



# Costs of occupational lung disease in South African gold mining

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**This paper analyses the costs of gold mining related occupational lung disease to the mining industry, the state health services and the mine labour sending communities. The extent of the liability of unpaid occupational lung disease compensation is estimated. It is shown that there is a high prevalence of uncompensated occupational lung disease in ex-mineworkers and that much of the cost of this disease is being externalised from the industry. The total cost, both internalised and externalised, of gold mining related lung disease represents 6 per cent of the 1996 wage bill and 2.6 per cent of the gold mining industry's contribution to South Africa's GDP in 1996. Better information on costs is critical for planning profitable and safe gold mining and also for the planning and budgeting of health care services.**

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The economic importance of South Africa's gold mining industry has been well studied however little attention has been paid to the concomitant social costs. Health and safety risks posed by mining have promoted the establishment of a legislated monitoring and medical surveillance system as well as a considerable health infrastructure run by the mining industry itself. This infrastructure makes it relatively easy to quantify the occupational health costs that have been internalised by the mining industry. Externalised costs are more difficult to quantify because of the lack of an occupational health infrastructure in the labour sending areas. Recent research on the burden of occupational lung disease in ex-gold mineworkers in the Libode magisterial district of the Eastern Cape Province, South Africa, has generated information allowing the scope of inquiry to include health costs not captured within the gold mining industry. It is important to note that the methodology of this paper is determined by the available information. In an industrialised country it would not be considered good practice to extrapolate from surveys undertaken in only two districts to the whole country. In South Africa basic occupational health databases are unavailable and the studies on which this paper is based are currently the only available data sources.

The focus of this paper is on the quantification of the direct costs of three factors. First, the unpaid liability of compensation for occupational lung disease; second, the treatment costs for diseases attributable to mining; third, individual spending on medication and transport costs to and from medical facilities. No attempt is made to quantify indirect costs of lost opportunities (such as the diversion of resources away from the education of children into medical purchases pertaining to occupational lung disease) or pain and suffering experienced by ex-mineworkers and their families. The results of the medical research underpinning this evaluation of the costs of occupational lung disease have been reported elsewhere.<sup>1</sup>

The economic cost of mining related occupational lung disease is considerable. Externalised health costs are being borne by the state and by mineworkers and their families. Furthermore, occupational lung disease represents a major, previously uncosted cost of production for the South African gold mining industry. The country's beleaguered gold mining industry needs good information on costs to devise strategies for safe and profitable mining.

## Migrant mine labour and occupational health

Migrant labour has been a central feature of employment for black workers on the South African gold mines for over a century. Oscillating labour migration has entrenched the geographic separation of home and work and the movement of workers, without their families, between rural and urban areas.<sup>2</sup> Despite South Africa's political transition to democracy, migrant labour remains the dominant form of labour supply to the gold mines and more than 83 per cent of those currently employed are migrants from rural districts within South Africa or from neighbouring states.<sup>3</sup> While mining initiated industrial development and urban growth in Southern Africa, rural labour sending areas have become, in effect, dislocated urban communities, with eroded subsistence economies dependant on mine wages.<sup>4, 5</sup> The implications for health are profound: diseases contracted while in employment are brought back to rural areas least able to cope with them.

Gold mining entails an occupational exposure to dust with a high content of free crystalline silica. The respiratory diseases associated with gold mining are simple chronic bronchitis,<sup>6</sup> emphysema,<sup>7</sup> chronic airways obstruction,<sup>8</sup> silicosis<sup>9</sup> and tuberculosis<sup>10</sup>. There can be a long latency period between exposure to risk factors on the mines and detectable occupational lung disease in mineworkers as a result of which many migrant mineworkers manifest occupational lung disease in the areas to which they return after leav-

### **Contract labour recruiting in a South African mine.**

ing mine employment rather than on the mine itself.

Compensation for occupational lung disease in mineworkers is provided in terms of the Occupational Diseases in Mines and Works Act (ODMWA).<sup>11</sup> The ODMWA is a "no fault" compensation system which makes provision for compensation for the following diseases: pneumoconiosis, pneumoconiosis together with tuberculosis, permanent obstruction of airways, progressive systemic sclerosis and any other permanent disease of the cardio-respiratory organs attributable to risk work. All in-service and ex-mineworkers are covered by the ODMWA regardless of citizenship. Not all radiological disease is sufficiently severe to merit compensation. The ODMWA defines disability due to compensable disease in two degrees; first degree being one of the scheduled diseases resulting in a permanent disability of more than 10 per cent but less than 40 per cent and second degree being either more than one compensable disease simultaneously or a single disease producing a permanent disability of greater than 40 per cent or simultaneous occurrence of tuberculosis and another compensable condition. Compensation under ODMWA is wage based with a first degree payment being approximately equivalent to eighteen months salary and a payment in the second degree being approximately equivalent to three years salary. There is no provision under the ODMWA for loss of earnings, retraining or recurrent medical expenses, as are catered for under the non-mining occupational disease compensation system in South Africa. Temporary loss of earnings benefits for in-service workers receiving treatment for tuberculosis are also provided for under the ODMWA.

South Africa has had mining related compensation legislation and a state run medical facility for mining related occupational lung disease since 1916 but until the 1993 amendments to the ODMWA access to this facility was reserved for white workers. Compensation payments

were also based on race and favoured whites over blacks until 1993. Access to the state run medical facilities for mining occupational lung disease was deracialised in 1993 but for the majority of former mineworkers access is still de jure and not de facto as occupational health screening facilities are still almost entirely based in the areas in which white workers have historically lived and not in the migrant labour sending areas. The lack of awareness on the part of ex-mineworkers and health workers in labour sending areas as to their rights and obligations respectively under the ODMWA has probably resulted in a large number of cases of undiagnosed and uncompensated occupational lung disease.

### **Prevalence of occupational lung disease**

There are only two studies of occupational lung disease in ex-gold mineworkers resident in rural labour sending communities. Both studies show a considerable burden of disease. Steen *et al.*<sup>12</sup> used a census of Thamaga village, Kweneng district, Botswana to draw a random sample of ex-mineworkers. Trapido *et al.*<sup>1</sup>

used the gold mine recruitment records, for the period 1969 to 1980, for the Libode magisterial district, Eastern Cape Province, South Africa from which to draw a random sample. Steen *et al.* found an overall prevalence of pneumoconiosis (defined as  $\geq 1/0$  on the ILO International Classification of Radiographs of Pneumoconiosis)<sup>13</sup> of 26 to 31 per cent (variation by radiological reader). Twenty six percent of the Thamaga group had a reported history of tuberculosis. Trapido *et al.* (1998a) found a prevalence of pneumoconiosis (1/0, ILO) of 22 to 37 per cent (variation by reader). Thirty three percent of the Libode group had a reported history of tuberculosis. Both studies were able to demonstrate that there is a statistically significant association between total length of service on the gold mines and pneumoconiosis. In both studies pneumoconiosis, emphysema and tuberculosis were all significantly associated with reduction in lung function.

Detailed information as to the eligibility for compensation for pneumoconiosis of study subjects is only available for the Libode study. Of the Libode random sample 24 per cent have been found eligi-



ble for compensation for pneumoconiosis by the certification committee of the Medical Bureau for Occupational Disease (MBOD). Appeals for the Libode cases are still pending and this may increase the prevalence of compensable disease somewhat. First degree cases accounted for 36 per cent and second degree cases accounted for 54 per cent of cases awarded compensation. 10 per cent of cases were certified as pneumoconiosis plus tuberculosis first degree, a certification explicitly not provided for in the legislation which states that one of the criteria for second degree disease is more than one compensable disease simultaneously. All these cases have been appealed. For the purposes of analysis these case will be treated as second degree on the grounds that simultaneous compensable disease is automatically second degree, brining the total number of second degree cases to 64 per cent. Of those cases certified as eligible for compensation 62 per cent had no previous history of compensation, 35 per cent had been previously compensated but their disease had progressed and they were entitled to additional compensation, only 2.5 per cent had been paid in full and were entitled to no additional compensation. This indicates a high prevalence of previously uncompensated compensable disease.

The average payment for first stage disease for the Libode group was 22 888 South African Rand (ZAR) and for second stage was 45 508 ZAR. The average payment for an upgrade from first degree to second degree was 39 208 ZAR.

The radiological prevalence of disease reported by both studies and the failure of the compensation mechanisms reported for the Libode group highlights the failure of detection mechanisms both on the mines and also in the labour sending areas.

### Estimating the liability of unpaid mining occupational disease compensation

Quantification of the extent of the liability of unpaid occupational disease compensation is hampered by the absence of accurate denominator data relating to the number of men who have worked on the gold mines between 1973 (when the ODMWA came into effect) and 1997. Based on available data, White<sup>14</sup> has produced a denominator estimate of 2 million men engaged in risk work, 70 per cent of whom he estimated to be South African citizens. Data from the annual reports from the MBOD show that between 1973 and 1997 37 598 men were certified as having pneumoconiosis com-

pensable under the ODMWA and 107 171 were certified with tuberculosis.

Data from Libode suggest that 240 per 1000 have compensable pneumoconiosis and 333 per 1000 have a history of tuberculosis. The best available data<sup>15</sup> indicate that 34 per cent of tuberculosis among ex-mineworkers can be attributed to mining. The best estimate of tuberculosis attributable to mining is thus 113 per 1000. Extrapolation to the total population of ex-mineworkers assuming the same prevalence indicates that there are an estimated 480 000 cases of compensable silicosis and an estimated 226 000 cases of attributable tuberculosis. The difference between the reported and the estimated cases of pneumoconiosis is 442 402 and the difference between the reported and the estimated cases of attributable tuberculosis is 215 283. White<sup>16</sup> estimates that 60 per cent of men who worked on gold mines between 1973 and 1997 are still alive, this means that there are an estimated 288 000 cases of compensable pneumoconiosis (201 600 inside South Africa and 86 400 outside South Africa). On existing data it is impossible to assess how much of the attributable tuberculosis is compensable. All one can say is that the cost of attributable tuberculosis currently falls on the state health services and the community and that some of this disease would be compensable.

Using the Libode compensation data as a model one can estimate cases of compensable lung disease generated by the gold mines between 1973 and 1997. The estimated liability of unpaid compensation under the ODMWA is shown in table 1.

The data shows that an estimated 6 973 MZAR (MZAR = Millions South African Rand) is owing to South African nationals suffering compensable lung disease. When amounts for which foreign nationals are eligible is added to the total, the unpaid liability rises to 9 961 MZAR (the compensation legislation makes provision for all mineworkers regardless of nationality).

**Table 1. Estimated liability of current unpaid occupational lung disease compensation.**

	No of cases	Pn1 <sup>1</sup> MZAR	Pn2 new <sup>2</sup> MZAR	Pn2 upgrade <sup>3</sup> MZAR	Total MZAR
Not eligible for further compensation	7200				0
South African cases	196 560	1 546	2 661	2 767	6 973
Foreign cases	84 240	662	1 140	1 186	2 988
<b>Total</b>		2 208	3 801	3 952	9 961

**Notes:** MZAR = Millions South African Rand. 1. "Pn1" is compensation for first degree pneumoconiosis. 2. "Pn2 new" is compensation for second degree pneumoconiosis for men with no previous history of compensation. 3. "Pn2 upgrade" is compensation for second degree pneumoconiosis for men with a previous history of compensation but who's disease has progressed.

South African nationals have been separated out for the subsequent analysis of externalised costs because neither data for state funded medical treatment costs nor individual expenditure for occupational disease is available for the neighbouring countries from which mine migrant labour is drawn.

### Quantification of occupational lung disease costs in the gold mining industry

Studies in a number of countries have attempted to quantify the cost of occupational disease and accidents in relation to Gross Domestic Product (GDP). Andreoni (1986)<sup>17</sup> argues;

"Occupational accidents and disease are costly. For the community as a whole, they represent a burden which is constantly growing and which affects the standard of living of everyone, to the point that one can well ask whether the money spent paying for them would not be better used in financing the efforts of all those who throughout the world, are devoting their knowledge and their research efforts to prevention. This is one good reason among many why we should know as accurately as possible the real cost of employment accidents and occupational diseases. The results of research and the statistical data published in many countries, especially industrialised ones, provide a certain amount of information which, however, shows how difficult it is to draw a precise list of the numerous elements which make up this cost. While some of these elements can be isolated and quantified easily, others are much more difficult to perceive accurately."

Andreoni<sup>16</sup> gives an indication of the ratio of costs of occupational disease and accidents to GDP for several developed countries but he does not distinguish costs of accidents and occupational disease. The ratio cost to GDP varies from 1.17 per cent for the USA (1977), to 2.03 per cent for Italy (1980) and 3.25 per cent for France (1977).

A 1994 study by the British Health and Safety Executive (HSE) has examined

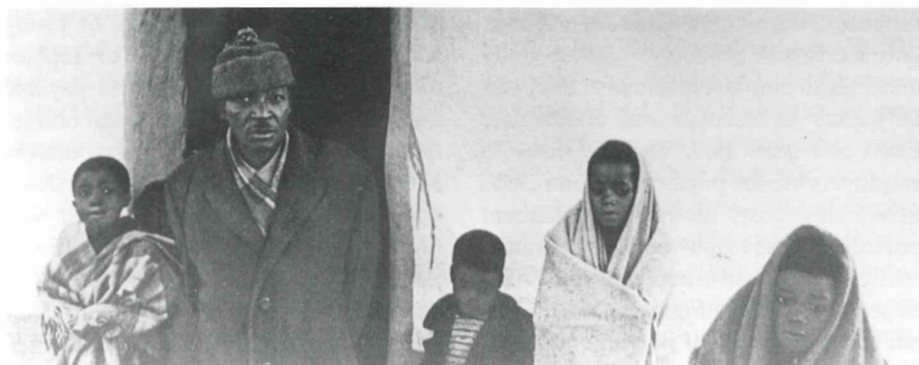
the cost of occupational disease and injury to the British economy.<sup>18</sup> In this study the costs to employers and also the costs to society of occupational disease are listed and quantified. The key costs to employers are the payment of compensation levies, costs of medical treatment provided by the employer, administrative costs, medical and compensation services provided by the employer, loss of output (due to absence of ill workers), additional costs of maintaining output in the

case of absent workers, costs of hiring and training new workers to replace those lost to disease, penalties payable for delays in meeting contractual obligations and loss of good will and reputation with workforce, customers and local community. In the HSE study it was found that the total cost of occupational accidents and disease is far higher than had been previously thought because previous studies failed to take account of societal costs, which include the loss of re-

**Table 2. Quantification of occupational lung disease costs born by the South African gold mining industry**  
(current prices for the 1996 work force of 342 893 men in-service)

Cost category	Cost category components	Annual value MZAR
<b>Employers contribution to compensation fund<sup>1</sup></b>	Contribution gold mine employers to compensation fund	38.0
<b>Medical surveillance</b>	Periodical examination <sup>2</sup>	137.2
	Loss of output during periodical exam <sup>3</sup>	128.6
<b>Medical treatment provide by employer</b>	Tuberculosis <sup>4</sup>	
	Hospitalisation <sup>5</sup>	10.5
	Costs of drugs for treatment <sup>6</sup>	4.1
	Costs of MDR Tb treatment <sup>7</sup>	1.9
	Costs of DOTS staff salaries <sup>8</sup>	1.0
<b>Loss of output for men with Tb</b>	Pneumoconiosis and Obstructive Airways Disease Case finding and reporting to MBOD <sup>9</sup>	2.1
	Remuneration costs <sup>10</sup>	20.4
	Cost of lost production <sup>11</sup>	118.5
<b>Total costs</b>		<b>343.7</b>

**Notes:** Medical costs supplied by a mine medical officer. 1. Based on contribution from April 1996 to March 1997. 2. Estimated cost 400 ZAR per person. 3. Salary costs at 55 ZAR per day and production loss at 320 ZAR per day. 4. Assuming 2 per cent annual incidence. 5. Assuming 30 per cent of incident cases are hospitalised for an average of 17 days at 300 ZAR per day. 6. Assuming six months of treatment at 600 ZAR per course. 7. Assuming 2 per cent of TB cases have multi-drug resistance costing 14 000 ZAR per course. 8. DOT staff salaries 2000 ZAR per month; one person per 8 000 men. 9. Including X-rays, medical staff, claim administration at 150 ZAR per patient assuming 1 per cent incidence of P.n. and OAD respectively. 10. Assuming 54 days off work on average at 55 ZAR per day in direct salary. 11. Assuming 320 ZAR per day for 54 days off work on average.



*Mine worker at a South African mine.*

to the patient and the cost falls on the public sector medical services. Treatment according to Department of Health guidelines differs according to whether the patient is a new case or a retreatment case (20 per cent of cases are retreatment cases). New cases are treated for six months. The first two months involve treatment with drugs that cost 38.6 ZAR per month. Total direct cost of new cases 142.8 ZAR. The following 4 months involves treatment with drugs that cost 65.6 ZAR in total. Retreatment cases are treated for 2 months with 5 drugs at 79.2 ZAR per month, 1 month with 4 drugs which cost 42.4 ZAR and 5 months with 3 drugs which cost 176 ZAR. Total direct cost of retreatment cases 376.8 ZAR.<sup>19</sup> Hence the cost of treating an average patient is  $0.8 \times 142.8 + 0.2 \times 376.80 = 189.6$  ZAR. Statistics from the rural hospital which serves Libode indicate that 2505 people were treated for tuberculosis at the hospital between January 1996 and December 1996, of these 537 were treated as in-patients (324 of whom were adult males) and 1968 were treated as out-patients (923 of whom were adult males). Ninety per cent of adult males treated for tuberculosis at St Barnabas had a mining history. Fifty per cent of those admitted as in-patients with tuberculosis spend two weeks in hospital and are then discharged into a program which includes directly observed therapy (DOT) in the community. The DOT in the community is undertaken by community volunteers and is not a paid job (common participants are church leaders, traditional leaders and also shop keepers). The remaining 50 per cent spend one month in hospital before being discharged.<sup>20</sup> It is important to note that while the DOT is administered by volunteers, the volunteers are administered and supervised by trained health care workers who themselves add costs to the health system. It is thought that the drug purchase price represents only approximately 5 per cent of the cost of a tuberculosis control program.<sup>21</sup>

sources (notably labour and capital), loss of future labour services from the victims, and loss of well being due to pain, grief, and suffering caused by premature death, and disablement. The HSE report concludes;

"The overall cost to the British economy of all work accidents (including avoidable non injury accidental events) and work related ill health is estimated to be between 6 and 12 billion pounds. This is equivalent to between 1 per cent and 2 per cent of total Gross Domestic Product... The total cost to society as a whole, including the estimate made for loss of welfare resulting from pain, grief, and suffering of individual victims and their families is estimated at between 11 billion and 16 billion pounds. This is equivalent to between 2 per cent and 3 per cent of total Gross Domestic Product, or a typical years economic growth. Illness accounts for about 4 to 5 billion pounds of this and accidents 6 to 11 billion pounds."

While recognising that the economy and the health and safety system in South Africa are very different to that found in England one can use this approach to assess the affect on the national economy of occupational disease and accidents. Applying the same macro ratios to South Africa suggests the total annual cost to society is estimated at between 9 681 MZAR and 14 522 MZAR in 1996. Good use can be made of the HSE methodology to construct a model quantifying the cost of occupational lung disease in the gold mining industry. The results obtained from applying this model, based on the assumptions stated, are shown in table 2.

The HSE model is able to estimate the total societal cost of occupational disease. Data for costs born by the mining industry is relatively easy to obtain. Costs born by society as a whole is more difficult to establish. Given the problems of extrapolating from a British economic and health and safety context to that of South Africa, a new method for evaluating societal costs was developed. In an attempt to cost that portion of mining related occupational disease that is being borne by the state health services and the households of diseased ex-mineworkers detailed interviews with members of the South African National Department of Health Tuberculosis Control Programme and the Medical Superintendent of St Barnabas hospital, the rural hospital which serves Libode were undertaken. In addition to the interviews with health workers questionnaires were administered to those members of the Libode random sample study group who were found eligible for compensation (for those who had died the next of kin answered the questionnaire). These interviews took place before the compensation arrived. While it must be acknowledged that the data from the questionnaires is based on a small sample size (56) the results indicate a burden of disease being borne by households which would merit further investigation with a larger study group.

The majority of those eligible for compensation (60 per cent) reported being currently treated for tuberculosis and could produce their medication. In South Africa treatment for tuberculosis is free

Only one study<sup>22</sup> has attempted to determine attributable risk of mining as a cause of tuberculosis and found that for patients at a large referral hospital in Mdantsane, Eastern Cape Province, South Africa there was an odds ratio of 1.51 ( $p \leq 0.05$ ). Hence the mining attributable risk of tuberculosis was 34 per cent. The data presented as to the mining attributable risk of tuberculosis represent the best available information and have been used to calculate the cost of treating tuberculosis attributable to gold mining.

$$N \times P \times A = 1247 \times 0.9 \times 0.34 = 382 = C$$

where  $N$  is the number of men treated for tuberculosis in the hospital which serves Libode,  $P$  is the percentage of those treated who have a mining history attending St. Barnabas hospital and  $A$  is the attributable risk of mining.

$$C \times Q = 382 \times 189.6 = 72\,427$$

where  $Q$  is the average cost of tuberculosis drugs.

Thus we see that the state medical services spent at least 72 427 ZAR on drug costs in 1996 for tuberculosis that can be attributed to mining in Libode. The adjusted costs, taking account of the capital and recurrent annual costs of providing tuberculosis control for ex-mineworkers in Libode is thus estimated to be 1.45 MZAR.

In addition to the state medical expenditure the data provided by the questionnaires indicated that prior to compensation the average ex-mineworker in Libode with compensable pneumoconiosis spent an average of 780 ZAR per year on medicines to relieve the symptoms of lung disease (medicines were bought from chemists and traditional healers) and 156 ZAR on transport to medical facilities, thus the average medically related expenditure per person is 936 ZAR per annum.<sup>23</sup> Gold mine recruitment records are available for Libode for the period 1969 to 1980. These recruitment records show that roughly 12 000 mine-

workers were recruited between 1969 and 1980 in Libode. Given the prevalence of radiological and compensable disease in Libode we can estimate that there are between 2 640 and 4 440 ex-mineworkers in Libode who have radiological pneumoconiosis and 2 880 with compensable disease. If we assume that 55 per cent are dead (as was the case for the Libode random sample) this leaves 1 296 people living with compensable pneumoconiosis hence we can estimate an annual personal medical expenditure of 1 213 056 ZAR for ex-mineworkers with compensable disease in Libode. If one adds the personal medical expenditure of men eligible for compensation to the state medical expenditure on disease that can be attributed to mining the total expenditure in Libode is 2.66 MZAR.

Assuming there are 1.4 million South African ex-mineworkers who worked between 1973 and 1997 (of whom 60 per cent are alive) there are 840 000 living ex-mineworkers in South Africa. Thus the annual cost of occupational lung disease health expenditure (state and private) in ex-mineworkers that can be attributed to mining is 186 MZAR.

There are additional costs which cannot be established on the available information; including the costs related to the time families give over to care giving, the cost of infection of family members by ex-mineworkers with tuberculosis attributable to mining, and the costs of missed opportunities that households bearing the costs of occupational lung disease have foregone. However the data above illustrate that there are many costs of occupational lung disease which are being borne by the ex-mineworker with pneumoconiosis, his household, his community and the public sector medical facilities rather than the mining industry. Part of the mining industry's tax funds the public health service however the industry's overall tax contribution has fallen dramatically since the late 1980's to just under 2 per cent of contributions to the fiscus.

Table 3 shows the internalised and externalised costs of occupational lung disease. While it is important to acknowledge the small sample size of the data relating to the questionnaires, the implications for the state health services and rural communities of the costs of occupational lung disease are clearly profound.

**Table 3. Application of the HSE model to South African gold mining industry** (current prices for the 1996 work force of 342 893 men and assuming 840 000 former mineworkers)

Category	Category components	Annual Value MZAR
<b>Costs of occupational disease internalised by the mining industry</b>	Employers contribution to compensation fund, employers costs of medical surveillance, employers costs of medical treatment for in-service workers, employers costs relating to loss of output for men with occupational disease.	344
<b>Costs externalised</b>	Costs born by ex-mineworkers relating to purchase of medicines and transport to medical facilities, costs born by the state relating to treatment for tuberculosis attributable to mining.	186
<b>Total</b>		<b>530</b>

**Note:** As this is an annual cost, it does not include the unpaid compensation liability.

It is also important to acknowledge that Table 3 does not include the unpaid liability of compensation which is not an annual figure.

The above data indicate that a large portion of the costs of mining related occupational lung disease are not being borne by the mining industry. Significant costs generated by the mining industry are being externalised. Eckhom<sup>24</sup> argues;

"health hazards in the workplace represent production costs that have seldom been counted, let alone billed to those responsible for them. Interjecting both worker and community health considerations more fully into the economic decisions will promote worker protection. It will also insure that, when prevention fails, workers will be more justly compensated for their sacrifices".

The cost to the state medical facilities and the labour sending communities of occupational lung disease is a cost externalised by the South African mining industry. Mr B. Godsell<sup>25</sup> (Chief Executive, AngloGold) has stated that "South Africa may have to choose between requiring the industry to compensate for past injustices and protecting present jobs" implying that these positions are tradeable. Mr Godsell's notion of a "past injustice" is not supported by the evidence presented to the 1994 Commission of Inquiry into Safety and Health in the Mining Industry<sup>26</sup> that there is no evidence of a reduction in dust levels on South African gold mines for 30 years which suggests no reduction in disease. Contrasting the compensation for occupational disease against preservation of employment fails to recognise that this not only a past problem but a current reality. If the gold mining industry does not accept liability for unpaid compensation and externalised costs who will? Mr L. Boyd (Deputy Chairman, Anglo American Corporation), has argued that South African government spending must be drastically reduced.<sup>27</sup> Spending cuts are likely to include health care and social services provided for labour sending communities. The logical conclusion of

approaching unpaid compensation and externalised costs in this way is that the burden of occupational disease amongst ex-workers and labour sending communities should be written off as bad debt or treated as obsolete capital.

Externalising the costs of occupational lung disease is extremely damaging for individuals, households and communities in labour sending areas. In a context of low levels of education and high levels of dependency on physical labour as a source of employment even a relatively minor degree of disability can be a major impediment to future employment. Chambers argues "the body is the poor person's greatest and uninsured asset. If this asset is devalued or ruined, from being an asset it becomes a liability that has to be fed, clothed, housed and treated. A livelihood is destroyed and a household is made permanently poorer."<sup>28</sup>

It is inefficient for the country as a whole to take on the externalised costs of mining related occupational lung disease. Internalising the costs of disease would almost certainly result in measures being taken to reduce dust levels with a consequent reduction in disease incidence and therefore a reduction in the costs to society of ex-mineworkers. It can be argued that redressing the unpaid compensation liability would result in a distribution of income, by legal entitlement, to one of the poorest sectors of the population and this would reduce societal inequalities.

We would argue that a modern mining industry must assume the full costs of occupational disease created by current practices. The complexity lies in how to deal with the historical legacy of unpaid compensation. Forcing mining companies to pay for past malpractice out of current income might force the closure of mines which having distributed profits to shareholders are not now in a position to pay. While the mining houses undoubtedly have some obligation for past wrongs it may not be pragmatic economics to insist that all of their past debts to their workforce should be paid.

## Conclusions

This paper is based on two studies of occupational lung disease in two different gold mine labour sending areas. Priority should be given to more extensive studies to establish the true prevalence of occupational lung disease in ex-mineworkers, the number of such men still alive in South Africa and the attributable risk of mining for the development of tuberculosis. There is also a need for more accurate denominator data on the number of living ex-mineworkers in the Southern African region. On the available information it has been shown that there is a high prevalence of previously undiagnosed, uncompensated pneumoconiosis in the two labour sending areas studied and that there has been a failure to identify and compensate occupational disease. Under the ODMWA, at a conservative estimate, there is a liability of 6775 MZAR in unpaid compensation owing to South African citizens. This liability rises to 9678 MZAR when one includes compensation owing to non-South African citizens. The internalised annual cost of occupational lung disease is estimated to be 344 MZAR which represents 4 per cent of the gold mining male wage bill for 1996.<sup>29</sup> The total annual cost of internalised and externalised gold mining related occupational lung disease (excluding the unpaid compensation liability) is estimated to be 530 MZAR which represents 6 per cent of the 1996 wage bill. South Africa's GDP in 1996 was 484 billion Rand of which gold mining contributed 4 per cent. The cost of gold mining related occupational lung disease represents 0.1 per cent of South Africa's 1996 GDP and 2.6 per cent of gold mining's contribution to GDP. This paper has demonstrated a high cost of disease in the South African gold mining industry and there is a need to examine the degree to which the incidence and prevalence of disease could be brought down through dust control and changes in working practices. By quantifying the costs of gold mining occupational lung disease to the industry and society we have provided an indica-

tion of a previously uncosted cost of production. The costs of occupational lung disease outlined above are the opportunity costs of improved dust control and changes in working practices. Better information on costs such as has been presented in this paper is critical for planning profitable and safe gold mining.

### Notes

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