

LOOKING BACK TO THE FUTURE: MINING FOR DEVELOPMENT IN AFRICA

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ABSTRACT

Mining is central to development progress in a number of African countries. Natural resource endowment has, however, produced suboptimal development outcomes in weakly institutionalised contexts. This paper locates the extractive industries within the context of the Africa Mining Vision and the Fourth Industrial Revolution. It examines the relevance of a number of policy recommendations that have emerged over the last decade to improve extractive industry governance and connect mining to development more broadly. New technologies, specifically energy and transport revolutions, will fuel demand for new types of minerals and metals. The paper concludes that linking countries' resource endowments to the development of new technologies that could mine those minerals and metals more effectively may yield positive spillover effects. Many of the policy recommendations that have emerged over the last decade remain relevant to optimising future resource potential for development on the continent. Stable and predictable rules of the game, for instance, are irreplaceable governance elements that will ensure that the extractive industries become flywheels for industrialisation instead of enclaves disconnected from other economic sectors.

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ABBREVIATIONS AND ACRONYMS

AMDC	African Minerals Development Centre
AMV	Africa Mining Vision
ANC	African National Congress
ASM	artisanal and small-scale mining
BEE	black economic empowerment
BSGR	Benny Steinmetz Group Resources
DMR	Department of Mineral Resources
FIFA	first-in first-assessed
GDP	gross domestic product
ICSID	International Centre for the Settlement of Investment Disputes

INTRODUCTION

Mining is central to development progress in a number of African countries. The global Fourth Industrial Revolution¹ is underway, and a recent World Bank study² concludes that the world will require approximately double the current volume of mined minerals and metals. Revolutions in transport and energy systems will be resource-intensive, although fossil fuel demand is likely to plummet. Chrome and manganese, for instance, are critical ingredients for wind turbines (a replacement for conventional fossil fuel-based power). Copper is an irreplaceable electricity conductor for solar power, and lithium and cobalt will be fundamental to the advance of battery technology for the electric vehicle. Smartphones will continue to require a range of minerals and metals.

The Africa Mining Vision (AMV),³ housed under the African Minerals Development Centre (AMDC), views mining as a potential flywheel for industrialisation in mineral-endowed African countries. Mining can serve as a focal point for creating vertical and horizontal linkages. Combined with the availability of new technology, many countries could use mining to leapfrog the traditional development trajectory. Technology-laden industrialisation could also attenuate the effects of premature deindustrialisation,⁴ a development trajectory that sees countries moving into low-value services before having industrialised. This trajectory would be particularly devastating for African countries that face the demographic challenge of a large unskilled labour force.

If the extractive industries are to contribute to realising the AMV, better governance is crucial, and national-level policymaking and implementation need to reflect the principles of the AMV in a more cohesive way. In this respect, it is worth reflecting on some of the governance challenges that have confronted mining jurisdictions in South Africa and beyond over the last decade.

On 16 August 2012, for instance, South Africa suffered the single most lethal use of force by security forces against civilians since 1960. The police killed 34 striking mineworkers and left 78 seriously injured at Marikana. For the families of those killed or maimed, justice has still not been served, while the factors that contributed to the stalemate have yet to be resolved.

In June 2013 the Labour Relations Amendment Bill arrived back in Parliament after having first been drafted in 2010. The amendments required pre-strike balloting to avoid union members' being coerced or intimidated into going on strike. A majority of the Labour Portfolio Committee voted against the balloting amendment. A refined amendment bill excluded balloting and was passed in the National Assembly on 21 August 2013. Union

1 Schwab K, *The Fourth Industrial Revolution*. Geneva: WEF (World Economic Forum), 2016.

2 World Bank Group, 'The Growing Role of Minerals and Metals for a Low Carbon Future'. Washington DC: World Bank, 2017.

3 AU, 'Africa Mining Vision'. Addis Ababa: AU, 2009.

4 Rodrik D, 'Premature deindustrialization', *Journal of Economic Growth*, 21, 1, 2016, pp. 1–33.

bosses could continue to dictate strike action on behalf of workers.⁵ This effectively produced a prisoners' dilemma, where major unions and mining houses pursue dominant strategies that have mutually destructive outcomes.⁶

Disproportionate power still accrues to the majority union on any given platinum mine. Crowding out smaller players through centralisation may reduce transaction costs for the majority unions and mining firms, but it creates a stranglehold on the bargaining process. Both players pursue their dominant strategy – firms offer only the wage increases that shareholders are willing to afford, and union bosses threaten to strike unless better offers are forthcoming. The outcome is almost always mutually destructive, and in one instance resulted in a five-month-long strike on the platinum belt, from January to May 2014.

Game theoretic analyses strongly recommended decentralisation to avoid another Marikana-type incident.⁷

Further analyses showed that, even two decades into a democratic dispensation, the communal land tenure system in labour-sending areas interacted with the migrant labour system in pernicious ways that reflected colonial and apartheid-induced inequality.⁸ Forging a new social compact in mining therefore remains imperative.

Beyond the difficulties of labour tensions and poor policy on that front, amendments to the [Mineral and Petroleum Resources Development Act \(Act 28 of 2002\)](#) have also been navigating their way through conflicted interests. Amendments to the act were decided in 2008 but only signed into law in June 2013. By then, a further set of amendments had already been submitted to the National Assembly. In early 2015 the last set of amendments were sent back to Parliament by the presidency in anticipation that they would fail to pass constitutional muster or withstand scrutiny from the international trade regulations to

5 Harvey R, 'Marikana as a Tipping Point? The Political Economy of Labour Tensions in South Africa's Mining Industry and How Best to Resolve Them', SAIIA (South African Institute of International Affairs) Occasional Paper, 164, November 2013, <http://www.saiia.org.za/occasional-papers/435-marikana-as-a-tipping-point-the-political-economy-of-labour-tensions-in-south-africa-s-mining-industry-and-how-best-to-resolve-them/file>, accessed 18 May 2018.

6 Harvey R, 'Releasing the Prisoners from Their Dilemma: How to Resolve Labour Tensions in South Africa's Mining Sector', SAIIA Policy Briefing, 81, December 2013, <http://www.saiia.org.za/policy-briefings/releasing-the-prisoners-from-their-dilemma-how-to-resolve-labour-tensions-in-south-africa-s-mining-sector>, accessed 20 February 2018.

7 Harvey RG, 'Why is labour strife so persistent in South Africa's mining industry?', *The Extractive Industries and Society*, 3, 3, 2016.

8 Harvey R, 'Minefields of Marikana: Prospects for Forging a New Social Compact', SAIIA Occasional Paper, 183, April 2014, <http://www.saiia.org.za/occasional-papers/minefields-of-marikana-prospects-for-forging-a-new-social-compact>, accessed 19 June 2018; Claassens A & B Boyle, 'A Promise Betrayed: Policies and Practice Renew the Rural Dispossession of Land, Rights and Prospects', SAIIA Policy Briefing, 124, January 2015, <https://www.saiia.org.za/policy-briefings/679-a-promise-betrayed-policies-and-practice-renew-the-rural-dispossession-of-land-rights-and-prospects/file>, accessed 19 June 2018.

which South Africa is a signatory. Two major sticking points were the questions of how prospecting and mining licences should be processed and allocated, and how raw minerals or metals should be beneficiated.

Across the continent more generally, questions over optimal taxation rates remain unanswered, along with how to extract optimal rent flows upfront without jeopardising investment or future returns, and how to use mining as a catalyst for green industrial development.

This paper examines the broader governance debates that have characterised the extractive industries in South Africa and beyond since Marikana. Under the banner of the ‘resource curse’, it brings to the fore a number of salient policy recommendations that have been offered over the last five years. It examines the relevance of these and what still needs to be done in the light of future challenges. We live in an era of quantum change, with the Fourth Industrial Revolution⁹ progressing apace alongside problems of premature de-industrialisation¹⁰ and rapidly rising youth unemployment. Questions of whether new technologies can help African countries to truncate the traditional development trajectory¹¹ – which has entailed industrialisation at the cost of environmental destruction – remain unanswered. What does remain clear, however, is that there is no substitute for good governance and the building of institutions that generate smart policy choices.

THE ‘RESOURCE CURSE’

Richard Auty first coined the term ‘resource curse’ in 1993.¹² The idea was formalised in an econometric model developed by Andrew Warner and Jeffrey Sachs in 1995,¹³ updated in 1997.¹⁴ Since then, a vast literature¹⁵ has tried to explain this paradox of underdevelopment in the midst of large resource endowments.

There is now near-consensus that institutional quality is the primary intervening variable.¹⁶ In other words, if a country is strongly institutionalised, resource wealth could be a development catalyst. If it is weakly institutionalised, resource rents further sever

9 Schwab K, *op. cit.*

10 Rodrik D, 2016, *op. cit.*

11 The Economist, ‘Special Report: What technology can do for Africa’, 9 November 2017, <https://www.economist.com/news/special-report/21731038-technology-africa-making-huge-advances-says-jonathan-rosenthal-its-full>, accessed 14 February 2018.

12 Auty RM, ‘Industrial policy reform in six large newly industrializing countries: The resource curse thesis’, *World Development*, 22, 1, 1994, pp. 11–26.

13 Sachs JD & AM Warner, *Natural Resource Abundance and Economic Growth*, vol. 3. Cambridge MA: NBER (National Bureau of Economic Research), 1995.

14 Sachs JD & AM Warner, *Economic Convergence and Economic Policies*. Cambridge MA: NBER, 1995.

15 Van Der Ploeg F & S Poelhekke, ‘The impact of natural resources: Survey of recent quantitative evidence’, *The Journal of Development Studies*, 53, 2, 2017, pp. 205–16.

16 Mehlum H, Moene K & R Torvik, ‘Institutions and the resource curse’, *The Economic Journal*, 116, 508, January 2006, pp. 1–20.

the citizen–state accountability link. There is, of course, extensive disagreement over how to define and measure institutions.¹⁷ The best work suggests that institutions are the social systems (norms and beliefs) that shape and incentivise regular human behaviour. Indicators such as ‘the rule of law’ are outcomes of institutions. Either way, variables such as ‘the rule of law’ or ‘freedom of the press’ can proxy – with varying degrees of reliability – for institutional quality. In Norway, for instance, the rule of law is upheld as a universal value, and oil wealth is managed for the benefit of the nation.¹⁸ In Angola, by contrast, oil wealth is managed for the benefit of a few elite families and their patronage networks.¹⁹

Considerable evidence exists to show that higher levels of petroleum income lead to more durable authoritarian rulers and regimes and the increased likelihood of certain types of government corruption; and that moderately high levels of petroleum and other mineral wealth tend to sustain conflict in low- and middle-income countries.²⁰

The final puzzle is what should be done. Many scholars have developed ideas about policy interventions, including greater transparency, stabilization and savings funds, community participation, cash payments to citizens, and alternative tax and royalty systems. We have little systematic knowledge, however, about which policies work and under what conditions.

WHAT IS TO BE DONE?

New Institutional Economics literature has established that there are few blueprints (divorced from specific contexts) for sensible development policymaking in weakly institutionalised contexts.²¹ Endogenous motivation to adhere to the formal ‘rules of the game’ is often absent, and informal institutions therefore determine policy choices.²² Even randomised control trials that show how well (or not) an intervention works in one place do not necessarily help in others. For instance, an education intervention that works well in India cannot simply be transposed into Liberia. The pre-existing conditions are

17 Voigt S, ‘How (not) to measure institutions’, *Journal of Institutional Economics*, 9, 1, 13 July 2012, pp. 1–26; Voigt S, ‘How to measure informal institutions’, *Journal of Institutional Economics*, 14, 1, 2018, pp. 1–22.

18 Wenar L, *Blood Oil: Tyrants, Violence, and the Rules That Run the World*. Oxford: Oxford University Press, 2015.

19 Soares de Oliveira R, *Magnificent and Beggar Land: Angola Since the Civil War*. Oxford: Oxford University Press, 2015.

20 Ross ML, ‘What have we learned about the resource curse?’, *Annual Review of Political Science*, 18, 2015, pp. 239–59.

21 Acemoglu D & JA Robinson, ‘Economics versus politics: Pitfalls of policy advice’, *Journal of Economic Perspectives*, 27, 2, February 2013, pp. 173–92; North DC, Wallis JJ & BR Weingast, *Violence and Social Orders: A Conceptual Framework for Interpreting Recorded Human History*. Cambridge: Cambridge University Press, 2009.

22 Greif A & C Kingston, ‘Institutions: Rules or equilibria?’, in Schofield N & G Caballero (eds), *Political Economy of Institutions, Democracy and Voting*. Berlin & Heidelberg: Springer Berlin Heidelberg, 2011, pp. 13–43.

too different²³ and too many development projects are incentive-incompatible with the existing distribution of power.²⁴

This is not to say that no universal principles can be applied to resource governance, but that their manifestation and practice look different in each case. A few examples from different African countries illustrate the point.

South Africa

The ANC government has expressed a policy desire to extract a higher rent share from the country's mineral endowment prior to production.²⁵ Instead of assessing licence applications on a first-in first-assessed (FIFA) basis, it wanted to move towards an auction-bid system that more closely resembled the allocation of oil blocks with associated signature bonuses. The end result was a lack of clarity as to how licence applications would be processed at all. This is arguably the single most important institution (set of rules) in any mining jurisdiction. How licence applications are processed signals to investors how the rules are likely to be interpreted and applied. If an auction system is to be followed, the conditions under which they are granted should be explicitly stipulated in law.²⁶ The lack of extensive geological information militates against an auction-based approach, as do the high transaction costs of administering it. The Department of Mineral Resources (DMR) faces capacity constraints as it is, and it is unclear whether it could navigate the risks of an auction system. The potential upfront rent windfall should therefore be weighed against the potentially unseen costs of a new system, including judicial appeals and reviews. Most importantly, whatever system the government chooses should be articulated clearly in the amendments, with minimal ministerial discretion.²⁷ Essentially, until more geological data is readily available, the FIFA system should remain.

Regarding beneficiation,²⁸ the South African debate has been unnecessarily polarised. The [National Development Plan](#), for instance, suggests that downstream mineral beneficiation can raise the unit value of South African exports. However, it also emphasises the

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- 23 Rodrik D, 'Getting interventions right: How South Korea and Taiwan grew rich', *Economic Policy*, 10, 20, 1995, pp. 53–107.
- 24 Douglass CN *et al.* (eds), *In the Shadow of Violence: Politics, Economics, and the Problems of Development*, 1st edition. Cambridge: Cambridge University Press, 2012; Levy B, *Working with the Grain: Integrating Governance and Growth in Development Strategies*. Oxford: Oxford University Press, 2014.
- 25 ANC, 'Maximising the Developmental Impact of the People's Mineral Assets: State Intervention in the Minerals Sector (SIMS)', Policy Discussion Document, March 2012.
- 26 Bello O, Benkenstein A & R Harvey, 'Assessing Competitive Resource Tenders as an Option for Mining Rights Allocation in South Africa', Occasional Paper 159. Johannesburg: SAIIA, 2013.
- 27 *Ibid.*
- 28 Beneficiation is a term used to describe adding downstream value to a raw product. The economic rationale is to produce higher value goods in-country to avoid commodity price volatility and the perennial export of high-bulk, low-value commodities.

importance of identifying sophisticated resource-based products that South Africa can manufacture, and warns against seeing beneficiation as a development panacea, as it is ‘usually highly energy and capital intensive, contributing little to overall job creation’.²⁹ This is not to say that no downstream opportunities should be pursued, and some ideas are worth exploring.³⁰ In many instances, however, it is unlikely to be an efficient or sustainable allocation of resources. Jewellery manufacturing, for instance, is not likely to be a significant employer, and South Africa would find it remarkably challenging to compete with centres such as Tel Aviv, Antwerp, Bangkok and Delhi. However, that does not preclude the policy option of building mineral or metal-centred horizontal and vertical linkages. This should be rigorously pursued and planned. Research conducted in 2015 concludes that ‘a focus on building upstream linkages was likely to yield greater benefit’³¹ for development than a narrow focus on downstream opportunities.

A recent editorial updated this view in the context of a changing world and argued that ‘fine-tuning of the country’s tariff regime to support a new “mining for industrialisation” policy is also necessary and will have to steer clear of the political temptations to support embedded players that are politically powerful but economically uncompetitive’.³² If, for instance, the DMR is of the view that certain minerals or metals should be declared ‘strategic’, then the criteria for defining them in this way should be made clear in legislation. The Integrated Resource Plan – a living document designed to inform government decisions for new energy generation capacity – should inform the decision too, but the updates³³ to this 2010 document have yet to be ratified, probably because a decision has not been taken yet on the role that nuclear power will play in South Africa’s energy future. Uranium and coal pose ‘stranded asset’ risks,³⁴ and any institutional investment in developing these deposits should be closely scrutinised.

29 National Planning Commission, ‘National Development Plan: Vision for 2030’. Pretoria: National Planning Commission, 2012, p. 125.

30 See, for instance, Jourdan P, ‘The optimisation of the developmental impact of South Africa’s mineral assets for building a democratic developmental state’, *Mineral Economics*, 26, 2013, pp. 107–126.

31 Harvey R, ‘Mineral Rights, Rents and Resources in South Africa’s Development Narrative’, Occasional Paper, 224. Johannesburg: SAIIA, 2015a.

32 Harvey R, ‘The outlook for SA’s mining industry, if Ramaphosa is quick, is bountiful’, *Business Day*, 7 February 2018, <https://www.businesslive.co.za/bd/opinion/2018-02-07-the-outlook-for-sas-mining-industry-if-ramaphosa-is-quick-is-bountiful/>, accessed 26 June 2018.

33 The November 2016 update has been released as a ‘draft for consultation’. See Department of Energy, ‘Integrated Resource Plan Update: Assumptions, Base Case Results and Observations’, <http://www.energy.gov.za/IRP/2016/Draft-IRP-2016-Assumptions-Base-Case-and-Observations-Revision1.pdf>, accessed 18 May 2018. The draft was approved by cabinet in late 2017, and the latest news on the process is that new Energy Minister Jeff Radebe has promised that the Department of Energy will finalise its review for submission to cabinet by August 2018. See Ensor L, ‘Radebe pledges to consult widely on future of energy mix’, *Business Day*, 9 May 2018, <https://www.pressreader.com/south-africa/business-day/20180509/281621010969749>, accessed 18 May 2018.

34 Altenburg T & D Rodrik, ‘Green industrial policy: Accelerating structural change towards wealthy green economies’, in Altenburg T & C Assmann (eds), *Green Industrial Policy*:

Beyond the institutional questions of licence allocation and beneficiation, South Africa's mining industry remains plagued by negative social and environmental externalities. In terms of forging a new social compact, four specific interventions are relevant.

First, the 'government should resolve to diminish the political and economic power of traditional authorities by formulating land tenure legislation that is more reflective of Section 25 of the Constitution's protection of property rights'.³⁵ This is because insecure tenure (land allocation power rests in the hands of tribal chiefs) in the former South African homelands continues to drive young men to the mines. On the platinum belt itself, many mines are located on tribal land too, creating difficulties over how to distribute benefit to communities. Further work on this particular issue recommended that national and provincial policy should³⁶

remove superimposed tribal boundaries based on the architecture of apartheid; intervene in litigation by traditional leaders to uphold the right to tenure security set out in Section 25(6) of the Constitution; and prevent threats to the basic land rights of poor people.

The third iteration of South Africa's Mining Charter – the guiding policy for how racial transformation should be achieved in the industry – did not reflect progress on the above recommendations (although it has been redrafted and will be gazetted in 2018). Continuing to bestow a large degree of power on an undemocratic office – the chieftaincy – does not bode well for ensuring that community trusts will deliver benefits to the communities of which they purport to be custodians.³⁷

Second, reinforcing some of the above points, 'traditional authorities should be prohibited from setting themselves up as corporations',³⁸ as such mechanisms are overly subject to the benevolence (or malevolence) of the relevant traditional leader. The Royal Bafokeng success, for instance, was attributable to selfless leadership, which has proved rare. Institutional strength depends on transitioning away from personalised forms of exchange to depersonalised exchange, where structures can exist for societal benefit beyond the life of any given leader.

Third, 'government and business should agree on legislation that prevents politically connected elites from engaging in BEE [black economic empowerment] transactions'.³⁹ BEE was designed to help previously disadvantaged South Africans gain access to economic opportunities. Political elites increasingly do not fit that category, and the nexus of politics and business through BEE is likely to create a situation of the 'fox guarding the

Concept, Policies, Country Experiences, 1st edition. Geneva: German Development Institute & Partnership for Action on Green Economy, 2017.

35 Harvey R, 2014a, *op. cit.*, pp. 24–25.

36 Claassens A & B Boyle, *op. cit.*

37 Harvey R, 'Charting a Way for South African Mining to Benefit Communities', Policy Insights, 50. Johannesburg: SAIIA, July 2017.

38 Harvey R, 2014a, *op. cit.*, p. 25.

39 *Ibid.*, p. 26.

henhouse’ – those who are tasked with good governance may have strong incentives to overlook transgressions that would result in profits for themselves.

Finally, it remains imperative for the mining industry to introduce a more humane migration cycle with better pay for workers. The idea is to restore family dignity so that young productive men are not incentivised to leave the labour-sending areas of the Eastern Cape, for instance, in search of work on hinterland mines. A continued pattern of migrant labour perpetuates the disintegration of the social fabric that was so prevalent during colonialism and apartheid. The social costs of not intervening in this pattern are high. As one mining labour expert put it, intervention of the type described above ‘would significantly reduce the propensity for HIV infections, enhance attendance and reduce absenteeism’.⁴⁰ For a range of reasons, a more humane migrant labour system would generate productivity gains and reduce social costs to the benefit of all stakeholders.

Moreover, the negative impacts of mining can be redeemed through better planning and partnership building. It seems trite to have to emphasise the importance of long-term relationships, but the lack thereof in the mining space continues to hinder efforts to mainstream social performance. A 2015 paper⁴¹ reinforced the work referenced above by recommending the pursuit of partnerships between all stakeholders for integrated development planning that would create shared infrastructure and improve community wellbeing in mine-affected areas. This kind of planning also needs to demonstrate support for policy frameworks such as the *AU’s Agenda 2063*.

Beyond social impacts, environmental concerns must also be given proper consideration in the mining governance equation. Minerals and metals geology is accidental. Titanium ore, for instance, is found in sensitive coastal zones, where mining activity is potentially harmful to the environment and future revenue streams generated by ecological integrity (ecotourism, for instance). An important 2015 paper⁴² documents the importance of effective coastal zone management, where, for instance,⁴³

the demands of a growing population place increasing stress on finite coastal systems and resources, and there is great pressure to convert natural coastal assets to man-made structures such as refineries, power stations, mining operations, ports, marinas, tourist facilities and residential developments.

In South Africa’s Eastern Cape province alone, unregulated small-scale sand mining is widespread and damages estuary performance. Estuary health is crucial to sustaining life on earth and cannot be compromised. But in addition to the destruction wrought by

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- 40 Hartford G, ‘Alienation, paucity and despair make for toxic catalysts’, *Mail & Guardian*, 11 October 2012, <http://mg.co.za/article/2012-10-11-alienation-paucity-and-despair-make-for-toxic-catalysts>, accessed 26 June 2018.
- 41 Limpitlaw D, ‘Maximising Positive Impacts of Mining Projects: Stakeholders and Partnerships’, Policy Briefing, 122. Johannesburg: SAIIA, January 2015.
- 42 Chevallier R, ‘Promoting the Integrated Governance of South Africa’s Coastal Zones’, Occasional Paper, 218. Johannesburg: SAIIA, June 2015.
- 43 *Ibid.*, p. 6.

small-scale mining, commercial prospecting for ‘minerals in sand, such as rutile, zircon and titanium’ also takes place along the coastline, ‘which will have a devastating effect on estuaries and catchments’.⁴⁴

In the light of some of these challenges, the paper called for the improved implementation and enforcement of special management criteria such as ‘delineating exclusion zones for mining in estuaries, forbidding the removal of riparian vegetation within 30 metres of a riverbank, and the obligatory implementation of a river corridor on either side of a river should be better implemented and enforced’.⁴⁵ These recommendations remain highly relevant and should be urgently implemented.

Environmental externalities invariably create social externalities too. Over the last decade, community members on the Pondoland Wild Coast (also in Eastern Cape province) have resisted attempts from Australian-owned mining company MRC and its local subsidiary, TEM, to access its titanium-rich Xolobeni coastal dunes.⁴⁶

It’s been a battle between a rural community expressing its right to determine its future, hoping to promote the area’s ecotourism potential, and an outsider, together with its local empowerment networks, hoping to mine the area and move the community.

Addressing the nexus of social disruption and environmental destruction requires sophisticated tools to ensure that planning in sensitive areas is inclusive and sustainable. Cases such as Xolobeni further highlight the need for natural ecosystems to be valued more appropriately: the ‘value of nature’s services and its non-market benefits need to be better understood and incorporated into the development choices that countries make’.⁴⁷ Doing so would also improve community welfare, as economic activity ultimately depends on ecological integrity. If water resources are compromised by mining, for instance, it affects all latent economic activity.

Guinea

Further afield, a 2013 article⁴⁸ about Simandou, Guinea led researchers to explore what could be done to ensure that this ‘tier-one’ iron ore deposit was utilised for optimal

44 *Ibid.*, p. 20.

45 *Ibid.*, p. 23.

46 Nicolson G, ‘Goodbye Bazooka: Wild Coast anti-mining activist killed’, *Daily Maverick*, 24 March 2016, <https://www.dailymaverick.co.za/article/2016-03-24-goodbye-bazooka-wild-coast-anti-mining-activist-killed/#.WoQOHWZ7HUI>, accessed 14 February 2018.

47 Chevallier R, ‘Reconciling growth and development with ecological integrity along Africa’s coastline’, SAIIA, 26 August 2013, <http://www.saiia.org.za/opinion-analysis/reconciling-growth-and-development-with-ecological-integrity-along-africas-coastline>, accessed 14 February 2018.

48 Keefe R, ‘Buried secrets: How an Israeli billionaire wrested control of one of Africa’s biggest prizes’, *The New Yorker*, 8 July 2013, <https://www.newyorker.com/magazine/2013/07/08/buried-secrets>, accessed 26 June 2018.

development benefit in the region. One major recommendation⁴⁹ was that the key mining players in the region (Guinea and Liberia) should convene a summit with all relevant stakeholders to craft a regionally focused strategy. Integral to this strategy would be a bold move away from plans to construct a railway line from Simandou to Conakry and instead refurbish the old Lamco Liberia line to run from Simandou to Buchanan (Liberian port city). This would allow for the industrial possibility of adding processing value to the region's ore. The recommendations remain relevant, although the global market for iron ore is currently stagnant with sufficient supply from places such as western Australia.

Moreover, governance concerns around the project persist. Numerous commentators suggested that Rio Tinto should publicly disclose why it paid a 'settlement agreement' of \$700 million to the Guinean government in 2011 to have its 2008 rights restored. In 2017 there were reports that the Rio Tinto board had fired two executives upon discovery of a 'payment to a go-between in Guinea from 2011 that it says failed to meet its code-of-conduct standards'.⁵⁰ The rights to two of the four Simandou blocks had been granted to Israeli tycoon Beny Steinmetz of Beny Steinmetz Group Resources (BSGR) before they were handed to Rio 2014 after a change in government. BSGR and Rio remain embroiled in a legal battle, with the latest news suggesting that the dispute before the International Centre for the Settlement of Investment Disputes (ICSID) is no closer to being resolved. Rio Tinto agreed in 2017 to sell its remaining stake to Chinalco, which could buy out Rio's blocks if the ICSID were to rule against BSGR. Either way, the 'project seems further away from reality than ever',⁵¹ which is suboptimal for Guinea's development prospects.

Botswana

Botswana has enjoyed relatively unusual democratic and development success in the region. A major concern, however, is that once diamond rents start to diminish, other economic opportunities – options for diversification – will be in short supply.⁵² Diamonds are the mainstay of the economy, and although they only contribute a relatively small proportion of direct gross domestic product (GDP), they provide over one-third of government revenues and a majority of export revenues. Moreover, a number of other

49 Harvey R, 'Mining for Development in Guinea: An Examination of the Simandou Iron Ore Project', Policy Briefing, 83. Johannesburg: SAIIA, February 2014b.

50 *The Economist*, 'Africa's largest iron-ore deposit has tainted all who have touched it: A pig of a project', 12 January 2017, <https://www.economist.com/news/business/21714388-billionaires-and-big-companies-have-come-cropper-one-worlds-poorest>, accessed 14 February 2018.

51 Yeomans J, 'Inside Simandou: The mining project that has cursed all who come near it', *The Telegraph*, 5 June 2017, <http://www.telegraph.co.uk/business/2017/06/05/inside-simandou-mining-project-has-cursed-come-near/>, accessed 14 February 2018.

52 Harvey R, 'Fossil Fuels Are Dead, Long Live Fossil Fuels: Botswana's Options for Economic Diversification', SAIIA Research Report, 20, August 2015b, <http://www.saiia.org.za/research-reports/872-fossil-fuels-are-dead-long-live-fossil-fuels-botswana-s-options-for-economic-diversification/file>, accessed 14 February 2018.

support sectors would likely collapse in the absence of diamond mining. Four policy recommendations are worth noting.

First, eco-tourism has to be prioritised to become the country's primary revenue generator. Unlike mining, it is a sustainable industry (provided it does not undermine the ecological integrity on which it depends). Properly managed, it will have a non-exhaustive supply of pristine wilderness that will become increasingly valuable as human populations expand across the globe and tourists place a premium on the last true wilderness areas. In this respect, models for ensuring optimal community benefit from wildlife tourism must be further researched and piloted.⁵³ This is crucial for ensuring that tourism rents do not accrue only to the domestic elite and to foreign businesses.

Second, mining should be viewed as a means to forging a higher-value industry that would endure beyond the available finite supply of minerals. Downstream opportunities do exist along mineral and metal value chains, and these should be exploited where it makes sense. Downstream diamond beneficiation in the form of cutting and polishing, for instance, has been attempted. The jury is still out as to whether this industry will prove sustainable. Its current comparative advantage is that the diamonds are mined in Botswana and that the government has negotiated a deal that insists on diamond purchases in Botswana. Yet even with transport cost and political advantages, the industry is struggling to compete. Infrastructure and skills availability are concerns in any kind of value addition industry in metals or minerals, highlighting the need for the government to prioritise investment in smart infrastructure and human capital.

Third, any new mining ventures – in coal, diamonds, iron ore or copper nickel – should pursue genuine partnership with local communities. The Debswana model of partnering with the government at a national level provides a solid blueprint for how extractive industry companies could operate in Africa, provided transparency and accountability are also core objectives. Furthermore,⁵⁴

Skills transfer and local procurement should feature prominently in the agreements on which mining licences are negotiated ... Appropriate timelines should therefore be negotiated. In the case of mining near environmentally sensitive areas, mining companies should contribute to the preservation of those areas.

Finally, Botswana needs to invest its remaining diamond rents as efficiently and effectively as possible now. Broad-based investments in human and physical capital⁵⁵ must be made,

53 Chevallier R & R Harvey, 'Is Community-based Natural Resource Management in Botswana Viable?', SAIIA Policy Insights, 31, April 2016, <http://www.saiia.org.za/policy-insights/is-community-based-natural-resource-management-in-botswana-viable>, accessed 14 February 2018.

54 Harvey R, 2015b, *op. cit.*, p. 60.

55 Water shortages remain a serious problem in Botswana. On this subject, see Setlhogile T & R Harvey, 'Water Governance in Botswana', SAIIA Policy Briefing, 144, October 2015c, <http://www.saiia.org.za/policy-briefings/water-governance-in-botswana>, accessed 14 February 2018.

as this is where new sources of growth are likely to come from. While downstream value-chain opportunities should be pursued, these should not be viewed as a panacea for development. Ultimately, ‘investments in new technology, especially renewable energy such as solar power, should also be seriously considered given the country’s perennial abundance of sunshine.’⁵⁶

Tanzania

Artisanal and small-scale mining (ASM) is low-tech, labour-intensive mineral extraction and processing. The AMDC estimates that it supplies about 10% of the world’s gold and provides between 13 and 20 million jobs worldwide. In Tanzania alone, at least 1.5 million people are directly employed in artisanal mining, with approximately 9 million dependents. Little development support exists for artisanal miners, hence its prioritisation in the AMV. This is a matter of urgency, as the negative environmental and social externalities associated with this industry undermine welfare not only for its participants but also for a range of other affected people. For instance, livestock and crop agriculture is impaired by mercury contamination of water resources (mercury is used to sift gold from gold-bearing rock that has been crushed).

Field research from Geita (a prominent artisanal gold-mining area in the Mwanza region)⁵⁷ in April 2016 led to recommendations⁵⁸ that legislators desiring to formalise the industry should do so in a way that recognises the real impediments to formalisation. For instance, insisting on compliance with bureaucratic procedures creates a barrier to entry that is incentive-incompatible with the benefits of informality (flexibility of movement and freedom from taxation). ‘Transformation towards enhancing human welfare and reducing negative environmental externalities will require reconceptualising the sector’⁵⁹ and a different view of the people involved. ASM is a fundamentally different undertaking to formal large-scale mining and should not be viewed simply as a lower form of the latter. Formalisation should be designed to retain the benefits of ASM (large-scale employment and flexibility). Given this, the recommendation was that the [2010 Mining Act](#) be updated or amended to lower the practical barriers to entry for informal miners to become licenced. Most importantly, and practically, we supported calls for technologies such as retorts to be provided and properly rolled out. These would, through preventing mercury contamination, simultaneously improve the health of miners and prevent the degradation of the natural environment.

56 Harvey R, 2015b, *op. cit.*, p. 61.

57 See Chevallier R & R Harvey, ‘Tanzania: Notes from the field’, SAIIA, 7 July 2016, <http://www.saiia.org.za/news/tanzania-notes-from-the-field>, accessed 20 February 2018.

58 Harvey R, ‘Climbing the Inclusion Ladder: Artisanal Gold Mining in Tanzania’, Occasional Paper, 259. Johannesburg: SAIIA, June 2017.

59 *Ibid.*, p. 40.

THE FUTURE

This section⁶⁰ highlights what that future might look like and locates it in the context of the challenges that confront the continent, such as premature deindustrialisation⁶¹ and expanding youth unemployment.

Ensuring better governance of the extractive industries across Africa remains a fundamental priority. Its importance cannot be emphasised enough in a rapidly changing world. If institutions are not strengthened to draw durable, broad-based benefits from mining, it will continue to operate in an enclave manner, depriving countries of the extensive spillover benefits it could bring. Stronger institutions should also inform smarter policy choices. For instance, it is becoming increasingly difficult to justify the extraction of coal.

Coal-fired power is now more expensive than a number of forms of renewable energy,⁶² and the extractive process is irreparably harmful to the environment, especially because of its negative impact on fresh water resources in many places. In a world that is becoming more water scarce as a result of changes to the climate, fresh water has to be valued more highly, and food security prized above coal revenues. Besides, coal revenues will plummet as divestment from fossil fuels starts to speed up. African countries have an opportunity to leapfrog ahead and leave their coal deposits in the ground in favour of extracting the minerals and metals of the future.

Klaus Schwab, the founder of the World Economic Forum, argues that the single most important challenge facing humanity today is how to understand and shape the new technology revolution. The ‘Fourth Industrial Revolution’⁶³ captures the idea of the confluence of new technologies and their cumulative impact on our world.

- Artificial intelligence can now produce a medical diagnosis from an X-ray faster than a radiologist and with pinpoint accuracy. Robots can manufacture cars faster and with more precision than assembly line workers. They can also potentially mine base metals such as platinum and copper – crucial ingredients for renewable energy and electric vehicle technologies such as solar photovoltaic panels and fuel cells respectively. Three-dimensional printing will change manufacturing business models in almost inconceivable ways, allowing the printing of parts in remote areas for mining vehicles, reducing delays and ramping up efficiency. Autonomous vehicles will change traffic flows by avoiding bottlenecks and accidents will be reduced. Remote sensing and satellite imagery will help to locate blocked storm water drains and avoid city flooding. Vertical farms could solve food security challenges.

60 Drawn from Harvey R, ‘The “Fourth Industrial Revolution”: Potential and risks for Africa’, *The Conversation*, 30 March 2018, <https://theconversation.com/the-fourth-industrial-revolution-potential-and-risks-for-africa-75313>, accessed 20 February 2018.

61 Rodrik D, 2016, *op. cit.*

62 Knorr K *et al.*, ‘Wind and Solar PV Resource Aggregation Study for South Africa’. Pretoria: CSIR (Council for Scientific and Industrial Research), SANEDI (South African National Energy Development Institute), Eskom & Fraunhofer IWES, 2016.

63 Schwab K, *op. cit.*

- Machine learning – machines teaching others how to improve their efficiency without human intervention – and the rapid advances in artificial intelligence may render the labour of most of the global workforce redundant.⁶⁴

The First Industrial Revolution spanned 1760–1840, epitomised by the steam engine. The second started in the late 19th century and made mass production possible. The third began in the 1960s with mainframe computing and semi-conductors. The argument for a new category – a Fourth Industrial Revolution – is compelling. New technologies are developing with exponential velocity, breadth and depth. Their systemic impact is likely to be profound. Policymakers, academics and companies must understand why all these advances matter and what to do about them.

The most exciting dimension of this new revolution is its ability to address negative externalities – hidden environmental and social costs. Rapid technological advances in renewable energy, fuel efficiency and energy storage not only make investments in these fields increasingly profitable, boosting GDP growth, but also contribute to mitigating climate change, one of the major global challenges of our time.

Some countries' growth trajectories may follow the hypothesised Environmental Kuznets Curve,⁶⁵ where income growth generates environmental degradation until it reaches a point where citizens start to care about degradation and are wealthy enough to invest in its attenuation.⁶⁶ The relationship occurs partly because natural capital is treated as free, and carbon emission as costless, in our global national accounting system.

New technologies make it possible to truncate this curve and transition to a 'circular economy', which decouples production from natural resource constraints.⁶⁷ Nothing that is made in a circular economy becomes waste. The 'Internet of Things' allows producers to track material and energy flows to achieve new efficiencies along product value chains. Even the way energy itself is generated and distributed will change radically.

Perhaps most importantly for African countries, then, renewable energy offers the possibility of devolved, deep and broad access to electricity. Too many citizens still do not enjoy the benefits of the Second Industrial Revolution. The Fourth Industrial Revolution may finally deliver electricity because it no longer relies on centralised grid infrastructure. A smart grid can distribute power efficiently across a number of homes in remote locations. Children can study at night. Meals can be cooked on safe stoves. Indoor air

64 See Bay S, 'Could artificial intelligence predict the next *Avengers: Infinity War*?', 3 February 2018, *Wired.com*, <https://www.wired.com/story/artificial-intelligence-box-office-predictions/>, accessed 2 May 2018.

65 Dinda S, 'Environmental Kuznets Curve hypothesis: A survey', *Ecological Economics*, 49, 2004, pp. 431–55.

66 Downs A, 'Up and down with ecology: The "issue-attention cycle"', *Public Interest*, 28, 1972, pp. 38–50.

67 See Raworth K, *Doughnut Economics: Seven Ways to Think like a 21st Century Economist*. New York: Random House, 2017.

pollution can be eradicated. Beyond renewable energy, blockchain technology may catalyse the financial inclusion that has long been elusive. It may also help to eradicate exploitative practices and make global supply chains cleaner and more transparent.⁶⁸

However, changes unleashed by new technologies do entail risks, one of which is rising joblessness.⁶⁹ Choosing appropriate policy options to respond to this risk is a global priority.

Developing countries have transitioned from manufacturing into services earlier than their more developed counterparts, and at fractions of the income per capita – a process described as ‘premature deindustrialisation’.⁷⁰

The employment share of manufacturing, along with its value addition to the economy, has long been declining in industrialised nations. Surprisingly, it has also been declining in developing countries. This is unexpected, because manufacturing is still the primary channel through which to modernise, create employment (especially by absorbing low-skilled labour) and alleviate poverty. Yet manufacturing industries that were developed under post-independence protectionism have largely disintegrated in the face of poor governance and negative terms of trade.

The social effects of joblessness are devastating. Demographic modelling indicates that by 2050, the population of sub-Saharan Africa will be 2.17 billion, 52.2% of whom will be under 24.⁷¹ For optimists, this means a ‘dividend’ of young producers and consumers. For pessimists, it means a growing problem of youth unemployment colliding with poor governance and weak institutions.

New technologies threaten to amplify current inequalities, both within and between countries. Mining – typically a large employer – may increasingly shed labour. Its activities, to borrow a medical metaphor, will be characterised by keyhole (underground from inception) rather than open-heart surgery (open-cast). That means driverless trucks and robots, all fully digitised, conducting non-invasive mining.⁷² A large proportion of the nearly half-a-million people employed in South African mining alone, for instance, may lose their jobs. The impact of new technologies will be felt on both the supply and demand sides of the mining equation in positive and negative ways.

68 See, for example, this article on how blockchain technology can help to clean up supply chain transparency with cobalt sourced from the Democratic Republic of Congo: Lewis B, ‘Blockchain to track Congo’s cobalt from mine to mobile’, *Reuters*, 2 February 2018, <https://www.reuters.com/article/us-mining-blockchain-cobalt/blockchain-to-track-congos-cobalt-from-mine-to-mobile-idUSKBN1FM0Y2>, accessed 20 February 2018.

69 For an important contribution to the debate over these risks, see Mahroum S, ‘The AI debate we need’, *Project Syndicate*, 16 February 2018, <https://www.project-syndicate.org/onpoint/the-ai-debate-we-need-by-sami-mahroum-2018-02>, accessed 20 February 2018.

70 Rodrik D, 2016, *op. cit.*

71 UNPD (UN Population Division), ‘World Population Prospects 2017’, <https://esa.un.org/unpd/wpp/DataQuery/>, accessed 3 May 2018.

72 This is the subject of a forthcoming book chapter on the future of mining in South Africa.

On the supply side, it appears that negative externalities could be minimised in at least two ways. First, the environmental footprint of mining will become considerably smaller. Because the technology is available to make mining cleaner, water is less likely to become contaminated, which bodes well for agricultural production, whereas there is typically a trade-off between mining and agriculture at present. Second, the health externalities associated with mining are likely to be eliminated if the work is done by machines. A potential end to mining-related illnesses such as silicosis would greatly reduce the burden on the social healthcare system, in addition to ensuring that young, productive workers do not spend their health and abilities on an unsafe occupation such as rock-drilling (for relatively little pay). However, the corollary – as indicated earlier – is that many workers may lose their jobs, which will generate social costs in the form of greater unemployment, higher inequality and more state dependants. Policymakers need to start thinking now about how to mitigate these risks and equip workers (and future job-seekers) with skills that make them employable and resilient in a fast-changing world.

On the demand side, it is difficult to predict which minerals and metals will be most sought after. However, it is relatively well established that more copper, chrome, manganese, cobalt, lithium, aluminium, platinum and a range of others are going to be necessary to fuel the transport and energy revolutions. Cobalt and lithium are key ingredients for electric vehicle batteries. Platinum fuel cells are irreplaceable for higher-power hydrogen-propelled vehicles. Copper is a key ingredient for solar panels and wind turbines. Chrome and manganese are key elements for wind turbines. The World Bank estimates that, as a result of these factors, the world will require roughly double the volume of minerals and metals than are currently being supplied. Investments in the minerals and metals of the future will yield promising returns.⁷³ In contrast, investments in fossil fuels face a ‘stranded asset’ risk, as coal and oil will play an increasingly smaller role in global electricity and transport markets.⁷⁴

Sub-Saharan African countries are geologically well positioned to take advantage of a new commodity boom, should one arrive. The DRC, for instance, is cobalt-abundant. South Africa and Zimbabwe are platinum-rich, and South Africa is extensively endowed with chrome and manganese. However, unless the associated governance institutions are similarly robust, the gains will accrue to the politically connected few and exacerbate inequality, already a significant risk in the broader context of technological advances.

Rising inequality and income stagnation are equally problematic. Unequal societies tend to be more violent, have higher incarceration rates, and have lower levels of life expectancy than their more equal counterparts. New technologies may further concentrate benefits and value in the hands of the already wealthy. Those who were excluded from the benefits of earlier industrialisation risk being left even further behind.

73 World Bank Group, ‘The Growing Role of Minerals and Metals for a Low Carbon Future’, June 2017, <http://documents.worldbank.org/curated/en/207371500386458722/pdf/117581-WP-P159838-PUBLIC-ClimateSmartMiningJuly.pdf>, accessed 3 May 2018.

74 Altenburg T & D Rodrik, *op. cit.*

CONCLUSION

To respond adeptly and mitigate some of the challenges mentioned above, African countries should avoid the import substitution industrialisation programmes of early independence. The answer to premature deindustrialisation is not to protect infant industries and manufacture expensively at home.⁷⁵ Industrialisation in the 21st century has a fundamentally different set of components. In policy terms, governments need to employ complex-systems thinking. Linking a resource endowment base to the development of new technologies that could mine that base more effectively may yield spillover effects that spawn new industries.⁷⁶

Rapidly improving access to electricity should be a key policy priority. Governments across the continent should view energy security as a function of investment in renewables and the foundation for future growth. More generically, African governments should be proactive in adopting new technologies. To do so they must stand firm against powerful entrenched interests that stand to lose from such changes and may pose barriers to economic development.⁷⁷ It pays – in the long run – to craft inclusive institutions that promote widespread innovation.

This paper has explored some of the policy-orientated recommendations for the mining sector from the last five years. They remain relevant in a rapidly changing world. No matter how much technologies change, governance basics are timeless. A few examples suffice to conclude.

First, democratising labour relations through better legislation (not only in South Africa) will help to smooth the transition from low-skilled labour-intensiveness to fewer direct and more high-skilled labour opportunities. New technologies can help to make the processes of licence applications and awards quicker and more transparent, but this only matters if the legislation governing the process is clear. For every single mining jurisdiction on the continent, having a clear, stable and fair set of de jure and de facto institutions to govern mining is irreplaceable in the development equation.

Second, a continual focus on extracting the minerals and metals of the future will always need to inform policy choices. For instance, it is strategically inept to view coal as a strategic mineral given that it is a finite resource that irreparably harms human health

75 See Leon P, 'Mining sector needs a strong dose of Ramaphosa's Eskom treatment', *Business Day*, 5 February 2018, <https://www.businesslive.co.za/bd/opinion/2018-02-05-mining-sector-needs-a-strong-dose-of-ramaphosas-eskom-treatment/>, accessed 20 February 2018.

76 This idea is most succinctly communicated by Hausmann R, 'The real raw material of wealth', *Project Syndicate*, 26 July 2014, <https://www.project-syndicate.org/commentary/ricardo-hausmann-advises-poor-countries-not-to-focus-solely-on-adding-value-to-natural-resource-exports>, accessed 20 February 2018.

77 Acemoglu D & JA Robinson, 'Economic backwardness in political perspective', *American Political Science Review*, 100, 1, 2006, pp. 115–31.

and our ecosystem.⁷⁸ Strategic minerals and metals should therefore be those required for building smartphones, solar panels, batteries, wind turbines, electric vehicles, drones, robots and so forth.

Third, orientating policies towards broad-based inclusion will produce positive political and economic development. This is not to argue for the adoption of some decontextualised 'best practice' blueprint, but rather for policies that are incentive-compatible with the distribution of power. However, these must not entrench economic backwardness to protect political privilege. For instance, crafting smart policies to include artisanal miners in the formal economy is crucial to improving their welfare and reducing the latent negative effects of informal mining. The adoption of simple technologies such as retorts in places like Tanzania will have significant latent benefits. Moreover, proper digital mapping (using drones) and an online cadastre system to show exactly where licences have been allocated will help to zone land specifically for ASM use and in turn reduce land conflict between large- and small-scale miners.

Fourth, building tools to help governments manage sensitive trade-offs remains a critical governance imperative. Mining in sensitive areas such as coastal zones or protected areas, or even the seabed,⁷⁹ may not be worth the environmental cost, especially if its effects are irreversible. Ultimately, humanity cannot breathe titanium, and will not be able to breathe at all if we damage our planet's carbon sinks and oxygen generators through mining for materials that may make production and consumption more convenient but are unnecessary. Valuing wilderness landscapes appropriately will therefore remain an ongoing governance challenge, even in a world that benefits from the potentially positive environmental effects of the Fourth Industrial Revolution's confluence of new technologies.

Finally, some countries (like Botswana) where mineral rents are declining will have to adapt to becoming post-mining economies. While certain industries (such as diamond cutting and polishing) can be developed (as is happening), it may not prove to be a comparative advantage in the long run (or beyond having the resources at hand without transport costs). Having one of the last major wilderness landscapes on the planet, however, is a resource that governments are going to have to protect at all costs, and from which they can generate sustainable tourism revenue.

78 See Harvey R, 'Book review: *The Silent Epidemic: Coal and the Hidden Threat to Health* by Alan Lockwood', *LSE Review of Books*, 7 February 2013, <http://blogs.lse.ac.uk/lseviewofbooks/2013/02/07/book-review-the-silent-epidemic-coal-and-the-hidden-threat-to-health/>, accessed 20 February 2018.

79 See Benkenstein A, 'Seabed Mining: Lessons from the Namibian Experience', Policy Briefing, 87. Johannesburg: SAIIA, 2014; Naidoo P, 'Environmentalists warn against seabed mining in SA', *Moneyweb*, 11 December 2015, <https://www.moneyweb.co.za/news/industry/environmentalists-warn-against-seabed-mining-in-sa/>, accessed 20 February 2018.

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