar in each location, on average about INR 14,000? each,. People in Duruskumar village, however, still have more assets; all respondents saying they had a cycle, motor-cycle and a bullock cart whereas there were no motor-cycles in Bapupara/Rudhi and only 4 bullock carts. This is probably a reflection that Duruskumar residents were closer to being involved in farming. When we asked about the reasons why they were involved in coal cutting, all said that poverty was the main driver for them entering the coal-cutting occupation and also noted the fact that there were no alternative livelihood opportunities.

With regard to services, all villagers had electricity connection to their homes but Bapupara/Rudhi respondents complained about the intermittency of the supply. All were dependent on wells or handpumps for water and only 2 had a privy, the remainder using the open fields.

Other comments concerned the fact that Duruskumar was within CCL Parej project command area so they cannot avail of the benefits of the various Rural Development Programme and schemes of the government. People from both villages complained about the lack of access to primary health care and the distance of higher education facilities. Seasonal lack of water was more acutely experienced in Duruskumar whereas monsoonal rains made access (by dirt road) difficult in Bapupara/Rudhi.

Associated Greenhouse Gas emissions

The coal utilized in this distribution network mostly comes from shallow underground village-dug mines or retrieved from abandoned formal opencut mines. Either way, there is no coal seam (ie methane, CH4) gas contained in this coal, either because the worked seam was too shallow or had been exposed long enough to lose any gas originally there. One component that will emit GHG is the heap coking. This process will release both CO2 and CH4 as well as volatile organic compounds (VOCs) and copious amounts of fine particles. However, there are few if any data on heap coke emissions, though there are some on coke oven gas which is typically about 50% H2 and 30% CH4 with a little CO and CO2. Usually this gas is utilized for heating within the steelworks generating the coke. Before natural gas became widely available it was used specifically generated for piping to industry or domestically. In coke oven gas, care is taken to keep air out to maximize the H2 and CH4, but in heap coking some air needs to seep in to maintain the heating. Perhaps the nearest approach would be to use emissions data from spontaneous combustion of coal which can occur in waste coal heaps and is in effect a form of smouldering combustion much like heap coking.

Using the measurements of Carras et al., (2009) for emissions from tailings and rejects, the CH4/ CO2 ratio is ~ 1% on a wt/wt basis for a high emission situation and assuming that the bulk of the volatilized carbon released by coking is oxidized to CO2 in the heap coking process, then coking 5.5 Mtonnes coal (to produce 3.7 Mtonnes coke) would release 6.6 Mtonnes CO2 and 60,000 tonnes CH4. Assuming CH4 is 21 times more potent than CO2 in regard to climate change the total global warming potential from supplying 3.7 million tonnes of coke would be would be 6.6 +(21 x.06) = 7.26 million tonnes CO2 equivalent. This is a rough estimate and assumes that nearly all the fuel delivered by cycle has been coked. This procedure estimates that the generation of CH4 in the heap coking process adds about 6% to the overall GHG emissions arising from the consumption of coal delivered by cycle.

Discussion and Conclusion

This study has shown that the informal coal supply system is alive and well; indeed it would appear to have expanded, perhaps doubled by 2012, in the amount of coal or coke being distributed around the coalfields since 2005.

From the temporal studies, it appears that there are three main explanations for this expansion: a) lack of a coal/coke supply system that small end-users can avail themselves of; b) intensifying rural poverty and decay in agricultural, forest-based livelihood systems; and c) growing urbanization throughout the region, creating an increased demand for coal as the domestic fuel. Besides the coal-cycle system, the supply chain of legally (and illegally) mined coal has led to the establishment of a coal mafia (Lahiri-Dutt and Williams 2005). However more details of the socioeconomic details of these miners, particularly the cycle-wallahs have been ascertained.

The miners are usually from tribal or scheduled caste communities from the villages surrounding the major open cut projects initiated in the area since late 1990s. Many of them have been displaced from their ancestral lands by large-scale formal coal mining operations. More importantly, livelihood opportunities have either shrunk or changed; the shift away from farming-forestry implies also an occupational dislocation of communities. Many of those surveyed have been doing this type of work for 10-15 years or so, and they see it as a moral right to dig up some coal themselves from what used to be their own land.

The social change is reflected in the organization of production. The manner in which labour is organized has changed; previously, only men used to work in group of 5-8 individuals, pushing their own bags, which weighed around 150 kilos. In 2012, we found distinctive changes in labour organization; the cycle-carrier groups were smaller, comprising a family unit of labour, but more numerous overall. The miner, usually together with a son or a daughter and his wife, works as a unit in which some are apprentice-cum-helpers. Consequently, there are many more children working in these cycle-delivery systems these days.

Income-levels, however, have not increased significantly in the intervening period; the miner tends to makes only about INR 3,000 per month, an amount that is still hovering around the official definition of poverty line in India. The cycle-wallah (along with his family) earns somewhat more with a monthly net income of INR 4,000-5,000, which is probably about four times the amount they might get from working as agricultural labourers. However, one needs to consider that earning this income involves many hours of labour, as the cyclists need to start at 2am to get to their selling destinations at 6am or so. The demand for the coal has been rising not just due to deforestation and the decreased availability of dry twigs as fuel, but also because of increasing urbanisation from constant inward-migration to the area. The two lead to each other; people moving into cities aspire to use coal instead of biomass, and conversely, the rising populations further fuel illegal mining of coal. Decaying agriculture is due to an overall change in local ecosystems; large-scale, formal coal mining expansion has impacted adversely on the water supply and in the undulating terrain of the area, irrigation was never available. Most importantly, despite the presence of large-scale and sophisticated extraction technology-based economy spreading all around, there is inadequate availability of and limited access to education and primary health care among those living at the bottom of the heap.

The two surveys show convincingly that the driving force for the cycle-carried coal distribution work is deepening poverty, the loss of land through expansion of open-cut coal mining and a lack of alternative

job opportunities in a context of rapid agrarian and social change. These are exacerbated further by the lack of a well-organised, legal, coal/coke supply system for the small-users. Any policy measure, therefore, must deal with deepening poverty rather than applying cosmetic and top-down policy measures to regulate the cycle-wallahs.

Undoubtedly, one cannot condemn the cycle-wallahs for taking up this work, dirty and degrading though it might be, when one is on the poverty line and faced with no alternative. They certainly do not want their children to follow in their footsteps. There needs to be a wider social, human rights and environmental impact assessment so that an open and transparent review of the way mine clearances are granted can be put into the public forum. Only then will justice manage to filter down to these people.

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Appendices

Appendix 1 Cycle-wallah survey

No of respondents	65	Years coal cutting	
Male	59	Average	10
Female	6	Min	5
Age		Max	25
average age	38.35	Loss of land	
min age	16	fathers who lost land	5
max age	65	Earnings pm	
Marital status		Average	4385
Married (males)	59	Min	2000
Education		Max	7000
illiterate	46	Preferred occupation	
literate	0	Farmimg	16
primary	14	Wage Labourer	32
secondary	4	Contractor	4
Family compostion		Driving	2
Average no of children	2.15	Not sure	1
Min	0	Coal destination	
Max	5	Hazaribagh	37
Religion		Ranchi	17
Animist	21	Ghutwa CCL Colony and Brick-kilns at Masmona (Ramgarh).	7
Hindu	32	Coal cycle arriers, roadside	4
Muslim	9	Electriciy	
Christian	3	No	12
		Yes	53
Having Land	21	House type	
average (ha)	0.14	pucca	3
Max	0.8	semi pucca	3
Min	0.008	Kucca	6
landless	44	hut	43
Prior Occupation		Toilet	
Self employed	5	private	2
Farmer	19	field	63
Farmer + Wage labourer	6	Fuel	
Wage Labourer	10	Coal	32
Student	2	Firewood + coal	33
Housewife/wage labourer	1	SHG?	

Fathers Occupation		Yes	21
Self employed	6	No	44
Farmer	58	Regular meetings?	
Farmer + Wage labourer	0	Yes	21
Wage Labourer	1	No	44
Grandfather's occupation		SHG Bank a/c?	
Self employed	5	Yes	20
Farmer	60	No	45
Farmer + Wage labourer	0	Assets	
Wage Labourer	0	None	30
		Mobile	35

Appendix 2. Village survey

	Duruskumar	Bapupara/Rudhi		Duruskumar	Bapupara/Rudhi
No of respondents			Would like to do anything else		
male	20	19	yes	20	4
female	0	1	no		16
Age			What work?		
average age	40.7	40.6	anything	20	
min age	24	28	farming		4
max age	70	65	Where do you sell coal?		
Marital status			Hz	14	20
Married (males)	20	20	Charhi & Hz	2	
Education			roadside	3	
illiterate	11	2	Why do you sell coal		
literate	7	3	for cash because of poverty	19	20
primary	1	4			
secondary	1	11	Loss of land		
Family composition			fathers who lost land	19	0
Average no of children	no response	no response	how much		0
Min			average	1 ha	
Max			compensation?		
Religion			yes	19	n/a
Animist	17	18	From?		
Hindu	3	2	Parej	19	n/a
Muslim	0	0	how much		
Christian	0	0	average	140000	
			min	30000	

Having Land			max	300000	
average (ha)	1.36	0.37			
Max	2.8	2.13	How spent		n/a
Min	0.62	0.05	Paid off debts	2	
landless	3		repaired house	1	
Prior Occupation			built house	10	
Self employed			built house + paid debts	2	
Farmer	4	4	bought m/cycle+bank	1	
Farmer + Wage labourer	7	9	bought m/cycle+ repair house	2	
Wage Labourer	2	7	banked	1	
Farmer and self-e	6		Children what do they do?		
Fathers Occupation			study	all school age	all school age
Self employed	2		Should they cut coal?		
Farmer	18	2	yes	0	0
Farmer + Wage labourer		2	no	20	20
Wage Labourer		16	electricity?		
Farmer and self-e			yes	20	20
Grandfather's occupation			no	0	0
Self employed	2		House type		
Farmer	18	20	Kutchha+clay tiled roof+mud house walls	20	2
Farmer + Wage labourer			Pucca made by the govt. Indra Awas Yojona	0	7
Wage Labourer			Mud house- Kutchha roof	0	4
Wifes occupation			Pucca and Kutchha with roof	0	3
Housewife only	17	1	Pucca	0	1
Wage Labourer		19	1 Pucca house and 1 Kuccha mud house with tiled roof	0	2
helps with coal cutting	3		2 Pucca house and 1 Kuccha mud house with tiled roof	0	1
Years coal cutting			source of water		
Average	12	12.4	well	20	19
Min	10	6	handpump/bore	0	1
Max	17	35	toilet		
			fields	18	20
			own privy	2	0
Earnings pm			cooking fuel		
Average	7220	6720	firewood + coal	20	20
Min	3200	4000	SHG?		
Max	14400	12000	yes	19	2
Transport			no	1	18
Bicycle	20	20	SHG meet often		
Motor cycle	20	0	yes	20	19
Bullock cart	20	3	no	0	1
Tractor			Economic status		
			red card	5	0