It's complex: reframing narratives around the social impacts of mine closure

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Abstract

Mining leaves communities better off: this is something the mining industry is committed to. However, the evidence base for the positive impacts of mining on communities enduring after closure is surprisingly thin. This also means an evidence-based approach to taking action on the social aspects of mine closure is similarly limited.

Since the late 1990s the mining industry's approach to social impacts has been framed by a narrative that mining has the potential for positive social impacts, that mining companies have responsibility for managing these impacts and that this can be achieved through the integration of company management systems.

This study reviews a wide range of mine closure cases to identify common typologies and patterns in how mining leaves communities, including the role of mining companies in this process. The study identifies negative, positive and more benign exemplars of the social aspects of mine closure. However, no example was identified which clearly demonstrated the ideal model of a community being left better off after mining as a result of planned pre-closure mining company activities, and the potential reasons for this are outlined. The need for an alternative exemplar of former mining communities is investigated, as well as some of the initiatives underway in these contexts.

The case studies highlight the complex nature of the systems in which many mines close and the 'wicked problem' of socio-economic transitions linked to mine closure. As such, there is a need to reframe narratives and further promote and adopt approaches which are better suited to the challenging complexity associated with former mining communities.

Keywords: *social, communities, sustainability, asset transition, planning, complex systems, wicked problems*

1   Introduction

1.1   Mining company commitment to leaving communities better off after mining

In 2013 Mark Cutifani (then CEO of AngloGold Ashanti and CEO designate of Anglo American), speaking at the Mining Indaba conference in Cape Town, stated that,

> *'Great mines contribute to society well beyond mine closure - leaving the world a better place to live today and for the future … We have to think beyond our historical characterisation … that talks to us being an "Extractive Industry" … we are overwhelmingly a "Development Industry" that creates new social possibilities'* (Cutifani 2013).

Mining activities have multiple ways in which they can contribute positively to human development, and for these impacts to provide sustainable benefits beyond the life of the mine (UNDP et al. 2016). Since the late 1990s the mining industry's approach to social impacts has therefore been framed by a narrative that mining has the potential for positive social impacts, that mining companies have responsibility for managing these impacts and that this can be achieved through the integration of company management systems. The idea that

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the mining industry can (and does) act as a catalyst for human development and leave communities better off was initially elucidated as part of the Mining, Minerals and Sustainable Development Project from 2000–2002, and has since become an important underlying narrative to support the industry's social licence.

Leading mining companies and industry associations have subsequently made clear commitments to leaving communities better off. More broadly, many mining companies have also committed to supporting the delivery of the United Nation's Sustainable Development Goals (SDGs) (International Council on Mining and Metals 2024). The ISO Standard (ISO 21795-1:2021) on mine closure and reclamation planning is also explicitly designed to contribute to the SDGs (ISO 2021). The SDGs are grounded in the Brundtland Commission's (1987) definition: 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. The centrality of 'future generations' to this definition is therefore particularly important in relation to how the mining sector talks about its role in sustainable development, and how this links to mine closure and its potential to impact future generations.

1.2   Theory of change: integration of social issues in mine closure planning

The principal mechanism through which mining companies ensure they enact their commitment to leave communities better off after mining is through integration of these issues in mine closure planning. This approach is exemplified in ICMM's Integrated Mine Closure: Good Practice Guide (2019) and the ISO Management System Standard ISO 21795-1:2021 (2021): Mine Closure and Reclamation Planning. These approaches are mirrored in company and site-level standards and processes. The key aspects of integration of social issues in mining company closure planning include: making the business case for consideration of the social aspects of mine closure; early consideration of the social aspects of mine closure in the mine life cycle; including social issues as part of the mine closure knowledge base; integrating closure-related issues in stakeholder engagement processes; working with stakeholders to develop the closure plan including vision, objectives, potential for asset repurposing and post-closure land use options; developing social transition plans; and maximising opportunities for local stakeholder involvement in mine closure activities and post-closure monitoring (ICMM 2019). While the field is rapidly evolving and new approaches are being proposed and developed, this theory of change is implicit in most mine closure processes.

1.3   Evidence base for communities being better off post-mining

The Eden Project's 101 Things to Do with a Hole in the Ground (Pearman 2009) has become a classic: providing an invaluable compendium of international examples of mine closure. However, the examples largely focus on the geophysical transformation of mine sites and have limited information on the social dimensions or on how these successful outcomes were achieved (although there are several more examples relating to community issues in the recently published sequel) (Whitbread-Abrutat & Lowe 2024). In addition, only a very small number of the examples appear to be a result of planned activities by the mining company while the mine was operational. The case studies in these two books are illustrative of the wider available literature on mine closure case studies.

Despite the long-term prevalence of specific company and industry commitments, the evidence base for the positive impacts of mining on communities enduring after closure is surprisingly thin. Similarly, the evidence base is weak to support the theory of change that the integration of social aspects in mine closure planning leads to positive outcomes for communities (Digby 2012; Holcombe & Keenan 2021). Of the literature that does exist, much of it is case-specific or focused on a particular (mining) region (particularly those in North America, Australia and Europe), and therefore may not address underlying factors (such as levels of economic development or national governance) or draw out common themes which apply across multiple different mining contexts internationally. In addition, the literature often relies on theoretical approaches, case studies which are often framed as successes and rarely interrogate the underlying factors, and practices which are still being implemented and have not yet demonstrated their longer-term success.

2 Methodology

This research took a case study-led approach drawing on a wide range examples of outcomes for communities after mine closure and to review the factors which may contribute to successful social transitions. The study identified and analysed a range of international case studies, based on an extensive review of publicly available information, peer-reviewed and scholarly literature, industry-oriented and industry-produced literature, and wider information published online, as well as the author's own experience.

To be included, case studies needed to meet a number of criteria including: the communities must have been affected by mining in the past, with the majority of mining activities now finished; impacts must be demonstrable at the local level (i.e. not regional or national impacts, and not only on specific social issues or individuals); impacts must be attributable to mining activity; social changes must be relative to a baseline or control; where possible, information must be available on intentional actions taken to achieve positive outcomes; and they must have a reliable evidence base.

Case studies were not included if they failed to meet these criteria, as, for example, in cases where: positive community development was not clearly linked to mining activities (e.g. they were potentially due to the development of other economic activities which are unconnected to mining); changes against a baseline were hard to determine (e.g. good closure practices but which may have limited attributable social impacts); and mining is ongoing and it is not possible to determine post-closure related impacts (e.g. good practices relating to managing potential social issues but these have not yet been demonstrated to be effective post-closure).

The examples included in this paper are a limited selection of the case studies reviewed and serve to illustrate common themes and patterns which emerged through the research.

3 Results

3.1 Positive exemplars: narratives around social closure are dominated by a small number of examples with (some) positive social aspects

Implicit in the narrative around mining activities leaving communities better off is the image of a community which existed prior to mining and which has thrived as a result of mining operations, and subsequently been in a better position to what it was pre-mining.

Publications and industry information relating to the positive social aspects of closure are dominated by a relatively small number of examples and case studies which are repeated. However, this research did not find a single example which fitted clearly and unambiguously with this narrative (although it was noted that the absence of evidence may not be evidence of absence). Rather than being emblematic of a wider group of common instances, these cases appear to frequently have some unusual factors underlying their positive impacts; some of which also involve less than positive impacts and which are discussed later in this paper.

A relatively large number of communities are commonly identified as mining communities, which have developed because of mining and are still thriving when the mining stops or becomes only a minor factor in the community's life. It is also worth noting that over 20 sites have been designated as UNESCO World Heritage Sites in recognition of their cultural heritage, which is specifically linked to mining. Examples of these emblematic 'mining communities' include: Potosi, Bolivia; Guanajuato, Mexico; the Hallstatt-Dachstein and Salzkammergut region, Austria; Røros Mining Town, Norway; Kuala Lumpur, Malaysia; Johannesburg, South Africa; and Longyearbyen on the Norwegian island of Svalbad.

Many of these communities have several features in common:

- Most of them have involved significant mineral deposits which have supported mining activities over many decades (often for centuries).

- Most of them are located very close to the mining activities, although a small number of impacted communities are more distant from operational or closed mines, such as labour-sending areas or hubs for fly-in, fly-out (FIFO) workers (Perry & Rowe 2014).

- Many of the positive cases involve close connections to other economic activities (such as being near other non-mining-dependent towns or cities, or centres of other economies such as tourism). The transport, administrative, power and water infrastructure and associated services developed specifically for mining activities have unintentionally also supported the development of other economic activities.

- None of the positive cases appear to have involved a clear intentional and long-term plan to ensure the community is successful post-mining. Instead, these communities have evolved and diversified in an ad hoc manner. Narratives often the path dependency, long-term and messy nature and role of a diverse group of stakeholders in the transition.

- In many cases the communities have involved some type of strong governance control, particularly colonial or royal power which has had a strategic or financial interest in developing and maintaining control of the mine site. This type of governance may also be a factor in the shadow side of the history of these sites, such as displacement of the original inhabitants, forced labour or discrimination and inequality.

- Many examples used to illustrate management of the social aspects of mine closure do not involve the mining companies in any way, such as entities responsible for post-mining care, rehabilitation and redevelopment (e.g. RAG-Stiftung and Lausitzer und Mitteldeutsche Bergbau-Verwaltungsgesellschaft mbH [LMBV] in Germany, and Korea Mine Rehabilitation and Mineral Resources Corporation), initiatives to support former mining communities in economic development and retraining (e.g. Coalfields Regeneration Trust, United Kingdom; and Retraining Programs for Dislocated Miners in coal mining regions including Kentucky, Ohio and West Virginia, USA [Diersing 2021]), and retraining for former coal miners in Poland to operate and service wind turbines).

- Several other flagship case studies of positive post-closure social impacts are not as a result of planned activities by the mining company prior to closure but have been developed by entrepreneurial individuals: such as the Eden Project, UK; the Kidstone Pumped Storage Hydro Project, Australia; and the Dalhalla open air theatre in Sweden. In other cases, the role of entrepreneurs may be downplayed relative to the role of the mining company. For instance, Kimberley, near the Sullivan mine in Canada, is often hailed as an example of the successful economic transition of a mining community and the mining company has invested significantly in land rehabilitation, land and economic development, and asset transfer leading up to, and after, closure in 2001 (ICMM 2019). However, the foundations for Kimberley's economic transition were laid by a group of entrepreneurial local businessmen in the 1960s (Rockandel 2002; Koch 1998).

These positive exemplars therefore illustrate the unique and sometimes unusual factors at play in each case, rather than them necessarily being models for what does or could happen more widely in the industry. They also highlight the need to consider factors beyond those which a mining company is directly responsible for planning or managing and which need to be considered in achieving positive socio-economic post-closure transitions.

3.2 Negative exemplars: a small number of extreme cases dominate narratives around negative social impacts

In contrast to the common positive case studies on the social aspects of mine closure are numerous but common examples of how mine closure can leave communities worse off. Flagship negative post-mining case studies can be roughly grouped into several different types:

- environmental legacies, such as the Giant mine, Canada (Sandlos & Keeling 2016; Beckett 2021), the 143 Superfund mine sites in the USA, and the Micronesian island of Nauru

- chronic health problems, for example, Kabwe, Zambia (Bose-O'Reilly et al. 2018; Yabe et al. 2015) and Bunker Hill, USA

- illegal post-closure mining such as illegal mining by 'zama zamas' (illegal artisanal miners) in closed gold mines in the Durban Deep/Roodepoort area of South Africa (Nhlengetwa & Hein 2015; Limpitlaw & Digby 2014)

- post-closure disasters such as the 1990 tailings dam failure at the closed Matachewan gold mine in Canda and the 2022 the tailings dam wall failure at the former Jagersfontein diamond mine in South Africa

- conflict, including links between mining and armed conflict in regions with gold and coltan (columbite-tantalite) in the Democratic Republic of the Congo, diamonds in Sierra Leone and Angola, and tin in Wa State, Myanmar, as well as the role which the social and environmental impacts of the Panguna copper and gold mine on the island of Bougainville amplified existing processes of social change and culminated in conflict (Regan 2014; Bainton & Burton 2024)

- labour-sending communities such as in the Eastern Cape and Northwest Provinces of South Africa, Lesotho and Mozambique

- 'brain drain' such as in Central Appalachian coal mining communities (Krause 2023)

- ghost towns such as Kolmanskop Namibia; Gunkanjima, Japan; Uranium City, Canada; Vorkutlag, Russia; and Sewell Mining Town in Chile.

Similarly to the positive exemplars, these high-profile negative cases also illustrate the unique and sometimes unusual factors at play in each case, which are discussed later.

3.3 Greener holes in the ground: most closed mines demonstrate limited transformational social impacts

Despite the higher-profile positive and negative cases outlined above, in the large majority of cases mining may be relatively benign in terms of having a significant role in community-wide development once mining activities have ended. This may be due to the specific context and history of the mine site or a result of actions taken by mining companies to minimise post-mining negative environmental impacts.

Countries with a history of mining often have a significant number of sites where mining has taken place, such as in Australia (Werner et al. 2020; Monash University 2020), Canada (NRCan n.d.), South Africa (Mhlongo 2023; Human Rights Watch 2022; Watson & Olalde 2019; Cole 2024) and the USA (GAO 2020), and therefore provide a large evidence base of how communities are left after mining. While there is usually limited specific information on the social impacts of these sites (again noting that absence of evidence may not be evidence of absence), it is likely that, for a variety of reasons, a significant proportion of these sites is likely to be relatively benign in terms of post-closure social impacts.

In many cases closed mine sites may be relatively small, particularly older abandoned sites, which would nowadays be classified as artisanal and small-scale mining sites with limited enduring social impacts. Even where there may still be physical artefacts of mining activities, closed mine sites may have no or very limited neighbouring communities remaining. Where there are communities located near closed mine sites there may be limited evidence that their location, size and current socio-economic status are connected to the historical mining activities. Where closed mine sites have not been properly rehabilitated and have limited environmental impacts, natural processes may mean that there will be some level of restoration to pre-mining status, or an altered post-mining natural environment. Mining company social investments during operations offer limited evidence that they provide measurable post-closure sustainable benefits to communities, and there are no clear examples of such benefits in the cases reviewed for this study.

Mine closure legislation, and a company's integrated and progressive closure planning processes, help ensure that mines are increasingly left safe, stable, sustainable and non-polluting: thereby avoiding potential negative environmental burdens on communities. Many closed mine sites have undergone significant work by mining companies to rehabilitate mined land to pre-mining conditions, or to suitable alternative conditions. In some cases, post-mining landscapes may provide natural environments which are of higher natural value than the surrounding landscape. For example, in England there are 600 Sites of special scientific interest which are former mineral extraction sites (Sinnett 2019). In many cases, particularly where these sites are in remote locations and/or on private land with restricted access, they may be considered to have limited post-closure social benefits beyond the (sometimes significant) inherent natural value of these sites. In cases where neighbouring communities may benefit from access to, and use of, natural post-mining landscapes, and while these may offer a significant improvement on the residents' status during mining, this study did not identify any evidence that the communities were demonstrably better off (relative to their access to, and use of, these sites) than they were prior to mining.

There are also examples of community engagement in closure planning processes that help ensure negative environmental impacts are identified and managed, and progress monitored. These include formalised processes for community input to mine closure implementation and monitoring (e.g. the Obuasi Closure Consultative Committee [CCC], Ghana [AngloGold Ashanti 2020]; Kurri Kurri Aluminium Refinery Community Reference Group, Australia; the Woodcutters Mine Agreement, Northern Territory, Australia; and the Community-Based Environmental Monitoring Program for Uranium City as part of the Ya'thi Néné Collaboration Agreement, Canada [Cameco & Orano 2022]), and post-closure infrastructure use (e.g. eMalahleni Water Reclamation Plant, South Africa [United Nations Framework Convention on Climate Change 2012]; and Lake Meirama water reservoir, Spain).

These examples highlight the fundamental importance of mining company closure planning in ensuring that mines successfully leave communities without enduring environmental legacies. However, it does not necessarily follow that mining company closure planning should be the primary mechanism for achieving positive social post-closure outcomes.

3.4   Alternative exemplars: better off? It's complex

The review of information relating to communities following mine closure shows that there is perhaps an alternative exemplar of how mining typically and more commonly leaves communities, in contrast to the higher-profile positive and negative exemplars, or the more socially benign greener holes in the ground. These might broadly be referred to as 'former mining communities' that may have existed prior to mining activities starting but which mining has fundamentally transformed during the life of operations, and where the community has experienced a general decline since mining finished.

These patterns in former mining communities appear globally. For instance, in the former coalfields of England, Wales and Scotland (Fothergill et al. 2024); former gold mining communities in Ghana, Mali and Tanzania (Chuhan-Pole et al. 2017); near-mine communities affected by the shift to FIFO working patterns in Australia; former coal-mining communities in Central Appalachia, USA (Hansell 2018; Anderson 2014), Russia, Ukraine and Romania (Haney & Shkaratan 2003), including the Apuseni region in Romania (Botezan et al. 2020); Shanxi, China; and Asturias, Spain (Bridle et al. 2017).

Mining changes will likely have principally included a growth in population and an increase in average incomes, alongside increased housing, infrastructure, public services and supporting economic activities which may or may not have been mining company and/or government run. The mining resource may not have been large or viable enough to sustain mining operations for the many decades needed to develop communities like the positive exemplars. The mining may not have been strategically, politically or financially important enough to warrant significant government control, investment and support for the community. There has likely been limited formal planning or investment in relation to the closing of the mine, the timing of the closure is likely to have changed several times, or mining may have reduced or closed and then restarted again several times.

The community may have been fortunate enough to not have suffered from significant long-term environmental impacts as a result of mining activities. The community is neither so remote and disconnected from other economic activities that it becomes a ghost town, nor so close to other economic activities that it becomes subsumed within the wider community and does not have a clear post-mining community identity.

All these factors mean that after mining activities end, the community experiences a steady decline compared to during mining – although this will be experienced differentially within the community. The population most likely reduces, with some former (particularly higher-skilled) mine workers emigrating to work elsewhere. Those remaining may have relatively higher levels of unemployment or rely on low-paid, low-skilled and insecure work. There may also not be a return to the livelihoods which predominated in the community pre-mining, such as agriculture. With decreased incomes and revenues, it is likely that the level of services and infrastructure can no longer be maintained by households, communities and/or local government. This may result in the communities' remaining residents having a higher average age while being multi-dimensionally and inter-generationally poorer, and more marginalised relative to the former mining period and comparable non-mining communities. Some investments from the mining period may still be valuable community assets, such as public buildings, physical infrastructure or open spaces. There are likely some government-supported initiatives to support employment and business development opportunities, although these will likely have mixed results and a relatively small impact on the gap created post-closure. Some entrepreneurial individuals may have established new small enterprises or community initiatives which help fill some of the gaps in service provision and economic opportunity. However, as the decline may be slow, the triggers for concerted action by government and communities may only occur some time after mining activities have stopped.

Importantly, these communities connect their identity to mining, although the meaning of being a 'former mining community' will vary between different people (Kingsbury & Wilkinson 2023). There is often pride in their mining history and their resilience in the face of these changes, as well as a distinct sense of community which mining activities fostered. There may even be a mining museum to celebrate this history and potentially attract tourists to boost economic activities. It may be difficult or meaningless for residents of these communities to compare their current status with that of a pre-mining condition if the community has transformed so considerably as a result of mining and its identity is so closely woven with mining. There may be recognition that the community was generally better off during mining (and, by implication, worse off after mining), as mining shaped the community to such an extent that it has become a complex and nuanced consideration.

4 Discussion

This review of a wide range of case studies of the post-closure state of mining communities reveals uncomfortable truths about closure processes, which are described below. These are contrasted with a conventional approach to mine-closure planning and lead to a suggested reframing in terms of seeing socio-economic transition as a 'wicked problem' resulting from the complex nature of these systems. However, patterns of success in the examples also point towards a richer understanding of where successful transitions may be more likely and approaches which may support this.

4.1 Uncomfortable truths about closure processes

This review of case studies raises some fundamental questions about the evidence base to support the theory of change that mining can leave communities better off through the integration of social issues in mining company pre-closure planning processes. This review was not able to identify a single case study which provided substantial support to this theory of change.

Therefore, it is perhaps useful to identify some of the realities emerging from these cases, even where they may not sit comfortably alongside fundamental assumptions about mining company closure processes.

While somewhat simplistic, a fundamental assumption which in the main holds true is that, in practice, mines rarely close, at least in the way in which they are assumed to do so in conventional mine planning processes. This applies not only to the incredibly small number of mines which are formally relinquished in line with

government regulations as the result of a company's implementation of a planned and funded closure process but also to many mines abandoned before being adequately closed. Larger mining companies conducting closure planning during operations will often sell the asset prior to implementing closure planning. Mines will be put under care and maintenance rather than being closed and life of mine estimations will often change. Mines will be expanded and new mines reopened on the same sites as closed mines. Communities may experience similar impacts as closure would cause but prior to mining activities stopping, such as when FIFO arrangements are introduced or large local contractors are replaced with non-local providers. Finally, even when mines are technically closed, the post-closure activities may represent a significant benefit to local communities for long periods, and potentially in perpetuity (National Research Council 2005).

Although the changing and uncertain end point of mine closure and relinquishment can often be accommodated when managing biophysical aspects of closure, this becomes more challenging in the context of social issues. For instance, communities respond dynamically and differentially to these changes in timeline, and post-closure expectations and opportunities are also likely to evolve. One specific uncomfortable truth related to this is that stakeholders may not want to be engaged in mine closure planning processes, despite it being industry good practice to do so. People may feel that closure is too far off, or hope that it may not happen, or find it difficult to engage in closure discussions alongside those about a potential extension of the life of mine.

A complicating factor in the theory of change is that mines create communities. Almost all of the cases reviewed here involve communities which have been fundamentally transformed during mining activities, however, in some cases they have been created in places where there were no pre-mining communities. Mine closure planning regulations and processes are typically founded on the basis that closure implementation will restore the mine site to its pre-mining condition, or an agreed alternative which is better or more suitable than the pre-mining state. This assumption works well in the case of environmental and landform characteristics but is less suitable in the context of social and economic issues. As such, very often there may simply not be a baseline against which to measure 'better off'.

Several uncomfortable truths relate to the complexity of the systems involved around socio-economic transitions: mine closure involves multiple interconnected 'actors' with different and changing roles; mine community development trajectories are unique and path-dependent; and many social aspects of mine closure are not predictable. Due to the many stakeholders involved, mining companies have limited direct control and responsibility for successful post-mining asset transition. The limited specific regulation, the sometimes significant investment needed for transition processes and the uncertainty of success mean accepting that there may not be a strong or straightforward business case for company engagement in social closure issues. The complex nature of the issues and distributed responsibilities may also mean that mining company closure teams may not have the capacity to manage transition processes.

Finally, the complexity of these issues, the context specificity and uncertainty involved, the wide array of disciplines they touch upon and the relatively recent focus on this topic mean there is also a need to confront another uncomfortable truth: as mine closure/asset transition practitioners we need to admit that we don't know what we're doing. This honesty is often reflected in discussions with practitioners but is rarely portrayed in guidance and toolkits.

4.2   Reframing mine closure for complex contexts

The cases do indicate a way forward by being more explicit about some of the uncomfortable truths for which there is a stronger evidence base; reframing the problem and intended goal as well as reframing the role which mining companies can play in this process.

Mining company closure planning processes function effectively (and are implicitly designed) for simple or even complicated systems, rather than the complex nature of socio-economic transitions linked to mine closure. A fundamental proposition which may be useful, although uncomfortable, to more clearly acknowledge is that mining communities are complex systems and achieving successful social development

outcomes from mine closure has many of the characteristics of a 'wicked problem' (Rittel& Webber 1973). Wicked problems are unique, with many interacting factors which involve incomplete, contradictory, changing and difficult-to-define requirements, making them seem impossible to solve.

Table 1 contrasts conventional approaches to addressing the social aspects of mine closure with the uncomfortable truths outlined above and provides some potentially more appropriate approaches in the context of wicked problems.

Table 1   Conventional mine closure approaches, uncomfortable truths and reframing as wicked problems for successful socio-economic transition (Table adapted from Mason et al. 2018; Game et al. 2014)

	Conventional mine closure	**Uncomfortable truths**	**Asset transition as a wicked problem**
A	*Predictable processes* Mine life cycles follow a time-bound and predictable linear process with a defined end point. Management interventions rely on feedback control or passive adaptive management	Mines rarely close	*Uncertain and dynamic pathways* Outcomes are subject to constant flux and changing pathways driven by multiple internal and external factors. Management interventions are adapted iteratively, following multi-scenario-based predictions
B	*Consultative inputs to process* Company-managed processes are improved through consultation with stakeholders	Stakeholders may not want to be engaged	*Empowered governance* Outcomes are improved if stakeholders are empowered to take responsibility in decision-making
C	*Success against a prior baseline* Clear measures of management success (and/or failure) exist	Mines create communities	*Trade-offs in objectives* Trade-offs and contested views in management success are recognised
D	*Standard practice* Standard or best practice management practices from elsewhere are used and can be applied across all mine site contexts	Development trajectories are unique and path-dependent	*Creative practice* Creative context- and problem-specific management practices are ideated, developed, tested and iterated
E	*Conventional evidence* Management is informed by evidence from single processes	Social aspects of mine closure are not predictable	*Pattern-based evidence* Management is informed by pattern recurrence in complex, interactive processes
F	*Top-down decision-making* Management decisions are made in a top-down hierarchical process by a single entity	Mining companies have limited direct control and responsibility	*Distributed decision-making* Management decisions are contributed to by different 'actors' with distributed responsibilities
G	*Business case-driven* Priorities and resources are allocated in relation to legal compliance and business risk	There may not be a strong business case	*Societal responsibility-driven* Resource allocation decisions are framed by a values-based approach and because it is the 'right thing to do'
H	*Restricted expertise* Management is guided by restricted expertise	Mining company closure teams do not have the capacity to manage asset transition	*Diverse expertise* Management is guided by a more diverse set of voices and a broader view of expertise
I	*Avoid sharing failures* Management failures are not shared with stakeholders	We don't know what we're doing	*Sharing failures* Management failures and uncomfortable truths are accepted and shared transparently

4.3   Better off how? Patterns of success in post-closure communities

The case studies, whether positive, negative, benign or complex, show some common patterns in what may be more likely to lead to long-term positive outcomes for communities. These include:

- a big, long-term mineral resource. Many of the positive examples involve mining activities which have operated in the same area over many decades; sometimes centuries (even though this may involve multiple mine sites, multiple and changing mining companies, and peaks and troughs in mining activities over time

- local re-investment. The most successful examples show a pattern of significant investment in communities from the mining activities. This is almost always not a result of intentional and planned investment to build post-closure resilience but may be a result of the necessity to build local infrastructure in remote regions or the strategic importance of building a local power base. Activities which disburse these economic benefits, such as FIFO arrangements, undermine the potential success of these near-mine communities

- limited negative legacies. While perhaps less of a consistent pattern, it appears that many of the successful cases have not been encumbered by significant long-lasting downsides linked to mining activities, particularly from environmental and health impacts, systemic discrimination, serious human rights abuses or conflict

- proximity to other economic activities. Communities which more successfully transition from mining are often endowed with close connections to other livelihood opportunities. It seems that this is rarely based on a reversion to pre-mining economic activities. These proximate activities may be co-located in the same communities or may be accessible by transport infrastructure (which may have been developed as a result of mining activities)

- empowered local governance. Many of the positive case studies show a pattern of some sort of local government or community authority which has the rights and responsibilities, the financial and organisational capability, and the incentives to support successful transition. This factor is also illustrated in its absence: for example, ghost towns often result when a mining company primarily holds power in the community and there is no post-mining authority existing, willing or able to take these responsibilities on when mining activities decline

- entrepreneurs. Perhaps a surprising common factor emerging is the importance of a small number of passionate and principled individuals able to play a catalytic or leadership role in the process and often promote innovative approaches. These people may be inside the mining company (intrapreneurs) or in other stakeholder groups including government, business and the community.

- trigger points. Another unexpected pattern which emerges from the cases is that many involve some sort of event which has resulted in a change in approach which then leads to more positive outcomes. In many cases this is some crisis which has led to lessons being learnt, increased awareness of potential risks in the future or key stakeholders being brought together.

It is also important to note several factors that do not appear as common patterns of success. For instance, the type of mineral commodity does not appear to be important (as long as it provides a big, long-term resource and does not lead to crippling environmental legacies). Nor does the size or ownership of the mining company (with major and junior, and public, private and state-owned companies all appearing in both the negative and positive cases). Most of these success factors also lie outside the immediate control of the mining company and hence place potential limitations on the extent to, and mechanism in, which mine closure planning is able to determine the likelihood of successful outcomes.

The case studies also identified examples of approaches connected to mine transitions which are suited to operating in these complex, multi-stakeholder contexts and engaging wicked problems. These include:

- stakeholder systems mapping, e.g. at Myrnohrad and Chervonohrad, Ukraine (Udovyk & Fouani 2021)

- collaborative multi-stakeholder partnership approaches (Prescott et al. 2020; ICMM & TPI 2021), e.g. the Kelian gold mine, Multi-stakeholder Closure Committee, Indonesia (Finucane et al. 2011), and the Upper Hunter Mining Dialogue in Australia

- design thinking (Erzurumlu & Erzurumlu 2014)

- community visioning processes, e.g. at Leigh Creek coal mine, Australia (Holcombe & Keenan2020; Blackwell et al. 2017), and Oranjemund, Namibia (Ndeleki 2018), and using gamification (Emeric et al. 2023)

- inter-generational approaches to planning (Ki-Moon & Robinson 2024; Krznaric 2020; OHCHR 2023), e.g. at the Giant mine, Canada (Beckett 2021; Jardine et al. 2013) and the concept of '100 Year Plans' for mine sites beyond the limited lifetime of a mining project (Cutifani 2013)

- scenario planning, e.g. at Meadowbank gold mine, Canada (Rixen & Blangy 2016)

- regional and landscape level planning, e.g. the Mine Water Coordinating Body South Africa, the Pilbara Development Commission and Latrobe Valley Authority in Australia, and the Ruhr Regional Plan in Germany (World Resources Institute 2021)

- encouraging community-led investment, enterprise and innovation, e.g. Royal Bafokeng Holdings, South Africa (Were 2024), initiatives in Blaenau Ffestiniog and the coal-mining region of Cynon Valley, Wales (Bevan Foundation 2023), Águas Claras mine in Brazil and Regeneration Enterprises

- outcome evaluations (Wall & Haslam McKenzie 2023)

- recognition of the skills and competencies needed to work in these complex social contexts (Ferguson 2024; ICMM 2022).

Mining companies have the potential to play a positive role in all of the approaches above (even though they may not have been involved in the specific examples cited). Some of the approaches may be well-aligned with good practices in mine closure planning, although many may require company action outside of the closure planning process and involve companies taking an enabling or catalytic role rather than leading or being solely responsible.

5 Conclusion

Conventional mine closure planning processes are generally well-suited to the biophysical aspects of mining company-led closure processes. These processes ensure mines increasingly are closed in ways which achieve safe, stable, non-polluting, sustainable greener holes in the ground.

Narratives of how mining leaves communities are often overshadowed by a relatively small number of either distinctively positive or negative outcomes. However, many of the factors for these outcomes often lie outside the domain within which mine closure planning processes can influence or, more broadly, which mining companies can influence or be solely responsible for. While well-known and commonly understood, the potential (and more likely) pathway to 'former mining communities' is rarely considered in mine closure planning scenarios, and the potential mechanisms for to managing this journey so it has less negative outcomes are not yet embedded in practice. Mine closure approaches are increasingly being enhanced to better respond to more complex environments, although these still remain as rare, isolated pockets. This evolution can also be seen in progressions in the use of language, such as the clearer distinction between mine closure and asset transition, the increasing focus of repurposing mine infrastructure, and seeing mining as a temporary land use (Keenan & Holcombe 2021). Notably, some companies are moving away from framing which implies they are able to leave communities better off after mining, and more reasonably refer to their contribution to supporting community resilience (ICMM n.d.; Syahrir 2021).

While many adaptations and improvements to mine closure are better able to cope with complex systems, there is an inherent limitation in how much they can be expected to achieve. These case studies have clearly illustrated that there is still a long way to go in how the wicked problem of post-mining communities can be approached, and fundamentally this will mean recognising and understanding the complexity of the context in which it occurs. There is therefore a huge potential opportunity for the mining sector to adopt existing practices which are used elsewhere to deal with this wicked problem.

Acknowledgement

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