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# MINING, WASTE AND ENVIRONMENTAL THOUGHT ON THE CENTRAL AFRICAN COPPERBELT, 1950–2000

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## ABSTRACT

Since the early twentieth century, the copper-mining industry on the Zambian and Congolese Copperbelt has moved millions of tonnes of earth and dramatically reshaped the landscape. Nonetheless, mining companies, governments and even residents largely overlooked the adverse environmental aspects of mining until the early 1990s. By scrutinising environmental knowledge production on the Central African Copperbelt from the 1950s until the late 1990s, particularly regarding notions of ‘waste’, this article problematises the silencing of the environmental impacts of mining. To make the environmental history of the Copperbelt visible, this article examines forestry policies, medical services and environmental protests. Moreover, by historically tracing the emergence of environmental consciousness, it contextualises the sudden ‘discovery’ of pollution in the 1990s as a local and (inter)national phenomenon. Drawing on rare archival and oral history sources, it provides one of the first cross-border environmental histories of the Central African Copperbelt.

## KEYWORDS

copper mining; pollution; knowledge production; environmental history; Zambia; Democratic Republic of the Congo

Lubumbashi’s *terril*, a slagheap containing 14.5 million tonnes of copper and cobalt mining residue, is an iconic landmark on the Congolese city’s landscape. Between 1924 and 1992, when the smelter processed much of Haut-Katanga’s copper, the slagheap gradually grew in height. This enormous pile of waste causes pollution from which nearby residents suffer on a daily basis, especially in June and July when dry winds spread mineral dust across the city. Yet the slagheap has rarely evoked environmental concern. Economic considerations have instead dominated environmental management practices. In 2000, the multinational consortium Société pour le Traitement du Terril de Lubumbashi started recycling the slag to recover valuable iron, copper and cobalt. Some 800 tonnes of slag are processed per day, turning waste into profit and steadily dismantling Lubumbashi’s *terril*.<sup>1</sup> Across the border on the Zambian Copperbelt, vast tailings dams are prevalent. Built to store mining waste in liquid form, these deposits, such as Kitwe’s Mindolo dam, have been perversely naturalised. Mining companies market the man-made lakes as ideal picnic sites, where workers can come to relax, boat or swim, despite the industrial and profoundly unnatural origins of the water.<sup>2</sup>

Since the beginning of the twentieth century, industrial copper mining has moved millions of tonnes of earth and drastically reshaped the landscape of the Zambian and Congolese Copperbelt. Despite profound changes to the soil, air and water of the area, environmental aspects of copper mining were largely overlooked until the early 1990s.<sup>3</sup> Whereas government officials and mining companies either tried to engineer environmental harm away through technoscientific fixes or subordinated environmental protection to a short-

term cost–benefit analysis, mining communities learnt to live with pollution, rather than staging environmental protests.<sup>4</sup> The blatant visibility of mining-induced environmental change on the Copperbelt landscape is thus accompanied by a paradoxical invisibility in historical representation. This article therefore asks how and why the environmental history of the Central African Copperbelt could remain invisible for so long. By analysing knowledge production – or in some cases non-knowledge production – and its underlying power relations,<sup>5</sup> it becomes evident how a hazardous tailings dam could be reimagined as a recreational site or why a massive slagheap seldom attracted attention, let alone criticism. Yet because mining companies, governments and even residents rarely reflected on the impact of copper mining on the environment, researchers have to adopt innovative approaches to render the environmental history of the Copperbelt visible. Examining forestry policies, medical practices and environmental protest sheds light on how different actors understood and constructed their environment. A focus on knowledge production, on the coexistence of knowing and not knowing about the environmental impacts of mining reveals that mining and government officials adopted double standards towards what was considered as waste, whilst doctors and mine managers sought to monopolise the definition of legitimate health concerns. Meanwhile, mining communities, who depended on mining for their livelihood, learnt to live with pollution instead of engaging in protest. These unequal power dynamics made mining waste relatively invisible, despite its sheer volume. Tracing changing environmental consciousness also highlights how notions of ‘waste’ were transformed into concerns over ‘pollution’. A historical approach, thus, contextualises the sudden ‘discovery’ of pollution in the early 1990s. This article argues that the surge in environmental monitoring and legislation – hitherto attributed squarely to international pressures – fed into and built upon already existing local environmental thought.<sup>6</sup> An overview of environmental consciousness and an evaluation of historical efforts to tackle pollution thus enables an assessment of current attempts to achieve environmental sustainability in mining.<sup>7</sup>

This article traces the ways in which mining engineers, government officials and mining communities represented environmental change – the production of waste in particular – on the Central African Copperbelt between 1950 and 2000. The first section outlines the context of copper-mining activity in the region and proposes the lens of knowledge production to better understand the power relations embedded in different representations of environmental change. Secondly, government and mining company discourses through which environmental impact has been represented on the Zambian and Congolese Copperbelt from the 1950s until the 1980s will be examined. Thirdly, the article proposes alternative approaches to make the environmental history of the Copperbelt visible, by looking at forestry, medical practices and protest. The final section historicises the concern with issues of pollution in the 1990s.

The article is based on archival research, utilising many previously unexplored sources in Zambia, Brussels and the Democratic Republic of the Congo.<sup>8</sup> Through full access to the historical records of the major mine companies involved, this article puts the extraordinarily rich sources for mining history that have not to date been analysed to use to write an environmental history of the Copperbelt. These mining archives contain thousands of files encompassing technical correspondence, annual reports and engineering bulletins, in addition to newspaper articles, information about the socio-economic life of workers, and trade union issues. This article distils the scanty references to the environment that can be found in this

abundant documentation in an attempt to trace a timeline of changing environmental thought among diverse Copperbelt actors from 1950 until 2000. The Zambia Consolidated Copper Mines and Gécamines archives, for instance, contain reports on river pollution from the 1950s, air quality measurements from the 1970s and background documentation on environmental impact assessments from the 1990s. As no overview of this material yet exists, this article draws primarily on these archives to examine dynamics of environmental knowledge production. Nonetheless, to place policy correspondence and the views of mining companies in perspective, this article draws on more than 100 oral history interviews with long-term Copperbelt residents conducted between May and August 2018. These interviews provide a first insight into popular perceptions of mining and its environmental impacts on the Copperbelt. In order to bring out parallels and differences in environmental thought, this article considers the Central African Copperbelt as a single geological region. How did different mining companies and government regimes, as well as the cross-border mobility of people and pollutants in a parallel socio-economic setting, influence environmental knowledge production on the Zambian and Congolese Copperbelt?<sup>9</sup> Feeding into broader debates on mining and environmental history, it considers how the Anthropocene may be understood from a Central African perspective.<sup>10</sup>

## **MINING AND KNOWLEDGE PRODUCTION ON THE COPPERBELT**

The Central African Copperbelt is a highly mineralised region, with one of the largest and highest-grade copper deposits in the world, as well as of minerals such as cobalt, zinc and gold. Following fierce imperial rivalry, the area was divided between British Northern Rhodesia and Belgian Congo (later Zambia and DR Congo respectively). Industrial mining started in Élisabethville (Lubumbashi) in 1907, whereas on the Northern Rhodesian Copperbelt Luanshya was the first mine to be developed in 1928. By the 1940s, the Copperbelt mines formed an almost continuous cross-border agglomeration from Kolwezi in the north-west to Ndola in the south-east. The mines, both open-pit and underground, used a variety of mining and processing techniques with differential but profound impacts on the surrounding environment. New urban communities developed around the mines, in which mineworkers, their families and a far larger and more diverse population numbering in the hundreds of thousands came to reside.<sup>11</sup>

All across the world mineral extraction has produced ‘enclave economies’ that ‘are, at one and the same moment, both deeply integrated into the global economy and also fragmented from national space’.<sup>12</sup> What is perhaps distinctive about the Central African Copperbelt are the multiple linkages that mining created with the broader urban and regional economy. Whilst at the start of the twentieth century the Copperbelt was an underpopulated and peripheral area, mining activity soon attracted capital, population and political power. The mines spurred urban growth through labour migration, as well as diversified urban economies, encompassing trade, crafts and the civil service. Mining companies’ paternalistic policies, which attempted to stabilise labourers by providing extensive social and welfare services, made the entire urban economy dependant, to a greater or lesser degree, on fluctuations in copper prices. The fate of teachers, vegetable sellers and construction workers directly reflected the fortunes of mineral production. As the high-wage employment opportunities of the Copperbelt contrasted starkly

with rural livelihoods, manual labourers and second-hand clothes traders alike sought to partake in imagined urban ‘modernity’.<sup>13</sup> Militant trade unionism concerning working conditions and wages has been well documented for the Central African Copperbelt. Historiography has portrayed Copperbelt workers’ militancy, detailing their strike actions for higher wages and better housing, or against the colour bar, in addition pointing towards the Copperbelt’s crucial role in national politics.<sup>14</sup> Yet pleas for improvement rarely encompassed environmental demands. This remarkable reluctance to antagonise mining interests can be explained, on the one hand, by short employment contracts, which made environmental damage relatively intangible among mining communities. On the other hand, it revealed the precarity of workers and the urban population at large, who fundamentally relied on mining as a source of livelihood. This dependency on mining narrowed the space for environmental protest movements.<sup>15</sup>

On a national level, on both sides of the border, the Copperbelt mining industry played an economically and politically dominant role. During the colonial and postcolonial period, copper constituted the foundation of national wealth and, as a result, mining figured prominently in policy discussions. Moreover, some officials held high positions in government and mining companies simultaneously. In the colonial era, mining capital and management was metropolitan in nature. The Union Minière du Haut-Katanga was financed with Belgian and international funds, whilst the Rhodesian Selection Trust and Anglo American in Northern Rhodesia benefited from British, American and South African capital. After independence, the mines were nationalised and amalgamated, eventually creating Gécamines in DR Congo after 1966 and Zambia Consolidated Copper Mines in Zambia from 1969 onwards.<sup>16</sup> In terms of financing, mine operations and regulatory policies, independence was not a major turning point. International capital continued to dominate Copperbelt mining, and Belgian and British mining engineers stayed on as advisors even after nationalisation, notwithstanding policies encouraging the Africanisation of the workforce. Whilst state mine ownership might have spurred more careful environmental stewardship, the dependence of national economies on copper revenues tended to dovetail with and reinforce the primacy of profit-making motives. Because in both countries mining was the heart of the economy and an important base of political power, mining companies presented unrestrained mineral production as something intimately aligned with the national cause.<sup>17</sup> In this context, mining companies, government officials and mining communities all tended to downplay the negative environmental effects of mineral production.

As Ross notes, ‘the role of mining in transforming regional environments remains underexposed, despite the fact that it has perennially been one of the dirtiest of all industries’.<sup>18</sup> LeCain has provocatively referred to copper mining as a form of ‘mass destruction’ of the environment.<sup>19</sup> Internationally, scholarship on the intersection between mining and environmental history has increased recently.<sup>20</sup> Nonetheless, works dealing with Africa in general and Central Africa in particular remain rare. Notable exceptions are the works of Hecht, McCulloch and Singer, on uranium, asbestos and coal respectively, who all explore how mining created particular regimes of knowledge and value, differentiated according to locality, gender and race.<sup>21</sup> By looking at copper mining and its relation to environmental knowledge production, this article builds on such work.

In sub-Saharan Africa, the Copperbelt is a much-studied region in terms of politics, social life and economic performance.<sup>22</sup> Colonial and postcolonial governments as well as mining companies engaged in active knowledge production about the Copperbelt region. CEPSI (—) and the Rhodes-Livingstone Institute are the most famous examples of such research.<sup>23</sup> The focus of this research was, however, specific and uneven. Whilst detailed studies about urbanisation and social change, leisure activities, religion and political mobilisation on the Copperbelt exist, the environmental aspects of copper mining have been the concern of very few studies. Recent exceptions from the Zambian Copperbelt are Frederiksen, who approaches mineral extraction through the lens of political ecology, and Schumaker, who examines river environments, damboes (—) and malaria.<sup>24</sup> Mostly, however, environmental issues were either studied merely in relation to the rural, agricultural sphere or otherwise overlooked and in some instances silenced. Such absence is striking, especially if it is considered how impactful copper mining, processing and waste handling have been on the environment of the Copperbelt.<sup>25</sup> A close reading of archival records and use of oral history reveals that mining companies, government officials and local residents were acutely aware of the (adverse) environmental impacts of copper mining, but that these effects were downplayed or otherwise only expressed in an overtly economic and extenuating manner, especially from the 1950s until the 1980s. This article thus foregrounds underexplored representations of the environmental impacts of mining on the Central African Copperbelt, thereby tracing the roots of environmental consciousness.

From a history of science and technology approach, Sellers and Melling have drawn attention to the ‘industrial hazard regime’, defined as ‘the material and institutional contexts within which industrial hazards themselves, as well as knowledge about them, are produced, reproduced and spread, and also the diversity of groups and individuals involved in or touched by these processes’.<sup>26</sup> The environmental effects of mining activity are examples of industrial hazards, which affect not only the workplace but also entire mining communities. This definition draws useful attention to processes of knowledge production and power relations. However, a focus on knowledge production alone is insufficient, as what we know is premised on ‘a “politics of sight” that relies on an obfuscation and concealment’ of certain issues.<sup>27</sup> This article argues that dominant representations of mining-induced environmental change on the Central African Copperbelt, especially before the 1990s, sought to make environmental harm relatively invisible, either by framing it as an inevitable externality of production or sometimes by concealing information about the toxicity of waste or the effects of pollutants on health.<sup>28</sup> It is therefore important to draw attention to ‘how or why’ certain actors, be they urban officials or people fishing in a polluted stream, ‘don’t know’.<sup>29</sup> Tracing what is not known ‘has the potential to reveal the role of power in the construction of what is known and provide[s] a lens for the political values at work in our knowledge practices’.<sup>30</sup> Although both knowledge and non-knowledge can serve as tools of power to achieve goals or promote interests, such as maintaining production in the face of environmental criticism, neither category is stable. Rather, knowledge and non-knowledge are always ‘open to political negotiations, scientific controversies and social struggles’.<sup>31</sup> Studying environmental representations – how they are established, challenged and change over time – thus sheds light on power relations between mining companies, government officials, scientists and residents of the Central African Copperbelt.

As Beck and Wehling stress, ‘knowledge is a contingent and fragile achievement which itself produces non-knowing as its “shadow side”’.<sup>32</sup> On the Copperbelt, scientific knowledge existed about the effects of dust and lead on workers’ bodies and the environment. People living close to a smelter or acid plant were aware that trees and vegetables failed to grow. Environmental consciousness about the effects of industry was as old as mining itself. However, strategies such as denial, dismissal, diversion or displacement ensured that such knowledge was rarely publicly discussed or acted upon.<sup>33</sup> The following examples show that knowledge about environmental harm on the Copperbelt was simultaneously visible and invisible. There are representational challenges to studying gradual processes of environmental damage that are ‘neither spectacular nor instantaneous, but rather incremental and accretive’ and therefore tend to remain unremarked upon by mine managers and mining communities alike.<sup>34</sup> Moreover, the political and cultural infrastructure can be such that ‘awareness of the possible dangers and actual damages [of industry] may be minimal, find few outlets, be actively suppressed – or be present but simply shrugged off’.<sup>35</sup> In order to illustrate processes of environmental knowledge production on the Copperbelt, the next section first examines those rare discourses through which mining companies and government officials either discussed or ignored and legitimised environmental harm.

## **ENVIRONMENTAL THOUGHT ON THE COPPERBELT, 1950S–1980S**

Two early examples from the Congolese Copperbelt illustrate recurrent representations of environmental change particularly well. In 1931, the management of the Union Minière du Haut-Katanga (UMHK) commissioned an investigation into water pollution caused by copper processing in Jadotville (Likasi). The city’s concentration, segregation and leaching plants were scrutinised for their effects on the surrounding rivers. In order to produce high-grade copper, tonnes of residues and waste materials (fine stones, sand and mud), known as tailings, were discharged daily into the rivers. Effluents further included palm oil, soda carbonate, sulphuric acid and lime. Sampling identified that these materials were probably lethal to vegetation and animal life. Notwithstanding the profound effects on fishing, forestry and agriculture up to 60 kilometres from the refining plants, the study was mainly concerned with whether the residues might be recovered and turned into economically profitable outputs – as the tailings contained up to 4 per cent copper. Its main recommendation was not to pay more attention to the environmentally detrimental effects of mining, but to build a dam that would retain valuable copper content more efficiently.<sup>36</sup> This report shows that mine management produced substantial knowledge about waste, the effects of chemicals on water and vegetation, and about pollution. In this instance, nonetheless, the interests of economic production clearly overruled environmental considerations.

Another report that analysed the environmental impact of mining activities is a 1936 study of fumes from Lubumbashi’s smelter. It examined the possibility of recovering sulphur dioxide to produce sulphuric acid, required for copper refining. Despite the 2,500 tonnes of toxic sulphur dioxide emitted in Lubumbashi every month, the mine engineer declared that, ‘The inconvenience of the fumes ... appears to us to be strongly exaggerated’. Although chemical methods existed to minimise the nuisance of fumes and the report’s authors considered building a higher chimney for the purpose of dilution, they instead recommended

to ‘desulfurise the minerals in a site where ... the risks of criticism are less severe’ than in Lubumbashi. Consequently, UMHK transferred operations to a smaller town, Kipushi.<sup>37</sup> Apart from giving evidence of nascent popular discontent, this report shows that UMHK officials were fully aware of the environmental impacts of copper mining and processing, even in the 1930s. However, the imperatives of copper production, rather than the environmental disruption experienced by surrounding communities, were uppermost.

On the Northern Rhodesian side of the Copperbelt border, the Smoke Damage (Prohibition) Act, first signed in 1934, is evidence of similar dynamics, stipulating that no person within a circle of 5 miles of a copper smelter be allowed to claim damages or to interfere with smelter operations, no matter how bad the pollution.<sup>38</sup> The Rokana Corporation of Luanshya, one of the largest mining companies, dismissively argued that land was ‘taken up by the public with the full knowledge of the actual disabilities arising from the proximity of the smelter, as well as the advantages of proximity to an industrial centre’.<sup>39</sup> Such legislation illustrates the economic motives of the copper-mining industry – maximising production and profit – and the willingness of government to protect the mines against environmental damage claims. This attitude proved remarkably persistent throughout the second half of the twentieth century.

In a display of the balance of power on the Copperbelt, Northern Rhodesia’s government officials in the 1950s accepted that ‘the requirements of the Mining Companies are overriding’ due to their ‘importance ... to the national economy’ and that therefore ‘no obstacles’ should be ‘put in the way of the industry’.<sup>40</sup> Still, it did set aside Copperbelt land for agriculture and forest reserves in addition to mineral development. Expressing environmental concerns in the language of conservation and protection, a 1955 government report claimed that the mines were becoming ‘increasingly conservation conscious’ by protecting watercourses from erosion or monitoring the subsidence of dumps.<sup>41</sup> Yet because of the conflicting interests involved, ‘conservation practice on the Copperbelt’ remained a ‘complicated subject’.<sup>42</sup> As one official remarked, it was probably true that ‘the Mines could sway the government officials whichever way they wanted’.<sup>43</sup> In the 1950s complaints about mining waste and the adverse environmental effects of industry remained isolated instances as there was a lack of mechanisms to hold mining companies accountable for their actions. The result was that, by and large, pollution continued unabated.

To an even greater extent than in Zambia, Congolese mining interests throughout the 1950s and 1960s focused on maximising production and profit.<sup>44</sup> Among mining engineers and in popular perception, heavy industry was associated with technical progress. Newspaper articles and official reports fondly described UMHK and later Gécamines as a ‘milk cow’ whose ore deposits were considered practically inexhaustible.<sup>45</sup> In a context of economic prosperity and expanding production, the environmental impacts of mining remained unremarked upon in Gécamines annual reports. Instead, a strong belief prevailed that engineering and technical expertise would solve problems of production, including environmental issues.<sup>46</sup> A report written in 1969 before the opening of Kamoto mine reflects technological prowess and the prioritisation of raising production. In it, an engineer underlines the ‘profitability, speed and flexibility’ of the mine, praising heavy mechanisation as a form of technical advancement.<sup>47</sup>



This attitude had changed to some extent by the 1970s and 1980s, when discussions about waste management gradually adopted the moralistic language of ‘pollution’.<sup>48</sup> Government and mine officials hesitantly recognised that ‘industrial and urban concentrations’, such as the Zambian Copperbelt, ‘normally have specific effects on their surroundings and the pollution they cause could result in irreparable damage to the environment, if it is not kept under constant surveillance and strict control’.<sup>49</sup> However, mine engineers still confidently maintained that ‘the discharge or disposal of ... wastes has resulted in little in the way of significant changes in the environment’.<sup>50</sup> Optimism about the capacity of engineering to contribute to sustainable development prevailed. In the 1970s and 1980s, environmental management by mining companies was mainly confined to feeble monitoring mechanisms and lax standards for environmental control. As part of the *Securité du travail* programme in Congo, tests of air and water quality were carried out within the mines.<sup>51</sup> In Zambia, the Mines Safety Department paid increasing attention to underground dust monitoring and related environmental risks.<sup>52</sup> Crucially, however, pollution control did not extend to the residential plots beyond the mining licence area. The imperatives of production and profit continued to dominate the minds of mining engineers and officials.

What stands out in these official documents from the 1950s through to the 1980s is a startling absence of discussion of the environmental impacts of mining activity. In most correspondence, technical, economic and productive concerns shrouded environmental awareness. As late as the 1980s, representatives of the nationalised Zambian Consolidated Copper Mine (ZCCM) could still assert that:

in combatting both air and water pollution, the mining industry has to keep in mind its unique role in the national economy ... [T]he industry has a duty to restrict its expenditure on the non-productive, usually costly, means of controlling pollutants so that the nation is not needlessly deprived of essential revenue.<sup>53</sup>

Technical optimism prevailed, as mining engineers pledged to introduce ‘new less polluting processes’ to meet ‘likely future environmental control standards’.<sup>54</sup> Mining companies either downplayed the adverse environmental impact of their activities, or expressed environmental consciousness in a decidedly economic discourse. As the archives have left few traces of alternative discourses, it is necessary to look at related fields – forestry policies, medical practices and environmental protest – to better understand both the official and popular dynamics of environmental knowledge production.

## **FORESTRY, MEDICINE AND PROTEST: ALTERNATIVE REPRESENTATIONS OF ENVIRONMENTAL THOUGHT**

### *Forests, charcoal and legitimate resource use*

Considering the extent to which mining companies disregarded their own adverse environmental impacts, it is striking to see how aware they were of deforestation caused by charcoal burning.<sup>55</sup> Even if charcoal burning was carried out to supply the fuel market created by mining-induced urbanisation, officials strongly condemned the activity. Mining companies

and government officials thus did not lack environmental consciousness, but rather adopted a dual standard. One set of discourses was used for mining, another for non-mining activities. The denunciation of charcoal burning tells us much about the environmental context of mining, and about the power relations underlying specific modes of production. Studying these discourses shows that environmental consciousness was situational – expressed in cases of illegal timber felling, but not when a tailings dam burst.

Forestry on the Zambian Copperbelt highlights a discrepancy in the ways in which resources could legitimately be exploited by different groups. Whereas officials accepted the woodcutting activities of the mining industry as unproblematic, African charcoal consumption for household use was denounced. In the 1950s, ‘large areas of the Copperbelt were reserved for ... the territory’s primary needs – timber for ... mine use, and land for afforestation’.<sup>56</sup> Government officials emphasised the efficient use of resources, through conservation, regeneration and the controlled exploitation of forests. The forestry department made tree-cutting plans to minimise the damage caused by industrial timber demands, whilst large-scale pine and eucalyptus revegetation schemes would allegedly allow land use ‘in a more economic manner’.<sup>57</sup> Even if the mining industry placed heavy demands on forests, officials were confident that this could be scientifically managed and that the environment could be restored.

In contrast, these same officials viewed African charcoal burning in wholly negative terms. In the 1950s, government and forestry officials lamented the ‘indiscriminate burning of local timber for charcoal’, stating that the ‘African method is very wasteful and is responsible for soil erosion’.<sup>58</sup> Moreover, ‘miles of bush was being turned into absolute brick dust’, and ‘this was another aspect of the African’s way of life which had not yet become adapted to modern conditions’.<sup>59</sup> The denunciation of charcoal burning had less to do with its inherent environmental unsustainability than with the fact that the occupation provided an independent source of income for urban Africans.<sup>60</sup> In 1956, the Mufulira district commissioner described charcoal burning as an ‘easy and unregulated form of work’, appealing to people of a ‘secretive and independent character’.<sup>61</sup> Essentially, mining and government officials adopted a dual standard to assess environmental harm. The environmental impacts of mining were rarely problematised, whereas the effects of charcoal burning were blown out of proportion. Complaints did not centre on environmental damage – although they were expressed in such language – but on population control. Environmental discourse was thus situational, masking the grave effects of the mining industry whilst underscoring the problematic nature of the activities of independent individuals.<sup>62</sup>

### *Medicine, health and environmental awareness*

On the Congolese Copperbelt, environmental awareness was most clearly expressed in the medical reports of the Gécamines department Médecine du Travail.<sup>63</sup> Especially in the 1980s, Gécamines engaged in thorough research into work accidents, occupational diseases and the health of workers. Doctors showed awareness of diseases such as silicosis and lead poisoning, as well as the risks that mining-related professions posed to workers’ health through contact with substances including arsenic, sulphuric acid, cadmium and mercury, or through exposure to excessive heat and noise.<sup>64</sup> Yet even this detailed knowledge was gathered with the objectives of production in mind. A 1985 report states that the activities of Médecine du Travail

would allow Gécamines to improve working conditions, which would raise productivity.<sup>65</sup> Doctors and engineers were to work hand in hand to reduce the risks of pneumoconiosis, through preventive and technical means, so that workers would not ‘lose’ days of work and the company could increase copper output.<sup>66</sup>

A 1974 Gécamines article on medical conditions illustrates the prevalent productivist attitudes. In it, a doctor asserts that the health of workers contributes to raising output, thereby creating a prosperous mining company. Although pollution was acknowledged as a cause of occupational disease, ‘to secure production, industries are obliged to accept these permanent risks to the health of their workers’.<sup>67</sup> The medical department generated detailed knowledge on health, disease and environmental risks, yet it suffered from a lack of budgetary and legal independence from Gécamines. In 1987, a doctor complained that within Gécamines there ‘is a problem of mentality [as] each activity that is marginal to production’, including medical services, ‘is badly viewed’.<sup>68</sup> Another report stated outright that despite evidence of the dangers of lead poisoning in the acid plant of Shituru, doctors could not do much ‘because the means of pressure at the disposal of Médecine du Travail are limited’.<sup>69</sup> Even when knowledge about the environmental ill effects of mining on health existed, this knowledge was rarely made public. What is more, rather than generating knowledge, medical research could manufacture doubt about the environmental effects of mining.<sup>70</sup> In 1984, a doctor in Likasi asked his Gécamines colleague whether chemical effluents from mineral processing might poison fish, rendering their consumption harmful to human health. Whilst not denying this possibility, the Gécamines official stated that nobody had yet considered the answer to this question, ‘which required a degree of very advanced scientific and legal maturity’.<sup>71</sup> Another report examined the high incidence of bronchitis at the Atelier Central de Panda, concluding that ‘undoubtedly air pollution in the workplace played a role’. This, however, did not prompt a change of policy as allergies, infections, smoking and age could equally contribute to the heightened incidence of bronchitis and therefore air pollution was not singled out as the cause of disease.<sup>72</sup> Through dismissal and doubt, in some cases, medical knowledge contributed to making pollution invisible.<sup>73</sup>

The medical services archives of Gécamines contain a lot of knowledge production about the environmental and health effects of mining activity. Yet unequal hierarchical power relations prevented such knowledge from entering the public domain. Mine management consistently superimposed a discourse of production onto medical and environmental issues. Inadequate technical means were proposed to combat the health risks to which workers were exposed, such as dust masks or annual medical examinations. Even work accidents and their causes were sometimes silenced for the sake of maintaining production and maximising output.<sup>74</sup>

### *Protest or ‘learning to live with pollution’*

Before the 1990s, environmental protest movements on the Copperbelt remained rare – remarkable when compared to the militancy of the Copperbelt population on social, economic and political issues.<sup>75</sup> However, the small number of mobilisations against pollution that did occur illustrate processes of knowledge production, as they challenged industrial representations of environmental change and the naturalisation of environmental harm as an

inevitable side effect of copper production.<sup>76</sup> Mining companies adopted a range of strategies to counter claims of environmental liability. These included pleading a lack of intentionality, proposing technical and scientific fixes to pollution as well as stressing the economic importance of mining to national interests.<sup>77</sup> One example demonstrates all these dynamics.

In the 1950s, farmers along the Mushishima river on the Zambian Copperbelt complained vehemently about polluted water, after a tailings dam at Nchanga mine burst and discharged a large quantity of slurry. Due to acid spills, ‘most of the local fish were wiped out’ and cattle died.<sup>78</sup> The mining company responded that ‘the best and most economic cure would be by nature’, as the damage was already done.<sup>79</sup> Besides, the disaster ‘certainly was not willful on the part of the Mining Companies’.<sup>80</sup> In preventing further damage, mining engineers relied on technical expertise, promising ‘a mechanical means of extracting the poisonous material from the slimes, which rendered them harmless’.<sup>81</sup> Farmers sought compensation from the mine for land destroyed and cattle lost. They called on the company to clean up the river, as ‘the obligation lay with the Mines not to discharge their slimes in such a way as to cause pollution’.<sup>82</sup> The mines countered that this was ‘a problem of equating between the needs of the countries [*sic*] greatest industry and the need of such agriculture as there is on the Copperbelt’.<sup>83</sup> This episode revealed not only the attitude of mining companies towards pollution and their liabilities, but moreover displayed conflicts over land use and power relations between mining interests, government and farmers. In the ‘Battle of the Mushishima’, government officials sided with the mines, asserting that ‘as long as there was a slimes dam, no matter how technically sound, it would be a nuisance to the farmers, and as long as there were farmers, they would be a nuisance to the mine’.<sup>84</sup> Eventually, the farmers lost the case and this issue disappeared from the archival record. Such instances however show that, occasionally, protest could entrench – rather than upset – unequal processes of knowledge production, as legal decisions legitimised polluting industries over victims of environmental harm.<sup>85</sup> That is what made protest so difficult and rare.

Whilst excellent studies of environmental protest movements across the Global South exist,<sup>86</sup> cases in which a lack of activism prevails have attracted far less attention.<sup>87</sup> How have the environmental effects of mining been normalised and made invisible? Which processes underlie the ‘engineering of consent’ to industry?<sup>88</sup> Environmental (in)action is linked to knowledge and ignorance in different ways, yet ‘a relative lack of action is not a simple consequence of lack of knowledge’.<sup>89</sup> On the Central African Copperbelt, residents have long been aware of pollution and of the multifaceted ways in which mining activity impacts on their environment. In oral histories, people living close to a smelter consistently complain about sulphur dioxide emissions, known locally as *senta* or *kachoma* fumes, which cause a sharp choking sensation in one’s lungs. Fumes and acid have further caused vegetation to wilt and fish to disappear from the rivers, and they are responsible for abnormally high incidences of pulmonary diseases and skin rashes.<sup>90</sup> This has certainly evoked dissent. One medical practitioner in Likasi voiced his complaints about lack of hygiene, dangerous working conditions and occupational diseases through the trade union, the Union Nationale des Travailleurs du Zaïre, in the 1980s. He wrote to the director of Gécamines reporting that at the Shituru acid plant a number of deaths had occurred due to occupational diseases caused by noxious fumes. The letter attracted attention, but no change in conduct resulted. The company even encouraged the doctor to remain silent about the origin of the diseases.<sup>91</sup>

Much more common than such petitions, however, were daily acts through which people learnt to live with pollution.<sup>92</sup> Mineworkers' wives would move their agricultural fields several miles to avoid excessive fumes, urban residents relied on the mining companies' water filtration systems to provide clean drinking water, and workers with signs of silicosis would be moved to a 'dust free' environment.<sup>93</sup> A teacher in Mufulira's Kankoyo neighbourhood complained that in the 1970s her entire vegetable garden had wilted due to fumes from the nearby smelter, but she decided to move her field elsewhere, as 'the mine will not stop producing anytime soon, so it is better for me to move my cabbage'.<sup>94</sup> Such adaptations should be understood as a sign of 'resigned activism', which Lora-Wainwright explains as efforts that people 'undertake routinely, individually or as a group, to counter or avoid pollution', as well as 'the simultaneous processes through which pollution comes to be regarded as a normal and unavoidable part of the natural environment'.<sup>95</sup>

What explains this relative absence of protest, despite longstanding environmental consciousness? Nixon attributes a temporal effect to 'slow violence' such as environmental pollution, 'a violence of delayed destruction that is dispersed across time and space, an attritional violence that is typically not viewed as violence at all'.<sup>96</sup> More fundamentally, most residents of the Central African Copperbelt came to regard pollution as inevitable.<sup>97</sup> The mining industry was 'socially, economically, and politically far too powerful for public health or environmental protection to have been considered by political authorities as a sufficient reason to restrict' its expansion.<sup>98</sup> In addition, the majority of the Copperbelt's population was directly or indirectly dependant on mining as a source of livelihood. That is why it was easier for farmers, a relatively autonomous group, to initiate protest against mining activities. Mineworkers and their wives, in contrast, tended to accept pollution as a normal side effect of mineral production and desired the economic prosperity that they associated with it. Although forms of resigned activism did generate alternative representations of environmental change, which challenged the power structures of mineral production, they could equally serve to naturalise environmental harm.<sup>99</sup>

On the Central African Copperbelt, especially from the 1950s until the late 1980s, the power relations of knowledge production tended to make environmental harm relatively invisible.<sup>100</sup> Mining companies, government officials and even Copperbelt residents themselves predominantly viewed the environmental effects of mining through representations of economic profit, scientific and technical progress or as an inevitable part of life. In this context, knowledge about pollution found few outlets, was dismissed or at times actively suppressed. The three case studies discussed above have illustrated strategies through which knowledge and non-knowledge about the environmental impacts of mining on the Copperbelt were generated and contested. Knowledge production about forestry is a case of diversion.<sup>101</sup> By focusing on African charcoal burning rather than on the mining industry's own environmental damage, mining companies and government officials expressed environmental consciousness in a highly selective and racialised manner. Gécamines medical services provide examples of dismissal and denial. Doctors at times acknowledged but shrugged off existing information, or denied the cause of diseases. Environmental protest illustrates alternative representations of environmental change, as well as their limits. These three strategies at once challenged and maintained established representations of environmental harm on the Central African Copperbelt.

## THE 'DISCOVERY' OF POLLUTION IN THE 1990S

Even if mining companies had monitored their environmental impacts before the 1980s, standards and laws remained minimal. A rapid change of policy occurred in the late 1980s and early 1990s in Zambia and in the late 1990s and early 2000s in DR Congo.<sup>102</sup> In accordance with international trends, various forms of protective legislation, standards and monitoring bodies were instituted and all mines compiled environmental impact assessments from the 1990s onwards. Environmental regulations and official documentation suddenly flagged up problems of 'pollution'. Legislative shifts were not merely benevolent attempts to save the environment, but had an economic rationale. In the 1980s, international agencies such as the World Bank and the International Union for Conservation of Nature started to focus on issues such as air pollution and water quality in Zambia and DR Congo. Yet the Copperbelt's growing economic difficulties, in particular, spurred stricter environmental management in the 1990s. ZCCM and Gécamines' spiralling debts forced governments to take out World Bank loans to stay afloat. One of the loan conditions was to have environmental regulations in place. This all took place within prevailing international frameworks of 'sustainable development' and natural resource conservation.<sup>103</sup> Copperbelt officials and mine management reconceptualised previous waste management practices as new efforts at 'pollution control'. Such discursive shifts were, however, largely tactical and did 'not challenge the often anti-environmental priorities for international extraction of and investment and trade in natural resources'.<sup>104</sup> A further incentive to formulate environmental impact assessments was privatisation, as investors interested in buying the mines wanted to know what they were committing themselves to – mining ventures were broken down into assets and liabilities, with investors only taking over the assets and leaving the liabilities to the state-owned companies ZCCM and Gécamines.<sup>105</sup> What prompted these changes in environmental legislation, and were there any parallels to earlier attempts at monitoring the mining industry?

In the late 1980s, Zambian mines started to take a more active approach towards environmental management, by regularly monitoring air quality, effluents and worker health. In its 1992 Environmental Policy Statement, ZCCM defined itself as a 'green mining company', which 'does not see an irreconcilable conflict between mining activities and the protection of the environment'. The company asserted that being a 'responsible corporate citizen' required developing 'site and situation specific plans to establish a sustainable balance between the generation of wealth and the protection of the environment'.<sup>106</sup> An economic rationale motivated environmental management, as 'the state of Zambia's environment could become a major constraint upon continuing development'.<sup>107</sup> Despite obvious geopolitical and economic motivations, ZCCM presented environmental management as beneficial: 'Spurred on by legislation and a realisation that good environmental management is cost effective, the Company is sparing no efforts in ensuring that its pollution control measures are adequate and effective'.<sup>108</sup> Still, there were recurrent complaints about the 'ineffective enforcement or outdatedness of most of the laws'.<sup>109</sup> A newspaper article urged the Environmental Council of Zambia not to be a 'toothless bulldog', but to actively monitor copper mining companies and ensure the enforcement of regulations.<sup>110</sup> Knowledge about the environmental effects of mining activity definitively became more visible in Zambia in the 1990s. On paper, there was a

remarkable change in environmental management practices through commendable laws and regulations. Yet a legacy of economic and technical representations of environmental change generated contradictions in environmental knowledge production, which made it difficult to bring pollution under control.<sup>111</sup>

The case of air pollution illustrates these tensions. New air quality regulations built on older understandings of the centrality of mining activity to the Copperbelt region, thereby entrenching unequal patterns of environmental knowledge production and impeding changes in production. Within Zambia, Mufulira is notorious for its bad air, caused by SO<sub>2</sub> emissions, or as they are locally known, *senta*. A 1997 report stated that Mufulira smelter still emits ‘98% of the total sulphur ... as SO<sub>2</sub> gas’.<sup>112</sup> Obviously, ‘the end result of these emissions can only be danger to lives of people and animals who are exposed to bad air day in day out’.<sup>113</sup> Air pollution caused respiratory and skin problems, and made it difficult for vegetation to grow. Despite these concerns, mining officials maintained that ‘the economic life of the nation needs to continue’ for if ‘standards were set to match European levels, some industries like the mines in Zambia would be shut down’.<sup>114</sup> Even though the Smoke Damage Prohibition Act was repealed in 1996, meaning the public could sue the mines for smoke damage, little action occurred.<sup>115</sup> In common with earlier periods, mining companies framed pollution control via an economic logic of reclamation. An acid plant was proposed to recover sulphur dioxide and generate economic value: ‘Major capital expenditure (±100 million US dollars) will result in the collection of 90% plus SO<sub>2</sub> gas’, which ‘contains some 12 tonnes per day of copper’.<sup>116</sup> Reports even estimated the cost of environmental protection in monetary terms, at one US cent per pound of copper.<sup>117</sup> ZCCM continued to confine itself to ‘technical and economic evaluations of commercially feasible options for reduction of sulphur dioxide emissions’.<sup>118</sup> Mining companies took few concrete steps to reduce pollution, beyond long-term plans for ‘abatement technology sufficient to reduce the total emissions of sulphur dioxide by a minimum of 60% before 1 January 2002’.<sup>119</sup> Tests could still conclude that, ‘air quality in Mufulira is generally good as far as it is affected by mining operations’, even if pollution levels exceeded South African maxima by a factor of ten. Laws existed to limit sulphur dioxide emissions, yet pollution continued irrespectively and was difficult to control. Newspaper articles in the early 1990s blamed government for adopting a ‘lukewarm approach’ to this ‘potentially explosive issue’ of ‘unchecked emission of toxic substances’,<sup>120</sup> and concluded that ‘what is worrying is the general lethargy towards’ Zambia’s environmental problems ‘which continues to this day’.<sup>121</sup> Despite rising environmental consciousness, concerns over problems such as air pollution did not immediately prompt changed behaviour on the part of mining companies, which continued to adhere to entrenched technical and economic representations of mining-induced environmental change. Government and mining companies’ discursive emphasis on ‘sustainability’ paradoxically served to cover up ‘the fact that there have been no significant reforms in how mining is practiced, or overall reduction of its harmful impacts’.<sup>122</sup>

On the Congolese side, the World Bank-commissioned SNC-Lavalin study examining the rehabilitation of copper and cobalt mines represents environmental knowledge production in this period.<sup>123</sup> Published in 2003, the report identifies a host of environmental problems related to historical and ongoing mining activity. It scrutinises the region’s mines, processing facilities and waste dumps for their contribution to air and water pollution as well as for their

effects on human health, animal life and vegetation. The report mentions numerous examples of heavy metal contamination, caused by factories that discharge toxic fumes or effluents straight into the rivers and air. Lubumbashi's smelter is a case in point, as 'sulphur dioxide is emitted directly to the atmosphere without any treatment' and 'the cooling water of the smelter furnace is discharged directly to the river'.<sup>124</sup> As a result, 'atmospheric wastes (SO<sub>2</sub>, hydrocarbons, dust, etc.) are a menace' for the surrounding population.<sup>125</sup> The consultants conceded that 'the common practice in the [DR Congo] for the management of mining waste ... is incompatible with modern practices'.<sup>126</sup> Although the report acknowledged severe environmental problems that required immediate corrective measures, proposed solutions still revolved around technical modifications framed within a cost-benefit analysis. The continued primacy of profit making clearly prevailed, as the report advised that if polluting mining wastes contain valuable metal, the retreatment of these 'artificial deposits' should be favoured: 'Although these [waste] accumulation sites can constitute a serious environmental problem, their restoration cannot be envisaged because this would imply definitively writing off the metals they contain'.<sup>127</sup> Displaying technical optimism, the report urged that old plants 'should be replaced by more modern and more efficient ones'.<sup>128</sup> Despite rapid policy change, environmental management practices changed only gradually.<sup>129</sup> By subordinating environmental concerns to market logics, World Bank interventions enlisted environmental policies 'in the service of the worldwide expansion of capitalism'.<sup>130</sup> Technical and economic imperatives continued to underpin environmental knowledge production. The SNC-Lavalin report concluded: 'There has recently been an awakening of environmental consciousness in the [DR Congo] that has not yet been able to manifest itself concretely in actual practice, due to lack of resources: the protection of the environment is a preoccupation that, naturally, comes far behind the satisfaction of needs linked to the survival of the population'.<sup>131</sup>

Environmental concerns on the Copperbelt soared in the 1990s. New legislation was enacted and monitoring agencies instituted, drawing unprecedented attention to problems of pollution. Yet the main environmental problems, as well as the solutions proposed to manage these, were not so different from earlier periods. Mining companies continued to approach environmental issues in a primarily economic manner, trying to remedy pollution through a cost-benefit analysis or engineering solutions. This period should, therefore, not be seen as a watershed. By tracing the roots of environmental knowledge production on the Central African Copperbelt, it can be argued that the alleged discovery of pollution in the 1990s was as much a local as an international phenomenon. Awareness of the environmental impacts of mining activity was longstanding on both sides of the border. Although the timing of the environmental turn on the Congolese Copperbelt was different from Zambia, environmental impact assessments built on established patterns of knowledge production.<sup>132</sup> By exploring these, local responses to donor pressures to address the environmental effects of mining activities can be better understood.

## CONCLUSION

Environmental considerations, even if they have been sidelined due to the socio-economic and political importance of mining interests, are remarkably long-standing on the Copperbelt. By examining archival and oral sources, this article has argued that studying forestry policies,



medical services and environmental protest can provide ways to overcome the apparent invisibility of environmental knowledge production. Understanding what the ‘copper society’ of the Copperbelt consisted of involves analysing the historical patterns of (in)visibility of environmental harm: how, for most of this period, mining companies and government officials adopted double standards to define environmental damage; why doctors so fervently debated ‘legitimate’ health concerns; and how mining communities learnt to live with pollution.<sup>133</sup> Such examples demonstrate the underlying power relations between mining companies, governments and residents of the Copperbelt. A focus on knowledge production reveals that the rise of environmental legislation and activism in the 1990s had its roots in entrenched representations of environmental change, which foregrounded economic and technical considerations. Economic conceptualisations of environmental harm as an externality to mineral production (‘collateral damage’)<sup>134</sup> had played a central role in making environmental concerns relatively invisible before the 1980s. Yet heightened environmental consciousness in the 1990s was mainly driven by economic imperatives, namely the need to secure World Bank loans for the struggling mining industry. Because international pressure could not resolve the contradictions between industrial production and environmental protection on the Copperbelt, environmental legislation proved difficult to implement. This article has shown that environmental considerations – even when not explicitly expressed – played a crucial role in the history of the Copperbelt. Creative approaches have to be adopted to make the environmental history of the Copperbelt visible. By examining areas such as charcoal production or occupational diseases, environmental knowledge can be placed in a clearer and more meaningful perspective. Future analyses might usefully focus on popular perceptions of environmental change or provide a more systematic comparison between Zambia and DR Congo.

This article has asserted the need to overcome the marginalisation of the environment in African mining histories. Whilst excellent work on rural environmental history or on the history of wildlife and conservation has been produced, urban and industrial environmental history on the African continent have attracted virtually no attention.<sup>135</sup> This article has suggested that histories of environmental thought profoundly shape current environmental management practices and their prospects for dealing with human-induced environmental change. Understanding the historical development of environmental consciousness is crucial for assessing future mining ‘sustainability’. This is important, as Odell, Bebbington and Frey have argued, because the relationship between mining and climate change is significant and multifaceted, yet under-researched, especially for developing countries.<sup>136</sup> Whilst on the Copperbelt global knowledge flows indisputably shaped environmental knowledge, for example regarding pollution control or environmental management practices, local dynamics equally gave rise to distinct specificities, informing the subtle differences between the Zambian and Congolese Copperbelts. Imperialism, corporate capitalism and engineering expertise crossed borders, but the specific features of the Central African Copperbelt, such as the history of labour migration and dependency on mining as a source of livelihood and regional power, make this case unique. By illuminating global–local dynamics, such research thus contributes to writing histories of the Anthropocene from an African perspective.<sup>137</sup>

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<sup>1</sup> Agence France-Presse, 'RDC: la deuxième vie du terroir de Lubumbashi', *Jeune Afrique*, 14 April 2014 (available at: <https://www.jeuneafrique.com/depeches/18949/politique/rdc-la-deuxieme-vie-du-terroir-de-lubumbashi/>).

<sup>2</sup> 'Geochemical and radiation characteristics of mineral waste in the Copperbelt', *Consolidated environmental management plan phase 2, Zambia* (2005).

<sup>3</sup> For exceptions, see Tomas Frederiksen, 'Unearthing rule: Mining, power and the political ecology of extraction in colonial Zambia' (PhD diss., University of Manchester, 2010); Corey Ross, *Ecology and Power in the Age of Empire: Europe and the Transformation of the Tropical World* (Oxford: Oxford University Press, 2017), pp. 164–98; Isabelle Vranken et al., 'The spatial footprint of the non-ferrous mining industry in Lubumbashi', *Tropicicultura* **31**, 1 (2013): 20–27; Constantin J. von der Heyden and Mark G. New, 'Groundwater pollution on the Zambian Copperbelt: Deciphering the source and the risk', *Science of the Total Environment* **327**, 1–3 (2004): 17–30. More generally, see Gavin Bridge, 'Contested terrain: Mining and the environment', *Annual Review of Environmental Resources* **29** (2004): 205–59.

<sup>4</sup> Lindsay Ofrias, 'Invisible harms, invisible profits: A theory of the incentive to contaminate', *Culture, Theory and Critique* **58**, 4 (2017): 435–56; Anna Lora-Wainwright et al., 'Learning to live with pollution: The making of environmental subjects in a Chinese industrialized village', *China Journal* **68** (2012): 106–24.

<sup>5</sup> Patrick Baert and Fernando Domínguez Rubio (eds), *The Politics of Knowledge* (London: Routledge, 2012).

<sup>6</sup> Marie Mazalto, 'Environmental liability in the mining sector: Prospects for sustainable development in the Democratic Republic of Congo', in Jeremy Richards (ed.), *Mining, Society, and a Sustainable World* (Dordrecht: Springer, 2010), pp. 289–318; Alastair Fraser and John Lungu, 'For whom the windfalls? Winners and losers in the privatisation of Zambia's copper mines' (Lusaka, 2006).

<sup>7</sup> Benjamin K. Sovacool et al., 'Sustainable minerals and metals for a low-carbon future', *Science* **367**, 6473 (2020): 30–33.

<sup>8</sup> In Zambia, the National Archives of Zambia (NAZ), the archives of Zambia Consolidated Copper Mines (ZCCM) and the Zambia Environmental Management Agency (ZEMA); in Brussels, the Union Minière du Haut-Katanga (UMHK) papers, *archives africaines* and Tervuren; and in DR Congo, the Gécamines archives in Lubumbashi and Likasi.

<sup>9</sup> Miles Larmer, 'At the crossroads: Mining and political change on the Katangese-Zambian Copperbelt', *Oxford Handbooks Online*, 2016 (available at:

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<https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199935369.001.0001/oxfordhb-9780199935369-e-20>).

<sup>10</sup> Gabrielle Hecht, 'Interscalar vehicles for an African Anthropocene: On waste, temporality, and violence', *Cultural Anthropology* **33**, 1 (2018): 109–41.

<sup>11</sup> Charles Perrings, *Black Mineworkers in Central Africa: Industrial Strategies and the Evolution of an African Proletariat in the Copperbelt, 1911–1941* (London: Heinemann, 1979); Larry J. Butler, *Copper Empire: Mining and the Colonial State in Northern Rhodesia, c.1930–1964* (Basingstoke: Palgrave Macmillan, 2007).

<sup>12</sup> Gavin Bridge, 'The hole world: Scales and spaces of extraction', *New Geographies* **2** (2009): 43–8; Benjamin Rubbers, 'Mining towns, enclaves and spaces: A genealogy of worker camps in the Congolese Copperbelt', *Geoforum* **98** (2019): 88–96.

<sup>13</sup> James Ferguson, *Expectations of Modernity: Myths and Meanings of Urban Life on the Zambian Copperbelt* (Berkeley: University of California Press, 1999).

<sup>14</sup> See Miles Larmer, *Mineworkers in Zambia: Labour and Political Change in Post-Colonial Africa* (London: I.B. Tauris, 2007); John Higginson, *A Working Class in the Making: Belgian Colonial Labor Policy, Private Enterprise, and the African Mineworker, 1907–1951* (Madison: University of Wisconsin Press, 1989); Kristien Geenen, 'Patronage, social proximity, and instrumentality in the mining industry in the Democratic Republic of Congo: The union elections explored', *Dialectical Anthropology*, in press.

<sup>15</sup> See Miles Larmer, 'Permanent precarity: Capital and labour in the Central African Copperbelt', *Labor History* **58** (2017): 170–84; Donatien Dibwe dia Mwembu, *Bana Shaba abandonnés par leur père: Structures de l'autorité et histoire sociale de la famille ouvrière au Katanga, 1910–1997* (Paris: L'Harmattan, 2003).

<sup>16</sup> In 1982, Nchanga Consolidated Copper Mines and Roan Consolidated Mines merged to form ZCCM.

<sup>17</sup> See René Brion and Jean-Louis Moreau, *De la mine à Mars: La genèse d'Umicore* (Tielt: Lannoo, 2006); Butler, *Copper Empire*; Ferguson, *Expectations of Modernity*.

<sup>18</sup> Ross, *Ecology and Power*, 137.

<sup>19</sup> Timothy J. LeCain, *Mass Destruction: The Men and Giant Mines That Wired America and Scarred the Planet* (New Brunswick, NJ: Rutgers University Press, 2009).

<sup>20</sup> See John R. McNeill and George Vrtis (eds), *Mining North America: An Environmental History since 1522* (Berkeley: University of California Press, 2017); François Jarrige and Thomas Le Roux, *La contamination du monde: Une histoire des pollutions à l'âge industriel* (Paris: Sueil, 2017); Stuart Kirsch, *Mining Capitalism: The Relationship between Corporations and Their Critics* (Berkeley: University of California Press, 2014).

<sup>21</sup> Gabrielle Hecht, *Being Nuclear: Africans and the Global Uranium Trade* (Cambridge, MA: MIT Press, 2012); Jock McCulloch, *Asbestos Blues: Labour, Capital, Physicians and the State in South Africa* (London: James Currey, 2002); Michal Singer, *Facing Coal: Changing Conceptions of South African Coal-Based Pollution, with Special Reference to the Witbank Coalfield, 1906–1978* (Leiden: African Studies Centre, 2011).

<sup>22</sup> For example Ferguson, *Expectations of Modernity*; Dibwe dia Mwembu, *Bana Shaba*.

<sup>23</sup> Benjamin Rubbers and Marc Poncelet, 'Sociologie coloniale au Congo Belge: Les études sur le Katanga industriel et urbain à la veille de l'indépendance', *Genèses* **2**, 99 (2015): 93–112;

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Lyn Schumaker, *Africanizing Anthropology: Fieldwork, Networks, and the Making of Cultural Knowledge in Central Africa* (Durham, NC: Duke University Press, 2001).

<sup>24</sup> For exceptions, see Frederiksen, 'Unearthing rule'; Ross, *Ecology and Power*; Lyn Schumaker, 'Slimes and death-dealing dambos: Water, industry and the garden city on Zambia's Copperbelt', *Journal of Southern African studies* **34**, 4 (2008): 823–40.

<sup>25</sup> Tomas Frederiksen, 'Seeing the Copperbelt: Science, mining and colonial power in Northern Rhodesia', *Geoforum* **44**, 1 (2013): 271–81; Brion and Moreau, *De la mine à Mars*.

<sup>26</sup> Christopher Sellers and Joseph Melling, 'Towards a transnational industrial-hazard history: Charting the circulation of workplace dangers, debates and expertise', *British Journal for the History of Science* **45**, 3 (2012): 412–13.

<sup>27</sup> Garrett M. Broad, 'Animal production, ag-gag laws, and the social production of ignorance: Exploring the role of storytelling', *Environmental Communication* **10**, 1 (2016): 47–8.

<sup>28</sup> See Soraya Boudia and Nathalie Jas (eds), *Powerless Science? Science and Politics in a Toxic World* (New York: Berghahn, 2014).

<sup>29</sup> Robert N. Proctor and Londa Schiebinger (eds), *Agnotology: The Making and Unmaking of Ignorance* (Stanford, CA: Stanford University Press, 2008), p. vii.

<sup>30</sup> Nancy Tuana, 'Coming to understand: Orgasm and the epistemology of ignorance', in Robert N. Proctor and Londa Schiebinger (eds.), *Agnotology: The Making and Unmaking of Ignorance* (Stanford, CA: Stanford University Press, 2008), p. 110.

<sup>31</sup> Ulrich Beck and Peter Wehling, 'The politics of non-knowing: An emerging area of social and political conflict in reflexive modernity', in Patrick Baert and Fernando Domínguez Rubio (eds), *The Politics of Knowledge* (London: Routledge, 2012), p. 38.

<sup>32</sup> *Ibid.*, 51.

<sup>33</sup> Steve Rayner, 'Uncomfortable knowledge: The social construction of ignorance in science and environmental policy discourses', *Economy and Society* **41**, 1 (2012): 107.

<sup>34</sup> Rob Nixon, *Slow Violence and the Environmentalism of the Poor* (Cambridge, MA: Harvard University Press, 2013), p. 2.

<sup>35</sup> Sellers and Melling, 'Towards a transnational industrial-hazard history', 419.

<sup>36</sup> Étude relative à la pollution des eaux des rivières de l'agglomération de Jadotville par les installations métalliques de l'UMHK, 1931 (Archives Africaines, DG 1753 3).

<sup>37</sup> 'Fumées des usines de Lubumbashi, Justification et examen des conséquences du transfert éventuel des opérations de grillage à Kipushi', 19 June 1936 (UMHK, 319).

<sup>38</sup> Smelter site, Luanshya, 2 June 1936 (NAZ, SEC3/261).

<sup>39</sup> Smelter site, Luanshya, April 1936 (NAZ, SEC3/261).

<sup>40</sup> Alienation of land on the Copperbelt, 3 December 1956 (NAZ, ML8/12/49 Loc. 6281).

<sup>41</sup> Soil conservation, 8 September 1955 (NAZ, WP1/14/27, loc. 5302).

<sup>42</sup> Chingola-Bancroft intensive conservation area committee, 8 October 1958 (NAZ, WP1/14/38, loc. 5304).

<sup>43</sup> Chingola intensive conservation area committee, 6 January 1955 (NAZ, WP1/14/27, loc. 5302).

<sup>44</sup> After the Katangese secession of 1960–1963, the Congolese central government in Kinshasa, under the leadership of Mobutu Sese Seko, redoubled its efforts to extract as much profit as possible from Katanga's mining industry through taxes and royalties. Hagglings over mineral wealth stimulated policies to maximise mineral production at all costs. See Erik Kennes and

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Miles Larmer, *The Katangese Gendarmes and War in Central Africa: Fighting Their Way Home* (Bloomington: Indiana University Press, 2016).

<sup>45</sup> Gécamines annual report, 1975, p. 16.

<sup>46</sup> Based on a reading of UMHK and Gécamines annual reports from 1950 to 1990 and the Gécamines' technical bulletin *Maadini*.

<sup>47</sup> Bulletin de l'ACP, 10 October 1969 (UMHK, Umicore, 977).

<sup>48</sup> John Copeland Nagle, 'The idea of pollution', *UC Davis Law Review* **43**, 1 (2009): 1–78.

<sup>49</sup> Konkola division water quality evaluation, Pollution writings from 1970s (ZCCM, 14.5B).

<sup>50</sup> Pollution general correspondence, April 1984 (ZCCM, 5.14.5B).

<sup>51</sup> Annual reports of *Hygiène et sécurité du travail*, 1970s and 1980s (Gécamines archives, Lubumbashi).

<sup>52</sup> Annual reports of the Mines Safety Department, 1976 to 1985 (NAZ).

<sup>53</sup> Pollution writings, 1980s (ZCCM, 5.14.5B).

<sup>54</sup> Pollution general correspondence, April 1984 (ZCCM, 5.14.5B).

<sup>55</sup> Emmanuel N. Chidumayo, 'Land use, deforestation and reforestation in the Zambian Copperbelt', *Land Degradation and Rehabilitation* **1** (1989): 209–16.

<sup>56</sup> Northern News, 13 July 1956 (NAZ, ML8/12/49).

<sup>57</sup> Regional survey of the Copperbelt, 1959 (NAZ).

<sup>58</sup> Charcoal production, 21 December 1953 (NAZ, WP1/14/10, loc. 5298).

<sup>59</sup> Chingola intensive conservation area, 8 October 1953 (NAZ, WP1/14/27, loc. 5302).

<sup>60</sup> Larmer, 'At the crossroads'.

<sup>61</sup> Mufulira annual report on African affairs, 1956 (NAZ, WP1/2/32, loc. 5244).

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<sup>72</sup> General correspondence, 1984 (Gécamines, medical archives, Likasi).

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